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50 years of Estudios de Economía

Guest Editors:
José De Gregorio and Sebastián Edwards

CONTENT

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POLÍTICA EDITORIAL

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SPECIAL ISSUE

CONTENT

Departamento de Economía

Introduction to the Special Issue

José De Gregorio*
Sebastian Edwards**

The articles in this special issue of Estudios de Economía were presented at a conference held in Santiago, Chile, in August 2023, to celebrate the 50th anniversary of the journal. When planning the conference, we decided that the papers should cover the most important policy issues faced by Chile since the early 1970s. We wanted to have a "one stop" publication where most problems addressed by economists during this period could be found.

The fifty years between 1973 and 2023 were very significant for Chile. Possibly the most important half century in the country's history. In 1973, President Salvador Allende was overthrown in a coup d'etat led by General Augusto Pinochet. A 17-year dictatorship followed. During this period human rights were violated systematically. Also, these were the years when deep market-oriented economic reforms conceived by a group of economists known as the Chicago Boys were put in place. These reforms opened the economy to international trade, privatized scores of state-owned enterprises, created a capital market, introduced a pension system based on individual savings accounts, and introduced market elements in the education and health sectors. In 1989, towards the end of the dictatorship, the central bank was granted independence. This period has generally been known as Chile's "neoliberal experiment."

The dictatorship came to an end in 1989, when Patricio Aylwin was elected president. During the years that followed further market liberalization reforms were undertaken by successive democratic governments, and a sturdy social safety net was put in place. During the 1990s Chile grew at an average rate of almost 7% per year, the incidence of poverty was reduced from 50 to 8 percent, and inflation declined to the 3% annual mark. These were the years of the "Chilean miracle."

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In the early 2010's the economy slowed down and social protests sprag up. Students and pensioners demonstrated and demanded changes in economic policy. Many called for ending "neoliberalism." In October 2019 the country went through a popular and violent uprising. This was considered by international observers as a major paradox. Why was the most successful country in Latin America subject to such violent protests? This question has become an area of research for economists, sociologists, cultural anthropologists, political scientists and other scholars.

In this issue of the journal the papers are presented by themes. The opening paper by Luigi Zingales was the keynote lecture at the conference and deals with market structures and competition. Comments on Zingales by Kevin Cowan and Alejandro Micco follow. The next two papers by Gonzalo Salinas and by Roberto Alvarez and Eugenia Andreasen focus on international trade and the effects of Chile's liberalization policies. Elías Albagli, Agustín Arias and Markus Kirchner deal with Chile's unique pension system based on individual savings accounts. Sebastian Edwards provides a historical analysis on initial conditions in the half century under study. He analyzes the inflationary dynamics during Salvador Allende's government (1970-1973). Andrés Velasco and Robert Funk develop a model of social unrest in Chile to explain the 2019 revolt. The three papers that follow – by Richard Blundell, Vicente Corral and Andrés Gómez-Lobo; José De Gregorio and Manuel Taboada; and by Catalina Morales, Cristina Riquelme and Sergio Urzúa – deal with labor markets, labor income and income distribution. The final piece by Rafael Novella and Andrea Repetto analyzes economic behavior and decision making by Chile's younger generations. Every one of the papers published went through the journal's customary refereeing process. We thank the referees and the discussants during the conference.

Of course, we are aware that despite our efforts not every topic of importance was covered. For instance, key issues such as the environment, mining, innovation and trade in services, just to mention a few, are missing. We are already planning a conference for the journal's 75th anniversary when we promise that those topics will be tackled in great detail.

Finally, we want to thank the journal's editor Professor Rómulo Chumacero for his support and, especially, for his patience.

September 2024

Half a century of Estudios de Economía

Rómulo A. Chumacero*

Fifty years ago, the Department of Economics at the University of Chile embarked on a remarkable journey by launching the first issue of *Estudios de Economía*. The original vision of the journal was to serve as a platform for the dissemination of empirical research, primarily focused on the Chilean economy. Over the past five decades, the journal has undergone a significant transformation, evolving into a truly international publication that presents theoretical and empirical research at the frontier of the discipline.

From its inception, *Estudios de Economía* has been a witness to and participant in the evolution of economic thought in Chile and around the world. It has documented the major economic events, challenges, and reforms that have shaped Chilean society, while also broadening its focus to address global issues in economics.

Today, after publishing over six hundred papers, *Estudios de Economía* has established itself as a prominent journal in the field of economics. It is no longer confined to Chilean research; approximately one-third of submissions come from Europe, one-third from the Americas, and the remaining third from other regions of the world. This international reach has greatly enriched the journal, enabling it to serve as a forum for diverse perspectives on a wide range of economic issues.

Before the term "Open Access" became fashionable, *Estudios de Economía* was already making its research freely available. Early on, the journal adopted the internet as a means of disseminating its publications, and today all papers published since the journal's inception can be freely accessed on our website.[1] This commitment to open access has allowed the journal to contribute to the dissemination of knowledge, ensuring that its research is available to economists, policymakers, and the general public around the world.

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1 https://www.estudiosdeeconomia.cl

One of the most significant milestones in the journal's history was achieving ISI (now Web of Science) status. This distinction places *Estudios de Economía* among the most reputable economics journals in the world. Currently, the journal is included in nearly all the major academic databases—Scielo, EBSCO, RePEc, Scopus, and others—further enhancing its visibility and impact in the field of economics.

The journal's success has been built upon the quality of its papers and the dedication of countless individuals. Our anonymous referees play a crucial role in maintaining the rigorous standards of our publications, offering timely and constructive feedback. I would also like to extend my sincere gratitude to the secretaries, executive editors, proof-readers, and the 28 editors who have served over the years. Their unwavering commitment has shaped *Estudios de Economía* into what it is today.

To mark the journal's half-century milestone, we have organized a special issue that honors the journal's origins by focusing on the Chilean economy. This issue not only pays homage to the journal's early focus on Chile but also acknowledges the international relevance of the Chilean economic experience. The issue covers various aspects of Chile's economic history, from its early economic reforms to its current challenges in the global economy.

While celebrating this anniversary, it is also essential to look ahead. As editor, I am optimistic about the future of *Estudios de Economía*. Although I may not be present to celebrate the journal's 100th anniversary, I am confident that it will continue to thrive, remaining at the forefront of academic discourse, adapting to new challenges and innovations in the field.

Our commitment to quality, innovation, and international collaboration will ensure that *Estudios de Economía* continues to provide valuable insights into the economic issues that shape our world. We look forward to another fifty years of excellence.

I would like to extend my heartfelt thanks to all the authors, commentators, and especially the guest editors who contributed to this special issue. Their dedication and contributions have made this celebration of fifty years a memorable and significant milestone.

Thank you for being a part of this journey.

Rómulo A. Chumacero
Editor, 1999–Present

The role of conglomerates in Chile*

LUIGI ZINGALES**

Abstract

In this article, I assess conglomerates in Chile have affected product market competition. The analysis starts with a review of the efficiency and rent-seeking for the existence of conglomerates. The prima facie evidence fails to find efficiency reasons for the existence of conglomerates in Chile, while it is compatible with rent-seeking explanations. For this reason, I analyze various rent-seeking explanations in detail. The evidence suggests that conglomerates in Chile enjoy and advantage in gaining political influence and market power and that this political influence and market power have the potential of distorting product market competition. I present a series of proposals to limit the rent-seeking dimensions of conglomerates.

Key words: *Conglomerates, Chile.*

JEL Classification: *D21, D40, D42*

* This article is based on a chapter of the report "Improving the competitiveness of the financial sector in Chile" financed by the Inter-American Development Bank. The data analysis has been conducted with the invaluable help of Gonzalo Valenzuela and – to a smaller extent – of Tamara Gallardo.

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Resumen

En este artículo, evalúo cómo los conglomerados en Chile han afectado la competencia en el mercado de productos. El análisis comienza con una revisión de las explicaciones basadas en razones de eficiencia y de "búsqueda de rentas" para la existencia de conglomerados. La evidencia prima facie no encuentra razones de eficiencia para la existencia de conglomerados en Chile, mientras que es compatible con explicaciones basadas en la búsqueda de rentas. Por esta razón, analizo en detalle varias explicaciones relacionadas con la búsqueda de rentas. La evidencia sugiere que los conglomerados en Chile disfrutan de una ventaja en la obtención de influencia política y poder de mercado, y que esta influencia política y poder de mercado tienen el potencial de distorsionar la competencia en el mercado de productos. Finalmente, presento una serie de propuestas para limitar las dimensiones de búsqueda de rentas de los conglomerados.

Palabras clave: *Conglomerados, Chile.*

Clasificación JEL: *D21, D40, D42*

Business groups—legally independent firms operating across diverse industries and tied together in various formal and informal ways—are pervasive throughout the world (La Porta et al. (1999)), especially in emerging markets (Khanna and Yafeh (2007)). One specific form of business groups is the "family-controlled pyramid," i.e., a group with a pyramidal structure of intercorporate ownership and a family firm at the apex. As Morck et al. (2005) show, this is the most common form of a business group around the world.

In this respect, the situation in Chile is not unusual. In 1999, business groups dominated the business sector. The top 50 groups controlled over 73% of the publicly traded companies and over 90% of their assets (Lefort and Walker (2000)). In 2019, the situation was not very different. The top 25 business groups by market capitalization controlled 20% of the publicly traded companies with more than \$100M of market capitalization and 63% of their value by market capitalization. If we exclude foreign-controlled companies, business groups represent 84% of the stock market capitalization of the Santiago Stock Exchange.[1] Most of these business groups are family controlled pyramids. Nevertheless, two groups (Sigdo Koppers and Camera Chilena de la Construción) do not have a family at the top of the pyramid.

[1] Calculations by the author as of the end of 2019.

In this article, we will try to assess the impact of the conglomerate form on the degree of product market competition in Chile. We will start the analysis with a review of the efficiency reasons (Section 1) and the rent-seeking ones (Section 2) for the existence of conglomerates. The prima facie evidence fail to find efficiency reasons for the existence of conglomerates in Chile, while it is compatible with the existence of rent-seeking reasons. For this reason, in Section 3 we analyze various rent-seeking explanations in details. The evidence suggests that conglomerate enjoy and advantage in gaining political influence and market power and that this political influence and market power have the potential of distorting product market competition. In Section 4, we present a series of proposals to limit the rent-seeking dimensions of conglomerates. Section 5 concludes.

1. Eefficient Reasons For Business Groups

The economic literature has long struggled to explain why firms choose to become conglomerates (see, for instance, Bebchuk (2012), Khanna and Yafeh (2007), Morck et al., 2005). While there is not an established grand theory, there is a long list of reasons why firms tend to organize themselves in groups. We will start here by reviewing these reasons, dividing them between "efficient" reasons (i.e., reasons that increase production efficiencies) and "rent-seeking" reasons (i.e., reasons that, while benefitting the group itself or its owners, do not add to production efficiency, but just enable the group or its owners to capture a larger share of the economic surplus).

Before doing so, it is important to distinguish between three related but different questions. The first is why firms operating in different industries are owned together in the form of a conglomerate. The second is why conglomerates take the form of pyramids in many countries, with several public-traded subsidiaries in the group. The third is why there tends to be just one family at the top of these pyramids. The first question has been greatly debated also in the U.S. context (for a survey see Maksimovic and Phillips (2013)). The second question is not debated in the U.S. context, because Franklin Delano Roosevelt in the 1930s greatly penalized multi-layer pyramids from a fiscal point of view, leading to their demise as an organizational form in the United States (Morck (2005)). Finally, the costs and benefits of family ownership are greatly debated also in the United States (for a survey on this topic, see Villalonga et al. (2015)).

In what follows, we will focus mostly on the first question, with only occasional references to the second and third. When we address the first question, we will use the terms conglomerate and business group interchangeably. When we address the second question, we will refer specifically to pyramids. In addressing the third, we will add the term "family-controlled pyramid."

1.1 Internal Capital Markets

One of the primary reasons for the existence of conglomerates is the presence of information asymmetries in financial markets, which make external financing more expensive than internal financing. It is not a coincidence that Myers and Majluf (1984), the seminal paper on this topic, was partly motivated by the Ph.D. dissertation of Nicholas Majluf (1978), a Chilean who was looking for a rationale for conglomerate mergers. In the presence of higher costs of external finance, a conglomerate can avoid paying the costs of financing externally by pooling cash flow across firms. A conglomerate can also engage in "winner picking," diverting resources allocated to marginally profitable investments towards the most profitable ones (Stein, 1997).

In the United States, industrial firms are de facto prohibited from owning banks, so the U.S. discussion on conglomerates ignores this aspect, which is paramount in all the other countries, where many conglomerates (especially the large ones) own a bank. If we ignore the possibility of abuses (which we will discuss momentarily), the presence of a bank in a group does not add another rationale for why groups exist, it simply strengthens the internal capital market argument.

1.2 Internal Laboral Markets

Informational asymmetries in the labor market can also justify the existence of conglomerates. If individual performance is not easily observable outside a firm, but can readily be observed inside a firm (and inside a group of firms), a conglomerate has an advantage in reallocating talents to the highest value use. It is the same idea of costly external finance, applied to the labor market. As for the external financial rationale, the labor market rationale is strongly dependent upon underdeveloped and inefficient labor markets. Both these rationales, especially the labor market one, are progressively losing their strengths as digital platforms aggregate more information that facilitates matching (e.g., the success of dating apps).

Note that the expectation of an inefficient labor market can easily lead to one. If the pool of managerial talents is small, most managers would prefer to do their careers internally, avoiding the external job market. Doing so makes the pool of available talents even shallower, generating a negative spiral that can keep the market underdeveloped for a long time.

1.3 Economies Of Scale

Economies of scale are often invoked to justify the existence of conglomerates. Economies of scale, however, arise from the increased quantity produced of one single product. By definition, conglomerates produce different products, so none of the traditional economics of scale would work here. Thus, unless we identify the nature of the economies of scale at the group level, assuming the existence of these synergies is tantamount to assuming the result, i.e., assuming what we try to explain.

The most obvious source of economies of scale in conglomerates is the existence of fixed administrative costs, which can be amortized on a broader set of products. For example, many firms in a conglomerate might need the service of an experienced patent lawyer, but none of the individual firms might have enough work to support a full-time patent lawyer: by dividing the cost of the patent lawyer, a conglomerate experiences lower average costs.

Note, however, that for this argument to make sense, no good patent lawyers should be available on the market. If there are, each firm could buy lawyers' services on the market, and there would be no economies of scale. Only if the market for patent lawyer services is missing, a conglomerate has a comparative advantage, because it has the scale to pay for the training of a lawyer in patent law and for retaining them in-house after the training, amortizing the cost of recruiting and training them. In sum, this form of the economies-of-scale hypothesis requires underdeveloped and inefficient labor markets, making it the same as the efficient internal labor market hypothesis.

1.4 Leverage a Scarce Resource

Business groups can also arise as a way to leverage a scarce resource, which cannot be transferred. As for economies of scale, this explanation can be convincing only if we are able to point out what this critical resource is.

An often-mentioned critical resource is entrepreneurial talent. To justify the existence of conglomerates, this talent cannot be industry-specific but must be portable across sectors. What is this talent, then? If it is a non-domain-specific innate skill, we should observe business groups everywhere in the world, since this skill should be equally distributed in the world population. Since we do not observe business groups in all countries, we should conclude that entrepreneurial talent is either an acquired skill or a skill specific to some institutional environments.

Two possibilities come to mind: either some reputation that might overcome the lack of contract enforceability in developing countries or some political connections. The first explanation seems suitable only for developing countries, while the second pertains to the rent-seeking theories of groups, which we will discuss in Section 2.2.

1.5 Improved Corporate Governance

The separation between ownership and control (Berle and Means (1932)) intrinsic to publicly traded firms generates important agency costs (Jensen and Meckling (1976)). In the United States, the last forty years have seen the rise and the diffusion of alternative corporate governance arrangements to mitigate these costs. Private equity funds, for instance, control a portfolio of diversified firms to improve their performance (Baker and Smith (1998)). In some sense, these private equity funds are similar to conglomerates. The main differences are i) the temporary nature of the arrangement (private equity funds have a predetermined life, generally ten years), ii) the hand-off approach vis-a-vis operating decisions maintained by private equity funds; 3) and the presence at the top of the conglomerate of experienced managers with a consolidated track record, not family members.

The rise of these "business groups" in the United States highlights the existence of some corporate governance benefits. The combination of concentrated ownership, massive use of leverage, and high-power incentive schemes can help mitigate the agency costs of the separation between ownership and control. One question that is not fully resolved is why this combination of concentrated ownership, leverage, and high power incentives necessitates a private equity fund at the top. In the early 1980s, at the beginning of the LBO wave, it was conceivable that the techniques to run a firm under those extreme conditions were not well known, and thus, only a small number of boutique firms knew how to do it. Almost forty years later, this hypothesis is untenable. Thus, the most plausible explanation is that individual LBO firms need a private equity fund at the top to mitigate the costs of financial distress. Those costs do not include only bankruptcy costs, but the cost of operating a firm under the severe risk of bankruptcy. When a firm risks going under, employees are reluctant to come and work for the firm and are eager to leave. Customers might be reluctant to buy, and suppliers to supply goods on credit.

In sum, the role of a private equity fund at the top of a group is to reassure the various stakeholders that highly levered but economically viable firms will survive idiosyncratic financial shocks. Their role is to provide financial resources to portfolio companies under a financial shock if and only if they are economically viable, as KKR did with RJR Nabisco in the early 1990s (Andrews (1992)). To play this role, private equity fund managers should have access to significant amounts of liquid resources and should be highly incentivized to deploy these resources only if they can be profitably employed (i.e., they do not have other financial or non-financial interests to keep the firm alive). Since limited liability constrains the power of incentive schemes, the general managers of a private equity fund should post a bond, in the form of a large amount of their own capital or their reputation, which they will lose in case of failure. Private equity fund managers generally post their reputation: if they mismanage their funds, they will have a hard time raising future funds, losing millions in future fees.

It is not easy to map the family holdings at the top of a family-controlled pyramid into a private equity fund. First, control is allocated based on bloodline, not skills. Second, the vertex of family-controlled pyramids is not as cash-rich as private equity funds. Third, unlike private equity fund managers, family members have many non-economic reasons to keep failed firms in the pyramid alive.

1.6 Can Efficiency Reasons Justify Chilean Conglomerates?

While the costly external finance rationale might have applied to the United States in the 1960s, and it may still apply to many developing countries today, it is hard to imagine that it might be relevant to the United States or even Chile today. In fact, Khanna and Palepu (2000) document that in the 1990s, the accounting profit premium enjoyed by Chilean companies belonging to a conglomerate declined as economic reforms further developed Chilean capital markets, suggesting that as Chile finalized the formation of efficient capital markets, this rationale might have disappeared.

There is some evidence in Chile for the "internal labor market" rationale. Huneeus et al. (2021) find that following an international shock, there is more labor reallocation among firms in the same group than among unaffiliated firms, particularly among top workers. In spite of this evidence, it is hard to imagine this can be a first-order effect in Chile. First, the Chilean labor market is fairly developed. Second, the managerial labor market is fairly integrated also with the rest of Latin America, especially the Spanish-speaking part. Thus, the pool of talents is not so small.

When it comes to economies of scale, a possible relevant economy of scale for Chilean firms is access to international capital markets. Chile is a relatively small country, with an economy that is not very diversified. As a result, the Chilean equity market contains a significant amount of risk that can be diversified internationally. If by tapping international capital markets a Chilean firm can significantly reduce its cost of capital, then we might have an important economy of scale, since a minimum size is needed to tap the international capital markets. Can this rationale explain the existence of Chilean conglomerates?

Once again, this hypothesis relies on financial frictions: is it costly for the marginal investor in the international capital market to invest in small Chilean companies? Historically, when American equity markets were dominated by individual investors, this assumption made much sense. You would not expect individual investors to pay the information costs and invest in small Chilean companies. Today, however, equity investing is dominated by institutions, in particular index funds. If individual investors buy Chilean index funds or international equity funds that invest in Chile, they do not need to know about the small companies included in the index, and they will invest in them automatically. Of course, indexation does not eliminate all the frictions. Very small Chilean companies would still be excluded from the index. Yet, the scale level at which these economies are realized is much lower, and Chilean companies do not necessarily have to diversify to achieve this scale.

The minimum scale argument is more realistic for the international bond market. It is unlikely that a small Chilean company, even if publicly traded, could access the international bond market. Even if it does, Calomiris et al. (2022) find an increased willingness of international investors to purchase emerging market bonds included in bond indexes, which require a minimum face value of $500 million. That level will cut out all but the largest Chilean companies.

Yet, we do not see why financial institutions cannot arbitrage this difference by issuing bonds in the international markets and lending the proceeds in the Chilean market. This is just an application of the general finance insight that financial intermediaries can more effectively exploit every financial arbitrage by themselves without requiring a change in the ownership structure of non-financial companies.

Prima facie, the corporate governance rationale seems more convincing for Chile. Chilean business groups can be seen as private equity funds, where the family at the top puts its wealth at risk. Obviously, the family at the top also puts its reputation at risk, but this reputation is less of a constraint than for typical private equity funds since these families are not in the business of raising multibillion-dollar funds every two or three years like private equity partners do.

While appealing, this analogy with PE does not fit the Chilean business groups' data very well. Subsidiaries in Chilean business groups are not highly leveraged as portfolio companies in private equity funds, and their managers are not so highly incentivized. The lack of a pre-determined time horizon and the access to plenty of financial resources through group-owned banks also hurt Chilean group incentives to finance portfolio companies only when they are viable. In fact, they might have an incentive to continue financing even when they are not viable to avoid negative reputational spillovers on the rest of the group.

Even if Chilean business groups were true analogs of private equity funds, as the private equity model is spreading around the world, it is not obvious what the comparative advantages of traditional Chilean groups are vis-à-vis private equity groups today. Notice that private equity groups select the leaders on the basis of past successes, while family control pyramids choose them based on bloodline. Thus, on average the former structure should be much more efficient than the latter.

In sum, none of the efficiency reasons for the existence of conglomerates, with the possible exception of the internal labor market, seems to apply well to Chile. We now consider rent-seeking explanations.

2. Ent-seeking Reasons for Business Groups

Besides efficiency reasons, the economic and business literature has identified many rent-seeking reasons for the existence of business groups. We are now turning to those.

2.1 Financial Benefits

In the previous section, we discussed the various efficiency reasons why a conglomerate might enjoy some benefits on the cost-of-capital front. Here, we are going to review why some financial benefits may come from exploiting minority investors, depositors, or government guarantees.

The first such advantage is the implicit government guarantee enjoyed by large companies, the famous too-big-to-fail. This benefit, however, comes with size, not with having a diversified group. It is an open question whether the political cost of letting a big firm fail is larger if this firm is concentrated in one sector or if it is diversified across sectors. On the one hand, a large firm concentrated in a single sector will generate a more than proportionally larger disruption in that sector. On the other hand, a smaller disruption across sectors will involve more voters. The answer depends upon the nature of the sector and its interconnectedness with other sectors. For example, the banking sector is interconnected with all the other sectors, and thus large firms in that sector (i.e., large banks) are traditionally considered too-big-to fail.

Conglomerates can also exploit the implicit government guarantee on bank deposits very effectively. By lending too much and too cheaply to their affiliates, banks belonging to conglomerates are more prone to failure. This is one of the main reasons why the United States severely restricts industrial firms from gaining any control over banks.

Finally, pyramids can take advantage of their minority investors by transferring value from companies where they have fewer cash flow rights to companies where they have more, a phenomenon first identified by Zingales (1994) and later labeled "tunneling" by Johnson, La Porta, Lopez-de-Silanes, and Shleifer (2000).

2.2 Financial Benefits

The most obvious rent-seeking reason why business groups might arise is to facilitate collusion (explicit or implicit) and increase market power. This facilitation can occur through three distinct channels. First, common ownership, a point first raised some years ago by Rotemberg (1984) and emphasized recently by Azar et al. (2018). Since business groups bring competitors under the control or influence of a single entity, firms belonging to a business group will compete less aggressively against each other.

Second, is the so-called multi-market contact hypothesis. This hypothesis was first advanced by Edwards (1955) and later formalized by Bernheim and Whinston (1990). The idea is that sellers' ability to raise and sustain prices above the competitive level increases when sellers interact in other markets. These other markets can be geographically distinct markets for the same product or the same geographic market for different products, as will occur with conglomerates. Edwards (1955) emphasized the increased ability to collude formally provided by a conglomerate, while Bernheim and Whinston (1990) have a game-theoretic model showing how the pooling of two (or more) incentive-compatibility constraints makes it easier to sustain "cooperation" (i.e., tacit collusion). Note that the more numerous the contact points are, the greater the incentives to collude. Interestingly, there is not much empirical research on this point. Nevertheless, by using FTC line-of-business data Scott (1982) finds that profits in concentrated industries are significantly higher when multimarket contact is high.

The third reason is that conglomerates might reduce the number of entrants in a market. They might reduce the entrant because the conglomerate itself would have most likely entered the market if it was unable to buy an incumbent. This effect is particularly important in sectors that require significant capital and specific expertise. Yet, the most important effect is probably the ability of a conglomerate to jeopardize the entry of other independent firms. To enter the market, a novel firm needs to pool many resources: energy, financing, technology, managerial expertise, etc. If these inputs are supplied in imperfectly competitive markets, an incumbent in any of these input markets can easily jeopardize entry into the output market by refusing to provide their services. But will an incumbent use its market power to prevent entry into another sector? An independent supplier would always prefer to exercise its market power through higher prices than through reduced supply. However, a supplier part of a conglomerate will act strategically and compare the profits lost by not supplying the input with the reduced probability that the new entrant will enter and compete away part of the conglomerate's profits in the output market. Thus, refusing to supply might be the profit-maximizing strategy for a conglomerate. This effect is true in general, but it is particularly true when a conglomerate owns a bank. The incentive of a bank to finance possible entrants in an industry where these entrants will compete with firms belonging to the conglomerate is significantly reduced (see Saidi and Streitz (2021) and De Franco et al. (2022)).

Note that this effect might work even when conglomerate firms do not ever deny services to anybody, as long as new entrants fear this might be the case. For example, a new brewery company might fear that Banco de Chile will not provide financing because Banco de Chile is controlled by the Lukisc Group, which owns CCU, a large brewery. This fear might discourage entry or induce the new entrant to accept very expensive financing from another bank, which is perceived as the only alternative. In both cases, entry is jeopardized without Banco de Chile doing anything: the mere possibility is sufficient to produce distortions.

This explanation can account for a feature observed in many markets: once the top industrialists create their own conglomerates, all the other entrepreneurs organize themselves in conglomerates. The reason is that, when they are organized in a conglomerate form, the largest incumbents have the ability and the incentives to use their control of critical resources (energy, technology, financing) to block new entrants by withholding supply of those critical resources. To protect themselves against this risk, new entrants need to be present in multiple markets contemporaneously in order to secure independent access to those resources to survive. As a result, they structure themselves as a conglomerate.

The conglomerate structure of Chilean industry might also explain why the often-repeated mantra that national industry concentration does not matter as long as the country is open to foreign competition might not hold in Chile. If the three main conglomerates get a hold of exclusive import rights from the main international producers, they can easily maintain a collusive equilibrium even in the presence of foreign competition, especially in a small country like Chile, where foreign competitors are not willing to invest major resources to penetrate.

2.3 Political Power

The political power of a group comes from three sources. First, it is its ability to pay for campaign donations and lobbying. Second is the ability to mobilize consensus in favor or against a candidate or policy. Third is the ability of a business group to reward or punish politicians, regulators, and judges from a financial and reputational point of view.

Since Chile is a country with low corruption and a strong rule of law, we limit ourselves to acquisitions of political power in this context. The political game is played differently in countries where corruption is rampant and physical violence diffused (see, for example, Dal Bo et al., 2006).

When there are legal restrictions to campaign financing, there are no economics of scale in campaign financing, since all firms beyond a minimum threshold have equal ability to finance candidates. For lobbying, there are no legal restrictions. Still, the amount of money firms spend on lobbying is not prohibitive. In the United States, the top lobbyists in 2020 were Blue Cross Blue Shield ($23M), Facebook ($20M), and Amazon ($19M). While significant, the amounts spent are not out of reach for most large firms. Thus, the first source of political power does not justify why firms need to grow past a certain threshold.

In general, the ability to mobilize consensus is proportional to the size of a group, size measured in terms of workers, profits, and resources. Workers bring votes, profits bring resources to the coffers of the local authorities, and other critical resources (like earthmovers after an earthquake) can be mobilized to generate consensus. Nevertheless, in a small country, where most markets are limited in size, achieving a large size almost inevitably means becoming a conglomerate.

The third source of corporate power is directly linked to being diversified. The ability to reward and punish depends crucially on being present in many different parts of the economy. Consider for instance the ability to ostracize (and thus ruin the career of) a regulator. In principle, a lawyer can work in many sectors, but if a conglomerate has a significant presence and a significant influence in all the major sectors where a talented regulator can work, the power to ostracize them is much bigger. The same can be said for the power to reward in nonmonetary ways. Sometimes there are restrictions to revolving doors in the same industry. Even when there are no restrictions, the move of a central banker to the board of one of the banks they used to regulate is frowned upon. It is much better if they are offered the same lucrative position in an unrelated business. The substance is the same if the unrelated business is part of the same group, but the optics are saved.

Not only are diversified groups more able to influence the political system, but they are also more able to extract benefits from the state. The best political deals are often triangulation and more diversified groups can triangulate better.

2.4 Can Rent-Seeking Reasons Justify The Existence Of Chilean Conglomerates?

We start by analyzing the rent-seeking financial benefits. During the 1981-82 crisis, most of the banks affiliated with a conglomerate failed and were taken over by the government. Thus, the implicit government guarantee for large banks is alive and well in Chile and can be a major source of comparative advantage for conglomerates that own a bank. We suspect the same too-big-to-fail problem applies to large conglomerates, regardless of the presence of a major bank in the group.

We cannot exclude the tunneling hypothesis either. While Chile does well in terms of the rule of law, historically, it has not done great in terms of protecting minority investors. As Dyck and Zingales (2004) argue, a good indicator of this ability to tunnel is the premium paid in control block transactions. Chile, with a 15% block premium, does not perform very well on this front. It is true that the Dyck and Zingales (2004) data are from the end of the 1990s, yet lacking more recent evidence of the contrary, we cannot rule out tunneling as a potential explanation for Chilean business groups.

The risk that conglomerate might facilitate collusion is particularly severe in Chile, where many of the businesses controlled by conglomerates are very highly concentrated to begin with. As Matamala (2015) writes "En las farmacias, tres cadenas (Cruz Verde, Fasa y Salcobrand) concentran el 95% de las ventas. En los bancos, cuatro compañías (Chile, Santander, Estado y BCI) suman el 65% de las colocaciones. El transporte aéreo nacional está en un 74% en manos de una sola compañía (Lan). Tres proveedores de telefonía móvil (Movistar, Entel y Claro) se reparten el 97% del mercado. Dos productores de pollos (Súper Pollo y Ariztía) acumulan el 71% de las ventas. CCU y Capel acaparan el 69% de las ventas de licores. British American Tobacco Chile (BAT Chile) tiene el 95% del mercado de los cigarrillos. CCU, el 87% en las cervezas. Y la generación eléctrica se concentra en 74% entre Endesa, Colbún y Gener."

Finally, the political rationale for the existence of conglomerates seems particularly plausible in Chile, given the size of the country and the closeness of its elite (Zimmerman, 2019). As Braun (2019) said, "Chile is not a country, it is a country club."

This preliminary analysis suggests that rent-seeking rationales might be more relevant to explaining the diffusion of conglomerates in Chile than efficiency ones. For this reason, we move to analyze these in greater detail.

3. A Deeper Analysis Of The Rent-seeking Motives

As our conglomerate sample, we use the top 25 economic groups by market capitalization at the end of 2019 from "Ranking de Riqueza de Grupos Económicos" generated by the Universidad del Desarrollo.[2] Table 1 reports the names of these groups, their market capitalization, and whether a bank is present in the group.

TABLE 1
MAIN BUSINESS GROUPS IN 2019

GROUP	STOCK MARKET CAP. (BILLIONS CLP)	BANK
Luksic	7,979	Banco de Chile
Solari	4,711	Falabella
Matte	4,522	Banco BICE
Yarur	3,056	Banco BCI
Angelini	2,609	-
Ponce Leru	1,882	-
Paulmann	1,509	
Cueto	1,182	-
Saieh	1,084	Itau - Corpbanca
Said	912	ScotiaBank
Sigdo Koppers S.A	787	-
Guilisasti – Larraín	560	-
CChC	554	Bank Internacional
Fernandez Leon	554	Banco Consorcio
Security	527	Bank Security

2 https://ceen.udd.cl/estudios-y-publicaciones/ranking-de-riqueza-de-grupos-economicos/.

Claro	401	-
Swett	357	-
Bofill	356	-
Hurtado Vicuña	350	Banco Consorcio
CGE	344	-
Multiexport Foods	287	-
Calderon	280	Ripley
Vicuña	274	-
Navarro	256	-
Gras Diaz	164	-

3.1 Financial Benefits

As we discussed, one opportunistic source of financial benefits is related to the possibility that conglomerate banks have to charge less for loans extended to other affiliates of the group. For this to be true, a business group must control a bank. As Table 1 shows, 11 of the top 25 groups had an affiliated bank in 2019. Thus, exploiting financial benefits can be a reason for the existence of some Chilean business groups, but not for all.

A more formal test of this theory would compare the interest rate group banks charge to firms affiliated with the same group (related lending) with the interest rate the same firms pay for loans extended by non-group banks. If group-affiliated firms only borrow from group banks, then the test would have to be done comparing the rate with the rate that other non-affiliated firms in the same sector (and with the same characteristics) pay for their loans.

Given the confidentiality requirements, we were able to perform only a very rough version of the second test by using some survey data. For this purpose, we use the Longitudinal Survey of Companies (ELE), carried out every two years by the National Institute of Statistics and the Ministry of Economy.[3] The only form of risk control we have available is the size of the firm. Micro are firms with annual sales between \$28K and \$84K, Small1 between \$84K and \$175K, Small 2 between \$175K and \$875K, Medium between \$875K and \$3.5M, and Big above \$3.5M[4].

3 https://www.ine.cl/estadisticas/economia/ciencia-y-tecnologia/encuesta-longitudinal-de-empresas.

4 The cutoffs are set in *unidades de fomento*, we translated them in dollar at an exchange rate of \$35 per unidad de foment.

Figures 1 –3 report the results of our analysis, in which we dropped a category if there were fewer than three respondents in that category. Figure 1 suggests that there is no evidence that firms affiliated with a conglomerate are paying less for their loans. This comparison is rough since we are not controlling for the intrinsic risks of the two groups of firms, except for the component of risk correlated with size.

Very often, discrimination in credit takes place through availability, not rates. Thus, Figure 2 looks at differences in the number of banks that a firm needs to consult before accessing credit. If anything, firms affiliated with a conglomerate seem to consult more banks than firms not affiliated with a conglomerate. Yet, it is difficult to draw a conclusion. It is possible that firms that are part of a group are required by the parent company to consult with more banks to get a better rate. It is also possible that conglomerate firms, knowing they will get credit anyway from the affiliate bank, are more willing to shop around for a better rate. In contrast, non-conglomerate firms, fearing they will not get funded, accept the first offer they receive.

FIGURE 1
INTEREST RATES COMPARISON BETWEEN CONGLOMERATE AND NON-CONGLOMERATE

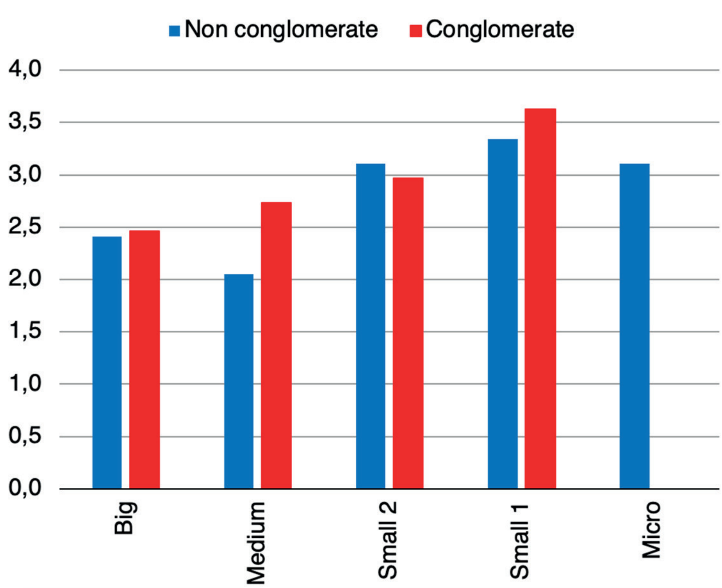


FIGURE 2
MEAN NUMBER OF BANKS CONSULTED FOR A CREDIT

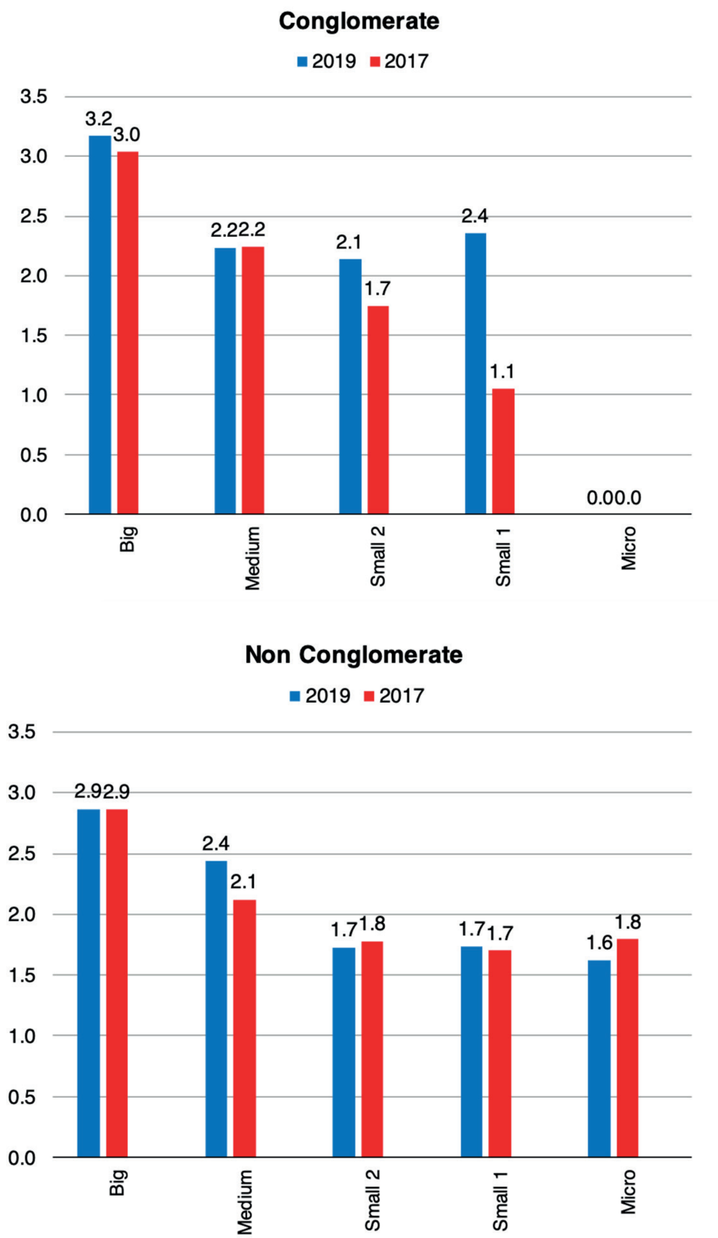
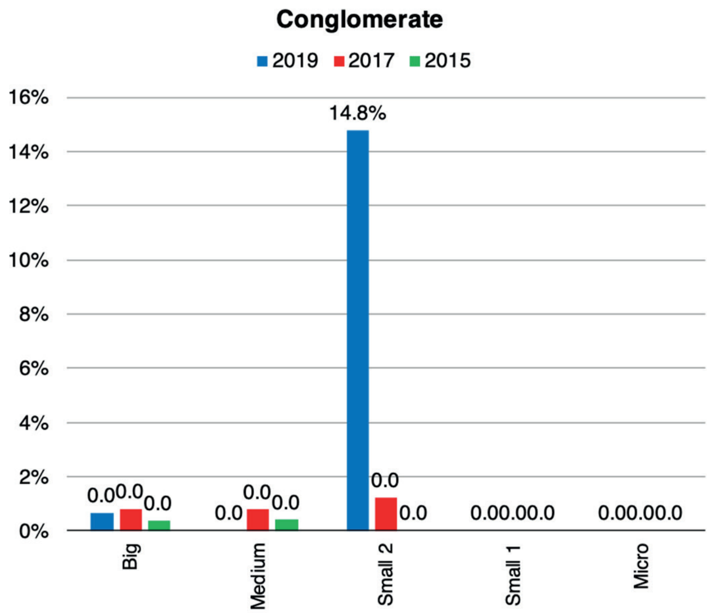
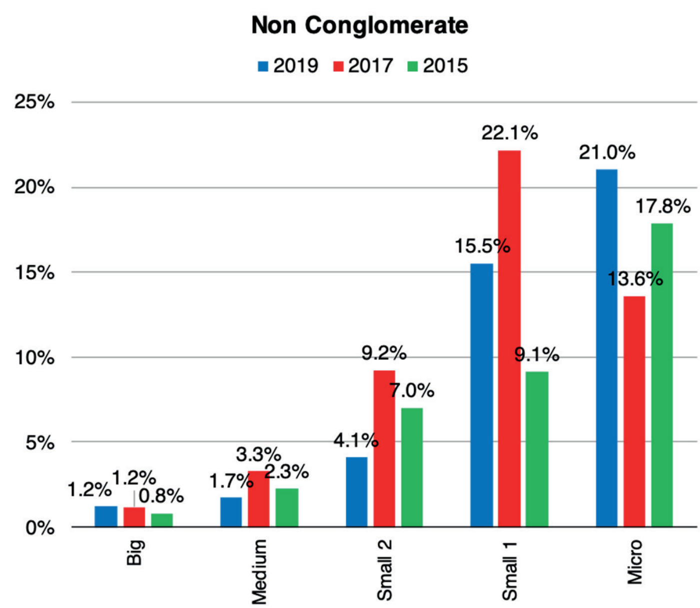


FIGURE 3
REJECTION RATE





Thus, the ultimate test is whether conglomerate firms are less likely to be rejected for credit. The evidence (Table 3) seems to confirm this hypothesis. With the exception of one group in one year, conglomerate firms have always had much lower rejection rates than non-conglomerate firms.

The CMF confirmed with us that it monitors related lending and finds no difference in the rates between affiliated and non-affiliated firms. The evidence above, however, suggests that there might be important differences in availability. Since the availability of credit is a very important competitive advantage, it would be important that the CMF monitor this aspect as well. At the same time, the CMF should monitor possible differences in the quantity of credit granted to affiliated firms versus non-affiliated firms.

Finally, there is another test the CMF should perform: whether there is any quid-pro-quo among conglomerate banks. It would be easy for the bank of Conglomerate A to lend at a favorable rate to a firm in Conglomerate B if the bank in Conglomerate B was returning the favor with a firm affiliated with Conglomerate A.

3.2 Multi-Market Contacts

If one of the main reasons why business groups exist is because multi-market contacts facilitate collusion, we should observe three phenomena. First, business groups should have several overlaps in their lines of business. Second, when these overlaps exist prices (or ideally mark-ups) should be particularly high. Third, these areas of multimarket contact should be more likely to be sanctioned by the Fiscalía Nacional Económica (FNE) for collusion.

Let's start with the first test. Once again, we use the Universidad del Desarrollo data to have an objective sample. We identified the main industries ourselves based on public sources, so we might have missed some smaller sectors of specialization. The results are reported in Figure 1.

TABLE 2

INDUSTRY DIVERSIFICATION OF MAIN BUSINESS GROUPS IN 2019[5]

Group	Industries
Luksic	Banking, Brewry, Cable Manufacturing, Fuel Distribution, Mining, Ports, Shipping, Transportation, TV, Wine
Solari	Airline, Banking, Media, Home Improvement, Retailing, Shipping, Transportation,Water
Matte	Banking, Construction, Communication, Electricity, Forestry, Tissue Paper
Yarur	Banking, Insurance
Angelini	Construction, Fisheries, Forestry, Gas distribution, Hotel
Ponce Leru	Mining
Paulmann	Retailing, Shopping Malls, Home Improvements.
Cueto	Airline
Saieh	Banking, Home Improvements, Retailing,
Said	Banking, Bottling, Shopping Malls, Real Estate
Sigdo Koppers	Chemestry, Construction, Explosive, Mining equipment, Transportation and logistic
Guilisasti-Larrain	Food, Wine
Cchc	AFP, Health, Insurance, Transportation and logistic
Femandez Leon	Banking, Mining, Telecomunication
Security	Banking and Insurance
Claro	Agriculture, Glass, Metal
Bofill	Agriculture, Food
Hurtado Vicuña	Banking
CGE	Electricity
Multiexport Foods	Agricolture
Calderon	Banking, Retailing. Shopping Malls
Vicuña	
Navarro	AFP, Software
Gras Diaz	Construction , Real estate

5 "Ranking de Riqueza de Grupos Económicos" does not have information about the specific companies of the conglomerate. All the information in the table is a result of our own investigation, based on public information. We could not identify any of the companies of the Vicuna group.

If we exclude Banking and Insurance, two sectors with natural synergies, and Retail and Shopping Malls, two other sectors with natural synergies, there does not seem to be a lot of overlapping among industries present in Chilean groups. The most remarkable one is Banking and Retailing, where the Solari, Saieh and Calderon Groups are all present.

It is very difficult to identify tacit collusion. A sign consistent with tacit collusion is high prices (at least high relative to costs). For this purpose, we use Numbeo, the world's largest cost-of-living database, to compare the prices of some basic items in Chile and in surrounding Latin American countries (excluding Argentina, since inflation makes the revelation of prices more difficult there).[6] We do this in Table 3. The prices were collected in April 2022.

When translated into dollars, prices of items purchased in supermarkets are on average 10% more expensive in Chile than in the rest of Latin America. This difference might reflect higher distribution costs in Chile. Yet, items sold in department stores are 13% cheaper in Chile vis-à-vis the rest of Latin America. While this evidence is consistent with possible collusion, it is certainly not evidence sufficient to infer collusion.

It is worrisome, however, that the Fiscalia Nacional Economica has recently found evidence of collusion in the supermarket sector. The Chilean Competition Tribunal (TDLC) found that between 2008 and 2011, Cencosud (Paulmann), SMU (Saieh) and Walmart, which together control 92.5% of the supermarket category in Chile, "consciously adhered to a common scheme that substituted the risks of competition for a practical cooperation between them", in order to "regulate the market" and "prevent a price war".[7]

Interestingly, this scheme was discovered by accident when the FNE was investigating collusion between fresh chicken producers. The investigations revealed that "the supermarket chains constantly monitored the prices at which their competitors were selling fresh chicken to the public, through their internal staff and through external companies specifically hired for this purpose."[8] The extreme concentration of the sector facilitates collusion even in the absence of multimarket contacts, but the combination between the two is very concerning.

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6 https://www.numbeo.com/cost-of-living/

7 https://www.fne.gob.cl/en/tdlc-acoge-requerimiento-de-la-fne-sancionando-a-cencosud-smu-y-walmart-por-colusion-en-el-mercado-de-la-carne-de-pollo-fresca/

8 https://www.fne.gob.cl/en/tdlc-acoge-requerimiento-de-la-fne-sancionando-a-cencosud-smu-y-walmart-por-colusion-en-el-mercado-de-la-carne-de-pollo-fresca/

TABLE 3

PRICES IN CHILE VS. REST OF LATIN AMERICA (IN US$)

Supermarket Items	**Average**		**%**
	Chile	**Latam**	**difference**
Milk (regular) (1 liter)	1.08	0.98	10%
Loaf of Fresh White Bread (500g)	1.10	1.42	-23%
Rice (white) (1kg)	1.34	1.19	13%
Eges (regular) (12)	2.75	1.77	55%
Local Cheese (1kg)	8.93	5.48	63%
Chicken Fillets (1kg)	5.04	4.80	5%
Beef Round (1kg)	9.10	6.91	32%
Apples (1kg)	1.64	2.41	-32%
Banana (1kg)	1.30	1.16	12%
Oranges (1kg)	1.52	1.31	16%
Tomato (1kg)	1.53	1.43	7%
Potato (1kg)	1.04	1.17	-11%
Onion (1kg)	1.25	1.19	5%
Lettuce (1 head)	1.01	0.79	28%
Water (1,5 liter bottle)	1.14	0.91	25%
Bottle of Wine (Mid-Range)	5.18	7.78	-33%
Domestic Beer (0,5 liter bottle)	1.36	1.16	17%
Imported Beer (0,33 liter bottle)	2.15	1.97	9%
Cigarettes 20 Pack (Marlboro)	5.18	3.34	55%
Department Store Items			
1 Pair of Jeans (Levis 501 Or Similar)	48.37	47.948	1%
1 Summer Dress in a Chain Store	27.65	36.224	-24%
1 Pair of Nike Running Shoes (Mid-Range)	55.95	76.016	-26%
1 Pair of Men Leather Business Shoes	71.34	72.219	-1%

Source: https://www.numbeo.com/cost-of-living/

3.3 Family Cross-Directorship

One of the major concerns about the complicated and non-transparent structure of ownership is the possibility of common ownership that might reduce, if not eliminate, the incentives of rival firms to compete. As we stated earlier, it was impossible for us to analyze the structure of ultimate ownership. Thus, this problem might exist, but we have no evidence. What we could analyze was the possibility of interlocking directorships.

Section 8 of the U.S. Clayton Act prohibits any person from simultaneously serving as an officer or on the board of directors of competing corporations. A similar law has existed in Chile since 1973 (Decree-Law No. 211 of 1973) and was strengthened in 2016 (Law No. 20,945). Given the group structure of Chilean corporations the risk of interlocking directorship, however, is greater. If one member of family A serves on the board of one company of conglomerate B and one member of family B serves on the board of a company of an affiliate of conglomerate A, we might have a de fact interlocking situation, while not de jure. For this reason, we decided to analyze how diffuse this problem is.

For each group, we identified a patriarch and we determined the next generations (including spouses) up to today by using a combination of a genealogy website,[9] Wikipedia, and newspapers.

We then used the CMF database of all directors in companies supervised by the CMF, with information, albeit sporadic, starting in 1961.[10] We matched the identification number (RUT) of the family member with the RUT number of people on the board of directors of the companies supervised by the CMF.[11] We could not find any cross-directorship.

We then looked at whether two members of distinct "conglomerate" families served together on the board of a third company. The only example is CCLV, Contraparte Central S.A, whose board seems to be the "who is who" of Corporate Chile.

At the end of 2021, the FNE filed a case for infringement of the prohibition of horizontal interlocking against Hernán Büchi and Juan Hurtado Vicuña. Hernán Büchi is contemporaneously director of Banco de Chile, Consorcio Financiero, and Falabella, which compete in banking and insurance products (Banco de Chile, Consorcio, and Falabella), and the supply of stock broker services (Banco de Chile and Consorcio). Juan Hurtado Vicuña is contemporaneously director of Consorcio Financiero and Larraín Vial, which compete in the

9 http://www.genealogiachilenaenred.cl/Default.aspx

10 https://www.cmfchile.cl/portal/principal/613/w3-article-25004.html

11 It appears that in some cases the RUT number of directors was entered by hand, resulting in some typos and thus in some undercounting.

supply of stockbroker services.[12] Our analysis of the CMF database suggests these are isolated cases and not the tip of an iceberg.

3.4 Revolving Doors

One advantage of large and diversified business groups is that they can offer better positions to politicians and bureaucrats after they step down from public service. To test whether this is the case in Chile, we analyze the board positions taken by all the Economics, Finance, Mining, Public Work, and Environment ministries since 1990. To these, we also add the heads of SERNAC, the IRS, and the FNE. In total, these are 140 people.

As Table 4 shows, we find that roughly 20% of the ministries end up on a board of a major company within two years of their resignations and 29% within five years. Roughly half of these positions are on the board of a company affiliated with one of the top conglomerates, while the rest is divided between boards of public sector companies and other private boards. Thus, if a ministry wants a life in the private sector, the top 25 conglomerates are the main game in town.

TABLE 4
REVOLVING DOORS AMONG MINISTRIES

	Public sector	**Top 25 Groups**	**Others**	**Total on boards**
in 2 years	7.1%	11%	1.4%	19%
in 5 years	8.6%	15%	5.0%	29%

The problem is even more pronounced when we look at the very top economic bureaucrats: central bank governors and the heads of the Superintendencia de Bancos e Instituciones Financieras de Chile (SBIF) and the Superintendencia de Valores y Seguros (SVS), in total 29 people. As Table 5 shows, almost all of these people end up on a board within two years of stepping down from their positions. These positions are either with a state-controlled com-

12 https://www.fne.gob.cl/en/fne-presento-primer-requerimiento-por-participacion-simultanea-de-un-director-en-empresas-competidoras-contra-hernan-buchi-banco-de-chile-consorcio-y-falabella/.

pany or with a top-25 group. In fact, in the majority of cases, these bureaucrats go to work for an affiliate of a top-25 group. Thus, these groups are the main (only) private employers of top bureaucrats.

TABLE 5

REVOLVING DOORS AMONG MINISTRIES

Institution	% on boards	% on board public institution	% board top 25 groups	% board connected to a bank	Total individual
Central Bank	92%	38%	62%	69%	13
SBIF	88%	25%	50%	50%	8
SVS	75%	50%	50%	50%	8

These numbers are only the tip of the iceberg. First of all, they ignore all the other positions (employees, advisors, consultants, etc.) that ministries and regulators might have taken in business groups after they stepped down. Second, it ignores the positions taken by lower-level bureaucrats. Finally, it ignores the other side of the revolving doors. For example, in 2014 four key ministries of the Bachelet government were previously working for companies in the Luksic group (Leiva, 2021). Only a large group can have this kind of influence.

3.5 Campaign Financings

Campaign financing is a problem in all Western democracies. In this respect, Chile is not necessarily worse than most other democracies. This is not a consolation. The distortions to competition that electoral campaign financing by corporations can bring are severe, especially in countries like Chile where large corporations are specialized in sectors that are heavily dependent upon government regulation, like mining, fishing, banking, and retailing.

Even the U.S. Supreme Court, which is very protective of the right of corporations to exercise their First Amendment Right to free speech, recognizes the dangers of quid-pro-quo in corporate direct contributions to candidates (McCutcheon, 134 S. Ct. 1434, 1441 (2014)). In Chile, the evidence of quid-pro-quo corruption intrinsic to campaign financing is very strong.

In 2021, the Public Prosecutor's Office secured a conviction for bribery of Jaime Orpis, a former senator, Marta Isasi, a former congresswoman, and the company Corpesca (Angelini Group). Isasi and Orpis received payments from Corpesca "to favor the interests of the company in the performance of their duties as a representative of Congress, during the discussion of a bill to regulate the fishing industry, enacted in 2013."[13] Interestingly, while both Orpis and Isasi served a jail sentence, Corpesca paid a very small fine (US$670,000), and – as of this writing-- the favorable new law has not been reformed.

In 2015 it was revealed that SQM (of the Ponce Lerou group) contributed between US$ 1 to US$ 10 million during each electoral campaign. This meant that "hypothetically the contributions by SQM represent an amount equivalent to fully funding the campaign of between 7 and 70 Congressional deputies."[14] One of the largest beneficiaries of these payments was Senator Pablo Longeira Montes. It was revealed that in 2010 Senator Longeira discussed with the then general manager of SQM Patricio Contesse the text of several new laws, leading to changes favorable to SQM.[15]

Following these scandals, in 2016, Chile's Congress reformed campaign financing introducing a significant amount of public funding in exchange for improvements in the transparency and accountability of political parties. It is still too early to assess the impact of this reform on the political power of business groups.

3.6 Other Legal Forms To Gain Influence

During the 2013 presidential campaign, Natalia Compagnon, married to Sebastian Davalos, the son of then-presidential candidate Michelle Bachelet, secured a bank loan for 6,500 million pesos (around $11 million at the time) to buy land on behalf of a company (Caval) that Compagnon half owned and had only 6 million pesos in equity.[16] The loan was secured after a meeting with Andronico Luksic, Banco de Chile vice-president and member of the family that controls the bank. The land was resold thirteen months later at a 46% higher price.[17] In resigning from the position of director of the Foundations of the Presidency in his mother's government, Sebastian Davalos declared he had

13 https://www.bakermckenzie.com/-/media/files/insight/publications/2022/03/antibribery-and-anticorruption-review-chile.pdf?sc_lang=en&hash=BCC13E9FF315195B56CAA89C7521F481.

14 https://www.latercera.com/noticia/politica/2015/04/674-626181-9-ponce-revelo-aportes-anuales-a-campanas-de-hasta-us-10-millones.shtml.

15 https://www.latercera.com/diario-impreso/los-correos-y-la-propuesta-de-contesse-que-se-transformo-en-ley/

16 http://static.emol.cl/emol50/documentos/archivos/2016/01/20/2016012015158.pdf.

17 Ibid.

done nothing illegal and in fact, after three years, all charges against him and his wife were dropped.[18] The legality of the transaction was also reaffirmed by Eric Parrado Herrera, Superintendent of Banks and Financial Institutions (SBIF), in a Parliamentary Hearing.[19] Yet, he added: "Esta transacción no reflejó el adecuado nivel de prudencia que el banco debe observar en la realización de sus actividades de negocio."[20]

The fact there was nothing illegal in this scheme is exactly the source of the problem. This was not a standard loan, as reiterated by the SBIF superintendent. The very fact that a meeting with the bank vice-president was needed and that Bachelet's son was present at that meeting suggests that it was not a standard loan, as was the fact that Santander had earlier rejected an application for the same loan.[21] That it was not a standard loan is reiterated by the fact that the daughter-in-law of the president made a return of 370 times the invested capital in thirteen months.[22]

This is exactly the kind of soft power a conglomerate can provide. The combination of future job offers, loans, and business opportunities gives large Chilean business groups a legal way to reward and punish key politicians and regulators. It is certainly a coincidence that, around the time this loan was negotiated, four key people of the Luksic group entered the Bachelet Government (see supra in Section 3.7). Yet, it illustrates that conglomerates have a possibility of arranging sophisticated quid pro quo, not available to individual firms. This additional power has the potential of blocking new entries and distorting competition.

4. Recommendations

In spite of the large literature on business groups, the literature on the political power of business groups is only in its infancy (Callander et al., (2022); Cowgill et al. (2021)) and so is the set of tools to assess this power. Furthermore, any systematic evidence would require access to data that is often not collected and, if collected, was not available to us. Finally, some effects like entry deterrence might occur without groups ever abusing their power, but only

18 https://www.bbc.com/mundo/noticias-america-latina-42553987

19 http://static.emol.cl/emol50/documentos/archivos/2016/01/20/2016012015158.pdf.

20 "This transaction does not reflect the appropriate level of prudence that the bank must observe in conducting its business activities." Ibid at page 129.

21 http://static.emol.cl/emol50/documentos/archivos/2016/01/20/2016012015158.pdf.

22 The land was sold at 390,000 UF in February 2015, after having being bought at 267,786 UF in early January 2014, where 267,518 UF came from the Banco de Chile loan and 268 UF of invested capital. Since we could not find any mention of the interest charged, we use as 8% (the average industrial and commercial lending rate, see Chapter VIIII) over a period of thirteen months.

threatening to do so (see Section 2.2). Thus, our conclusions here are necessarily tentative. It would be easier to hide behind the classic "more research is needed." Yet, this is not an academic paper and our mandate was to provide an assessment of the situation and the opportunities for improvements. Thus, in this section, we will provide the best assessment and recommendations possible given the evidence at our disposal.

In transparency and the rule of law, Chile is substantially better than its Latin American neighbors and it has been constantly improving in the last couple of decades. Nevertheless, there are margins for improvement. In particular, Chile should shed some developing-country institutions and embrace institutions more typical of an advanced economy. Let's start with the presence of large conglomerates. The efficiency rationale for their existence in today's Chile is very weak. In the past, the creation of internal capital or labor markets might have been a good reason, but not anymore. It is hard to see Chilean groups as some form of private equity funds since the top management is strictly hereditary. The composition of business groups is peculiar too. While Chile's economy is light in manufacturing and heavy in mining and fisheries, the business groups accentuate this imbalance. They are mostly dedicated to the exploitation of natural resources and the management of local services (from electricity to retail distribution and banking). These are all regulated sectors, where foreign competition has to play by the local rules, often shaped by the Chilean groups themselves. Last but not least, while some groups have ventured abroad, an overwhelming fraction of their assets are in Chile. All these factors seem to point in one direction: the critical resource that gives these groups a comparative advantage is the connections with the political establishment. The scandals that exploded in the last decade seem to confirm this view.

The other source of comparative advantage for some business groups is access to a captive bank. While regulation seems to prevent groups from benefitting themselves through lower interest rates, it seems ineffective in preventing favoritism in terms of access to credit. This dimension is very important, especially when it comes to new entries. If banks are reluctant to lend to new entrants, especially to new entrants that compete in the same line of business as affiliated companies, product market competition will be jeopardized. Last but not least, there is anecdotal evidence (but more can easily be collected if there is a political will) that groups could use banks to ingratiate themselves with politicians and regulators, strengthening their political power.

4.1 Separation Of Banks From Industry

Many Western countries (including the United States) have a strict separation between banking and commerce. This separation has many justifications:

from financial stability to product-market competition (Kreiner, 2000). Most importantly, the only efficiency-based defense for letting industrial firms control banks relies on the underdevelopment of external capital markets, which does not apply to Chile. Given these considerations and the evidence presented in the previous sections, the case for an ownership separation between banking and commerce is strong.

How could such a separation be implemented? The first step would be a prohibition of cross-directorship so that any director, manager, or controller of an industrial firm could not sit on the board of a bank and vice versa. Then, one could pass a norm sterilizing the voting rights of any investor who owns more than a certain threshold of a bank (let's say 5%) and has more than a 5% share in any non-financial company with revenues above a certain threshold (let's say $20M). The combination of these two norms should be sufficient to isolate the governance of banks from the governance of other firms, without forcing a divestiture. If conglomerates want to keep banks in their portfolio, without exercising any control, we do not see it as a problem.

4.2 Taxation

If pyramidal business groups are not efficient but are mainly rent-seeking then an argument can be made to introduce a form of Pigouvian taxation, to reduce the negative externalities produced by these pyramids. The obvious area of application is corporate taxation.

The structure of corporate taxation, as commonly applied in most countries, tends to favor pyramids, rather than penalize them. If investors were to pay corporate taxes at the statutory rate at every level of a pyramid, the pyramidal form would be prohibitively expensive from a tax point of view. In most countries, business groups have succeeded in getting some exemption from this taxation. If company A owns more than a certain threshold of company B, company A gets a credit on the corporate taxes paid on the dividends B pays to A. The lower this threshold is, the more tax-advantaged pyramids are.

In the United States, this threshold is very large: 80%. This threshold eliminates any incentive for company A to list a subsidiary in the stock market. If it wants to retain the tax exemption, company A has to float less than 20% of the subsidiary, reducing the amount of money it can raise. According to Morck (2005), this is the main reason why pyramidal structures are very rare in the United States.

Introducing a similar rule in Chile would penalize a large concentration of control rights in a few hands. If we think this concentration is good for the economy, such a tax would be detrimental. Yet, our analysis above suggests that it is not the case. The concentration of power is what generates the political influence and the risk of product market collusion. Thus, penalizing this concentration makes sense from an economic point of view.

4.3 More Transparency

The first recommendation of the 2015 IMF conglomerate supervision report reads "Use the recently approved financial stability law to gather more information on the conglomerates' structure, business opportunities, and risks."[23] Nine years went by and not much has been done on this front. The time has come to do something, but what?

The first step is to mandate full transparency of the ultimate ownership of any company operating in the country or owning assets (whether financial or real) in the country. The G20 is already moving in this direction, and thus, Chile will be forced, sooner or later, to follow suit. The sooner this decision is made, the better for Chile's economy.

This information should be freely available to researchers and journalists because this is the only guarantee that it will be analyzed with some degree of regularity and objectivity. Any attempt to centralize this information in some agency will put the independence and objectivity of the analysis at risk. Powerful interests will likely capture the agency itself, and the researchers will find that they can only access the data to study "innocuous" topics (Zingales (2019)).

The same strategy cannot be pursued with data on the cost and availability of credit, since these data are confidential for good competitive reasons. Yet, both the CMF and the Central Bank of Chile should be in charge of reporting on potential anomalies in the granting of credit. These anomalies are likely to disappear if the full separation of control between banking and commerce takes place. Nevertheless, monitoring these anomalies could be a good way to check the progress toward an effective separation between commerce and industry.

The report required from the CMF and the Bank of Chile should regard not only the rates at which loans are granted to affiliated and unaffiliated firms but also the quantity granted and the probability of having an application for credit rejected. Particular attention should be given to startups, especially in the industries where firms affiliated with the bank are present.

Finally, following the Caval scandal Chile has introduced a special procedure for the extension of credit to Politically Exposed Persons (PEP). This procedure requires approval of these loans by top executives and disclosure of the approval process on the bank's website. Unfortunately, this procedure does not address the fundamental problem of these transactions: that they might be

[23] IMF, "Chile Conglomerate Supervision" September 2015.

used to ingratiate politicians and regulators. The best solution for this problem would be that banks disclosed on their website the list of loans (with interest rates and conditions) granted to any PEP, letting journalists, researchers, and ultimately customers decide whether these conditions were fair (i.e., similar to the ones offered to otherwise identical non politically exposed persons). Alternatively, the data on these loans should be communicated to the CMF, which will create a databank of politically exposed persons and their close relatives. In this case, the CMF should produce a report once a year on whether these loans were treated like any other loan. Once again, the focus should not be just on the rates, but also on the quantity granted, the amount of collateral demanded, and the speed of approval.

4.4 Resolving Doors

Business groups' political influence distorts regulation and hampers competition. While more transparency and separation between banking and commerce can alleviate this problem, it does not fix it. The same is true for the Pigouvian tax on pyramid layers. Two steps are necessary to reduce the power of large groups in the legislative process: reducing the influence that money has on elections and imposing some stricter constraints on the revolving door policy.

Chile recently changed its campaign financing law, and thus, it is not wise to propose other changes before having studied the effects of the ones just introduced. Unfortunately, the time passed is so short that there are no good systematic studies on these effects. Thus, it is doubly important to operate on the other margin: reducing the constant revolving of positions between large business groups and government and vice versa.

There is a long-standing debate in economics about the costs and benefits of revolving doors. Revolving doors can provide incentives for public sector workers to perform and bring private sector expertise to the public sector. The possible costs are that a regulator might exercise leniency in exchange for (or in the hope of) a future job from the regulated industry, or that a former regulator might intercede with her former colleagues to buy some slack for her new employer. Growing evidence (summarized in Lancieri et al., 2023) suggests that the costs tend to exceed the benefits.

One simple way to reduce the risk of quid-pro-quo is to create a black-out period (let's say two years) after the end of their public office, where former ministers and top bureaucrats cannot go work in private firms affected by the actions of the agencies or ministry they were heading.

It would also be useful to have some restrictions on the other side of revolving doors. In 2008 U.S. President Obama issued an executive order requiring all appointees entering government not to “participate in any particular matter involving specific parties that is directly and substantially related to my former employer or former clients” for a period of two years from the date of the appointment.[24] At the very minimum, Chile should adopt this rule.

To avoid business groups bypassing this norm, the law should establish that if a firm affiliated with a business group falls in the restricted category, all the business groups should fall into it as well. Thus, a central banker would not be able to join the board of CCU for two years because Banco de Chile is in the restricted category, and CCU belongs to the same group as Banco de Chile.

5. Conclusions

Some of the negative effects that we attributed to conglomerates in this article can also be caused by wealth concentration. For example, wealth concentration favors collusion in the product market and financial restrictions to new entrants who do not belong to the club. Chile is one of the countries with the highest level of wealth concentration in the world. In the 2019 Credit Suisse Report, Chile comes 6th for the share of wealth controlled by the top 1% (38%), twice as much as countries like Japan and Belgium. This confounding effect could justify a more benign approach to conglomerates: why blame them alone when they are not the only cause?

We think the opposite. Conglomerates amplify the negative economic effects of wealth concentration (not to mention the political ones). Since there is precious little evidence in favor of the economic efficiency of the conglomerate form (at least in Chile), and plenty of evidence that it might exacerbate the effects of wealth concentration, the desire to penalize the conglomerate form should be more pronounced in countries with very high level of wealth concentration, like Chile. In fact, the anecdotal evidence goes in the opposite direction. The higher the level of wealth concentration is, the broader the use of conglomerates and the political support to protect them. This political economy of the conglomerate form is an important topic for future research.

[24] https://obamawhitehouse.archives.gov/21stcenturygov/actions/revolving-door.

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Comments on "The rol of conglomerates in Chile"

Kevin Cowan[1]
Alejandro Micco[2]

In these comments we briefly summarize the report, discuss its main findings and comment on the policy recommendations.

A brief summary…

The focus of the report is how conglomerates in the Chilean economy may be affecting competition and may also be affecting policy making in general because of undue influence on the executive, supervisors, and congress.

The report starts by discarding reasons for why conglomerates may be an efficient ownership structure: internal capital markets, internal labour markets, economies of scale and leverage of a scarce resource. The report argues that technology has reduced the relevance of internal labour markets and economies of scale, while leveraging a scarce resource fails to explain why conglomerates are only prevalent in some countries. As for the role of internal capital markets, the report argues that the relative depth of the Chilean capital market has made internal funding markets unnecessary.

Having discarded that conglomerates may be an efficient response to the current characteristics of the Chilean economy, the report focuses on two mechanisms through which conglomerates may be the response to rent seeking behaviour – leading in turn to lower levels of competition across markets and distorting economic policymaking in general.

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The first mechanism relates to the presence of banks in conglomerates. Theoretically, banks could distort competition by lending to related firms in favourable terms, or by blocking finance to firms that may compete with the other activities of the conglomerate. For Chile, however, the report argues that preferential terms of financing to related firms is unlikely to be affecting competition. Indeed, the Chilean legal framework places strict limits on related lending from banks and other financial institutions and prohibits financial institutions from lending on more favourable terms to related firms[3]. On the other hand, the report suggests that conglomerates may be distorting competition by restricting bank funding to competing firms, something that we argue below is unlikely to be the case in Chile.

The second form of rent seeking relates to the undue influence conglomerates may have on economic policy via the financing of the political process, favourable lending to officials by banks or by promising future employment to high level government officials (a revolving door).

To avoid negative effects on competition by banks in conglomerates, the report proposes restricting directors from sitting on boards of banks and real sector firms, and that voting rights be eliminated for all shareholders of banks above a certain threshold. The report also argues for changes in taxation, that would make pyramidal control schemes more costly and for publicly available data on ultimate ownership – which would further enhance supervision and private sector monitoring of related party transactions. To limit undue influence the report proposes carefully evaluating recent changes in campaign financing law, significantly increasing restrictions on post-employment of public officials, and introducing conflict of interest regulation for officials entering senior posts from the private sector.

Comments on the findings…

This report raises several topics that are potentially very relevant for competition and economic policy in Chile. It provides theoretical arguments, some examples, and a list of potential policy tools. It is, therefore, a starting

[3] The Chilean banking law restricts related party exposures (Art 84.2). There are also quantitative limits to related lending in the insurance law and in broker-dealer regulation. The banking law also requires that loans to related parties cannot be more favourable in terms of maturity, interest rates or collateral requirement that similar loans to non-related parties. In addition, the *Ley de Sociedades Anónimas* (the Chilean corporation law) regulates the conditions for related party transactions. This law states (Art147) that all related transactions must be similar in price, terms and conditions to arm's length transactions. This legislation was strengthened with the recently approved *Ley de Agentes* (Law 21.314), and the CMF has issued regulation in this matter This regulation requires that related party transactions be publicly reported twice a year.

point for a data driven discussion on some of these topics.

Our first comment is that the concerns raised by the report regarding undue influence in policy making are more closely related to the concentration of assets and wealth than with the presence of conglomerates, a point the author recognizes in the conclusion. In a small economy with a high level of wealth inequality, safeguarding economic policy from undue influence is a key priority – as some of the examples included in the document show. However, the report does not focus on the distribution of wealth, but on the specific role of conglomerates on undue influence. These two factors may well be correlated, for policy recommendations however, the distinction is important.

The author presents two mechanisms through which conglomerates can exert undue influence. The first, is that Conglomerates that include a financial institution, in particular a Bank, can use access to credit to expand their political influence. The second is that by operating in several markets, conglomerates can make it easier to reward or retaliate against a regulator if it acts in favour or against the economic group.

Although both effects are conceptually plausible, it is not clear how relevant they are in distorting actual policy making. If, for a given level of wealth distribution, economic policy distortions are much larger in the presence of conglomerates, then limiting the size or complexity of conglomerates or prohibiting banks within conglomerates should be a policy priority. If, on the other hand, the main risks arise from wealth concentration, then the costs of intervening the structure of conglomerates could outweigh the benefits and may in fact be a distraction from the main policy priority: to further reforms aimed at shielding policy making from undue influence. High levels of wealth concentration are a significant issue in Chile. However, it is not clear to what extent conglomerates exacerbate this problem or if they are primarily a byproduct of wealth concentration without adding additional concerns beyond the concentration itself.

Our second comments is that much more careful data driven analysis is needed to discard efficiency reasons for conglomerates and to evaluate the potential negative effects on competition that the report mentions. This analysis is key to being able to determine policy responses. Policy discussion should be based on the importance of the distortion, the efficiency of the proposals in tackling the rent seeking behaviour, and the potential transition and permanent costs of doing so.

In relation to the efficiency reasons for conglomerates: it is not evident that internal capital markets do not play a role in explaining the existence of conglomerates. Although Chile has a relative deep capital market, this does rule out capital being cheaper within the group. Simply as a reference, corporate lending rates for the highest rated firms (AAA, AA and A corporates) are respectively 1%, 1,5% and 2,3% above the sovereign rates[4]. Conglomerates may also play a role in accessing global capital markets via bonds. Although Chilean banks can (and do) issue bonds to finance local lending, borrowing from banks is more expensive for firms than issuing bonds in global markets. Interestingly recent research Calomiris et al (2022) find evidence of a minimum size threshold when accessing international bond markets[5].

More evidence is needed to sustain the hypothesis put forward in the report that competition in Chile is being hurt because of banks limit financing to entrants that try to compete with firms in the conglomerate. For a start, the structure of the Chilean banking sector raises doubts about the relevance of this mechanism. The are 14 banks operating in Chile, several of them offering services in multiple product lines[6]. Moreover, concentration indicators are not far from averages for mid-sized economies. For example, the assets of three largest commercial banks as a share of total commercial banking asset are 52% for Chile, while the world average is 67%, and for the 27 OECD countries 67%. More importantly for the issued flagged in the report, 4 of the 6 largest banks do not belong to a business group with any real sector activities. In addition, Santander, Scotiabank and Itaú are controlled by global or regional banks, and Banco Estado is state-owned. Hence, it seems highly unlikely that any individual bank could block the entrance of a firm to a market even if it wanted to. Moreover, banks are only one sourcing of funding for firms. Factoring firms, leasing firms and private debt funds all compete with banks in funding firms[7]. Finally, in the last two decades, there have been a couple of conglomerates that decided to sell their financial institution or reduce their their share in bank property. Grupo Paulman closed Banco Paris and Grupo Said has significantly reduced their participation in Scotiabank. This behaviour is not consistent with the presence of large rents from owning a bank within a conglomerate.

We also have doubts regarding one of the main empirical findings of the paper: that firms belonging to a conglomerate consult more banks and face lower credit rejection rates. First, the differences between search efforts are not consistent across years and firm sizes, and in those cases where firms in conglomerates search more, the differences are probably not statistically significant. Although the data for rejection rates seems to be very noisy (for example rejection rates of small-2 firms in conglomerates jumps from 0% to 15% in two years) it does paint a more systematic picture of lower rejections for

4 Data for 2023, source Central Bank of Chile.

5 Calomiris, Charles W. & Larrain, Mauricio & Schmukler, Sergio L. & Williams, Tomas, 2022. "Large International corporate bonds: Investor behaviour and firm responses," Journal of International Economics, Elsevier, vol. 137(C).

6 There are also 3 branches of foreign banks in Chile.

7 Banco Central de Chile, Informe de Estabilidad Financiera 2do Semestre 2023.

firms in conglomerates. One explanation for this finding is the one put forward in the report: banks prioritize lending to firms in their groups. However, it is unlikely that the "small" firms in the ELE survey belong to an economic group that includes a bank. These are very small firms and conglomerates that own banks are mostly made up of larger firms. An alternative explanation is that firms in conglomerates are better managed or are more credit worthy than "stand alone firms" because of support from the conglomerate. Better management would also explain differences in search efforts.

The report includes some interesting data on product price differences. Specifically, the report argues that high prices of food in Chilean supermarkets, relative to neighbouring countries, may be due to supermarkets being part of a conglomerate. However, it is hard to explain why food is relatively expensive in Chile, but clothes are cheap, considering that several of the largest supermarkets and retail stores are also part of the same conglomerates. In addition, several of the products listed have specific taxes that vary across countries. As an example, the tax on alcohol is almost an order of magnitude higher in Chile than in Peru. Finally –by Balassa Samuelson one would expect higher wages in Chile, and hence higher prices for non-traded goods. As a large share of fresh food products are not traded, this could also be behind the findings.

Comments on the recommendations…

We fully agree with the report on the need to move forward with a robust final ownership registry. This is not only important for safeguarding competition, but also to strengthen financial supervision, to combat crime and money laundering and to reduce tax evasion. Currently there is a bill being discussed in the Chilean Congress which would create a Registry of Final Beneficiaries (*Boletín* N° 16.475-05). The information in the proposed registry would be public for entities that contract with the state or receive tax benefits from donating.[8]

We also agree on the suggestion in the report to allow time to evaluate the effectiveness of recent reforms regarding the financing of politics in Chile. The *Observatorio Anticorrupción*, finds that although there has been an important improvement in the way politics is financed in Chile in recent years there are still gaps remaining.[9]

8 There is no clear OECD standard on the disclosure of the registries: https://oo.cdn.ngo/media/documents/oo-briefing-public-access-briefing-2021-05.pdf

9 *Observatorio Anticorrupción* is an independent organization that monitors progress in the reforms proposed by the *Consejo Asesor Presidencial Contra los Conflictos de interés, el Tráfico de influencias y la Corrupción* (a presidentially mandated committee often called Comisión Engel). https://observatorioanticorrupcion.cl/cumplimiento.html#fulfillment-1

We also agree with the report on the need to continue to strengthen institutions and disclosures to limit undue influence from large corporations and wealthy individuals on policy making. We believe, however, that alternative approaches could be as effective as those proposed in the report. The report proposes that banks disclose loans to Politically Exposed Persons or that they be communicated to the CMF. However, Chile already has a system for reporting assets and liabilities of public authorities. This *Declaración de Interes y Patrimonio (DIP)* must be completed by many public authorities. For senior authorities the DIPs are made public. Hence, it is worth analysing whether DIPs could be complemented to include terms of the credits, in addition to other needed changes also flagged by the *Observatorio Anticorrupción*, instead of generating a parallel mechanism.

Having a comprehensive information set from the DIPs is however not enough – it is crucial that these reports be effectively monitored, and that conflicts of interest be identified in a timely manner. For example, an automatic alert system that could flags conflicts of interest for members on Congress voting on specific bills could be a valuable improvement. Indeed, it would be very valuable that additional funding be provided to the *Observatorio* and other similar entities, as so to able con continuously monitor progress in this area.

As for proposals regarding cross directorship and vote sterilization for those conglomerates that include banks and assigning the CMF and Central Bank explicit roles monitoring differential access to credit from these banks, it is important to carry out a more careful diagnosis to substantiate whether differential access to credit is present, before embarking on policy changes. This evaluation would necessarily consider all sources of funding for firms, including factoring, leasing, private debt and more recently crowdfunding and crowdlending.

The market studies that the *Fiscalia Nacional Económica* (FNE, the Chilean competition authority) can carry out would be a potential mechanism to analyse the relevance of this mechanism[10]. Previous FNE studies show that these reports are a powerful policy tool. One example is the FNE study on competition in the annuities market. This study proposed a series of regulatory changes to improve competition, of which all but one was latter included by the CMF in new regulation[11].

Before embarking on policies to limit conglomerates, it is also important to quantify the costs of doing so. As we mention above, internal capital markets may still play an efficiency role. In addition, there may also be economies of scale present in financial management functions, and transition costs may be also be important.

10 https://www.fne.gob.cl/estudios-de-mercado/estudios/estudios-de-mercados-actuales/

11 The suggest changes to laws were included in pension reform bill sent to congress in the 2nd administration of President Piñera.

Regarding the cooling off periods discussed in the report – recent laws in Chile explicitly include cooling of periods and legal conflict of interest restrictions for incoming officials that had prior jobs in the private sector. This is the case of the CMF whose law that was passed in 2017.

However, the discussion of how best to design cooling off periods is not trivial. For institutions like the CMF, Central Bank or Finance Ministry cooling off periods would effectively close off a large share of private sector jobs. Hence, they should be remunerated so as not to limit candidates that have the required expertise for the positions. But in this they compete with scarce resources that could be spent on other public policies. Short cooling off periods are useful to limit use of insider information – but are likely less effective in avoiding preferential treatment by officials expecting future employment opportunities. As mentioned by the author, there is new evidence that shows that the cost could be larger than the benefit of these type of policies. (Lancieri et al., 2022)

Regarding changes in taxation, in particular the introduction of dividend tax as in the USA, we agree that this would be a strong disincentive to have conglomerate or pyramid structures because any movement of money between corporations will lead to additional taxes. However, there are several other issues that must be considered. First, in the USA large firms are subject to a disintegrated tax system where corporations are final contributors. It is standard in this type of tax system to have corporate and dividend taxes. Chile has a partially integrated system, where natural persons and foreigners are the only/main final contributors.[12] Dividend taxes are not logical in an integrated tax, except in those cases in which the tax dividend is a credit for final taxes. In this last case, the incentive to avoid conglomerate is drastically reduced. Second, it is important to note than in most other OECD countries with disintegrated systems, dividend taxes between corporation are smaller than for final contributor, or null. Finally, while the US dividend tax system indirectly influence ownership structures, it's not typically cited as one of their primary objectives.

An issue that report does not touch on but is extremely relevant in Chile is bank secrecy. Chile has gradually allowed supervisory institutions access to bank account data. A law currently in congress significantly expands access for the *Unidad de Analisis Financiero*, the Chilean financial crimes task force. A proposed tax reform facilitates the access, in real time, of the Internal Revenue Service (SII) to financial transactions. Supervising cash flows to detect tax avoidance and money laundering will also help to detect bribery.

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12 It could be considered that in the semi-integrated tax system corporation are 35% final contributor.

In the near future, we need to assess the impact of these reforms on competition and determine whether any adjustments or reinforcements are necessary. It is also important to expand powers of prudential regulation to financial conglomerates. In addition to "too big to fail concerns" firms in financial conglomerates can potentially carry out regulatory arbitrage, may rely excessively on shared resources (making resolution very complex) and are exposed to contagion from other members of the group. This would also force public disclosure of the structure of conglomerates to enhance market monitoring. The CMF currently has powers -granted by the financial stability law- to request information on the conglomerate for the supervision of regulated entities, it does not have legal powers to force public disclosure on conglomerate structure.

Finally, Chile has taken some important recent steps aimed at fostering competition in the financial sector. The recently approved Fintech law creates a level playing field between startups and traditional financial institutions. In addition, it sets up a regulated open finance system that should expand competition by reducing information asymmetries, reducing switching costs and facilitating innovation. The comprehensive credit registry recently approved by the chilean congress will also reduce asymmetries and expand competition.

Is Chile a role model of export diversification policies? A reassessment*

¿Es Chile un modelo en políticas de diversificación de exportaciones? Una reevaluación

GONZALO SALINAS**

Abstract

Largely because of its vast copper reserves, Chile's exports are highly concentrated on this low complexity product and this is often cited as a major drawback of its economic policy framework. However, its exogenous copper abundance conceals the country's success in developing non-mineral and complex exports. This achievement is remarkable considering its remoteness from the large international economic centers, which limits its integration to global value chains. As suggested in this paper, this accomplishment reflects Chile's strength in policy areas that foster non-mineral exports (including complex exports), making the country a role model in export diversification policies among emerging market countries.

Key words: *International trade; economic growth; economic development; export diversification; export complexity.*

JEL Classification: *F1, O1, O4*

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Resumen

En gran parte debido a sus vastas reservas de cobre, las exportaciones de Chile están altamente concentradas en este producto de baja complejidad y esto a menudo se cita como una importante desventaja de su marco de política económica. Sin embargo, su exógena abundancia de cobre oculta el éxito del país en el desarrollo de exportaciones no minerales y complejas. Este logro es notable considerando su lejanía de los grandes centros económicos internacionales, lo que limita su integración a las cadenas de valor globales. Como se sugiere en este estudio, este logro refleja la fortaleza de Chile en áreas de políticas que fomentan las exportaciones no minerales (incluidas las exportaciones complejas), siendo así un modelo para seguir en políticas de diversificación de exportaciones para otros países de mercados emergentes.

Palabras clave: *Comercio internacional; crecimiento económico, desarrollo económico, diversificación de exportaciones, complejidad de exportaciones.*

Clasificación JEL: *F1, O1, O4*

1. Introduction

Although strong economic fundamentals have allowed Chile to experience economic growth and poverty reduction on par with East Asian countries, its continued dependence on copper exports nurtures a perception that the country has underperformed in promoting export diversification and structural transformation. This hypothetical failure is considered of particular importance by many economists who argue that developing other more labor-intensive export sectors (such as manufacturing and services) may have more direct social benefits than copper exports and that export diversification, by lowering output volatility, could further enhance Chile's long term economic growth (see for example Haddad and others, 2010). Nonetheless, Gonzalez and others (2020) counter this argument by noting that Australia and New Zealand prospered socioeconomically while preserving their export concentration on traditional products.

While the need to diversify Chile's exports is still under debate, this paper reassesses its success in promoting export diversification. It finds that, though it is factually correct that Chile has an export basket highly concentrated in copper products, it is also true that it has superlatively developed non-hydrocarbon/mineral (NHM) exports (including of complex products, as defined in Hidalgo and Hausmann, 2009), which is the ultimate goal of export diversification policy strategies. This country has also performed well in the development of *complex* exports, products that are considered more valuable according to a large empirical public policy literature (see Annex 1 for its description).[1] Chile's traditional indicators of export diversification and complexity are not favorable because of its exogenous abundance of copper and high international copper prices, not because of a weak capacity of the country to develop non-copper exports. The paper further shows that Chile's positive performance in developing other exports is in line with its significant strength in often cited horizontal policy determinants of export diversification and complexity. In fact, its policy strength is such that, controlling for the negative effect of its remoteness to other markets, Chile's per capita exports of NHM and complex exports are among the highest in the world.

Section 2 describes the analytical framework under which this study assesses the success of Chile's export diversification policies. Section 3 discusses how Chile's development of NHM exports is significantly better than implied by common export diversification and complexity indices while Section 4 shows how this performance is even more impressive considering its remoteness from large international markets, which most likely reflects its strength in diversification policies. Section 5 describes how Chile's development of NHM exports in recent decades happened while the country strengthened its export diversification policies, particularly its governance and trade policy openness. Section 6 presents concluding remarks.

2. A New Assessment Framework

This section, based on Salinas (2021), presents a more accurate and meaningful perspective to gauge the progress of commodity dependent countries in developing non-commodity exports that can lead to export diversification and structural transformation. Specifically, it proposes switching focus away from tracking commonly used indices of export diversification and complexity to tracking levels of NHM and complex exports, because those indices are largely determined by exogenous fluctuations in Hydrocarbon and Mineral (HM) reserves and international prices, not just by policy frameworks. Furthermore, by switching focus from traditional indices to export levels, the identification of policy determinants of export diversification can be grounded in a gravity equation setting, which is widely backed by the theoretical and empirical trade

[1] Although the concept of complexity is not part of mainstream economic growth or international trade theory, it is used in this paper given its wide influence on the empirical public policy literature, and because its related Product Complexity Index is broadly related to an intuitive understanding of the complexity or sophistication of products.

literature. In other words, and from a regression analysis viewpoint, these proposed two changes to the analytical framework of export diversification can be described as a change in the dependent variable from indices to export levels and the inclusion of independent variables better rooted in international trade theory. The next paragraphs deepen this discussion.

The Dependent Variable

Most empirical attempts to identify the factors that foster export diversification use as dependent variable an export concentration index, such as the Herfindahl-Hirschman Index (HHI), while those aiming to identify the determinants of exports complexity use the Economic Complexity Index (ECI) (Hidalgo and Hausmann, 2009). Nevertheless, these indices are substantially affected by exogenous factors, thus weakening their statistical link to policy determinants. Take for instance the HHI of export concentration for country j including exports (x) of several sectors *(s)*:

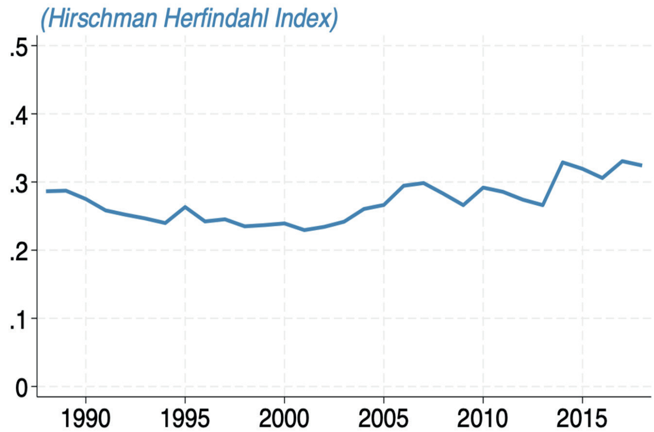
$$HHI_j = \sum_s \left(\frac{x_{sj}}{\sum_s x_{sj}} \right)^2 \tag{1}$$

This index is higher when the nominal export value of one or few commodities is high relative to the total export basket, indicating more (less) exports concentration (diversification). In most developing countries, partly due to their weak production capacity, a handful of hydrocarbon/mineral (HM) exports account for most of their total exports. Hence when aiming to diversify exports these countries seek policies to nurture NHM products. If successful, the value of these products will narrow the gap with respect to the dominant HM exports and this would reduce their HHI.

But the HHI can also significantly fluctuate in response to variations in the nominal value of their HM exports, which are commonly the result of largely exogenous events such as changes in international commodity prices or findings of additional HM reserves. Such fluctuations can considerably weaken the statistical relationship between policy frameworks and the desired development of NHM exports needed to diversify export baskets.

This is quite evident when looking at the evolution of the concentration index in Chile and other commodity exporters (Figure 1). Chile's HHI remained flat in the 1990s after a previously downward trend and then markedly reverted in the early 2000s. Assuming a significant connection between the HHI and the policy framework, Lebdioui (2019) argues that this end of the downward trend in export concentration is the result of the abandonment of some industrial policies that were implemented in previous decades.

FIGURE 1
EXPORT CONCENTRATION IN CHILE



Source: UN Comtrade.

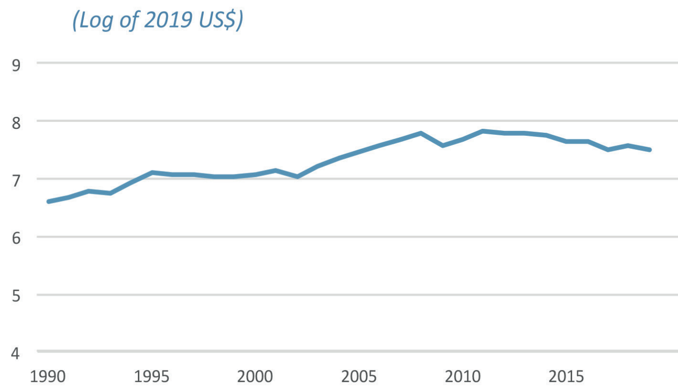
However, the evolution of per capita NHM shows a completely different picture (Figure 2).[2] Its continued upward trend throughout the 1990s and 2000s confirms that the surge in export concentration was not related to a weakening in Chile's NHM export policy determinants. The surge in concentration in the early 2000s is evidently related to the international copper boom, which multiplied the value of Chile's copper exports from US$ 8 billion in 2003 to a peak of US$ 54 billion in 2011, when it accounted for half of its goods exports. Because most countries that seek export diversification are strongly dependent on HM exports, this disconnect between the HHI and policy determinants of NHM exports due to commodity fluctuations is highly consequential.[3]

2 In this paper, NHM exports are estimated based on SITC Rev 2 classification, and include codes 0-2700, 2900-3000, and 5000 and higher, excluding 5121, 6831, 6841, 6851, 6861, 6871, 6880-6895, 9310-9610.

3 In a regression analysis with the concentration index as dependent variable and a set of policy variables as covariates, heterogeneity in HM abundance and prices could bias coefficients of policy variables that are correlated to HM heterogeneity and/or inflate error terms thus lowering estimation efficiency. In general, countries with high HM abundance could be unfairly judged as failures of pro-diversification merely because of their exogenous HM abundance.

FIGURE 2

NON-HYDROCARBON/MINERAL EXPORTS PER CAPITA



Source: UN Comtrade; and author's calculations.

A similar confusion occurs when trying to identify a statistical relation between export complexity and policy variables by using the ECI as dependent variable.[4] This index can be broadly understood as the product of each exported product's complexity (measured by the Product Complexity Index (PCI), defined in Hidalgo and Hausmann, 2009) times the product's share in the country's export basket. Because HM products have low PCIs, exogenous increases in international HM prices or HM discoveries lower the ECI without any change in the value of exports of higher complexity. Regression specifications that aim to identify a link between policies and complex exports using the ECI as dependent variable are thus weakened by exogenous commodity related fluctuations.[5]

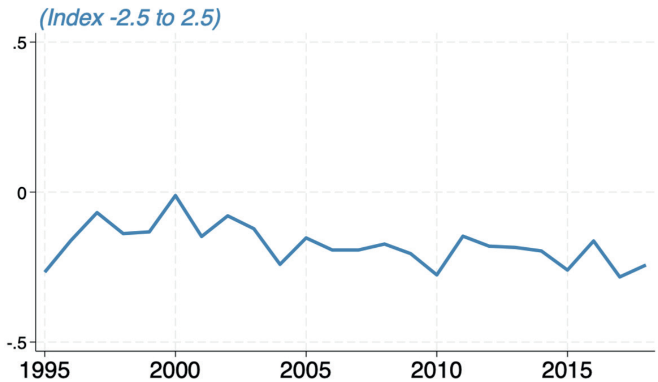
Chile during the early 2000s is also an illustrative case of how these indices can mislead the identification of policies that foster *superior* exports. Chile's ECI slightly declined from close to zero in 2000 to about -0.25 in 2015, a considerable fall as the ECI broadly ranges between -2.5 and 2.5 (Figure 3). This decline seems at odds with the sustained productivity growth that Chile experienced those years which, a priori, should have increased its capacity to produce complex goods for exporting. As was the case with the HHI, Chile's ECI decline is most evidently related to the boom of copper (a low complexity

4 Hidalgo and Hausmann (2009) argue that countries need to enhance the complexity of their export basket to attain sustained economic growth.

5 The notable inaccuracy of the ECI in measuring an economy's complexity and productive capabilities if further discussed in Salinas (2021).

product), thus showing again how commodity fluctuations erode the relation between target variable (complex exports) and dependent policy-related variables.[6]

FIGURE 3
ECONOMIC COMPLEXITY INDEX IN CHILE



Source: Hausmann and Hidalgo (2013).

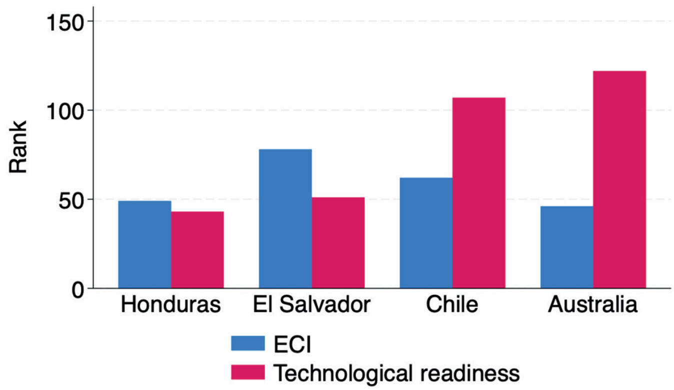
The disconnect between the ECI and a country's policy framework is similarly evident in very telling cross-country comparisons. A priori, the advanced Australian economy, with strong institutional and educational quality, should be more capable of producing complex products than Latin American countries. Yet the ECI of Australia is considerably below the ECIs of El Salvador and Honduras (Figure 4). According to its authors the ECI is a proxy for *productive capabilities* and measures *the knowledge of a society* (Hausmann and others, 2013), but it is questionable that Australia's *productive capabilities* are inferior in this illustrative cross-country comparison. Also, the ECI appears unrelated to the Technological Readiness index of the World Economic Forum's Global Competitiveness Report (GCR). Australia's low ECI is clearly

6 As an example of a similar disconnect in oil exporting countries, Nigeria's ECI has considerably deteriorated during oil price booms (in the early 1970s and early 2000s) and improved significantly in 2008, as a result of the oil price collapse of that year. At a regional level, as noted in Ding and Hadzi-Vaskov (2017), a growing trend in the share of complex exports in Latin American and Caribbean in the 1990s was reversed in the 2000s because of the commodity price boom, as the region is a major exporter of these products.

related to its exogenously high mineral endowment and resulting high exports of minerals (which are low complexity products), not to its capacity to export complexity.[7]

FIGURE 4

WORLD RANKS OF ECI AND TECHNOLOGY 2016-2019



Source: Hausmann and Hidalgo (2013), World Economic Forum and Harvard University (2020)

The evident disconnect between the above discussed indices and policy determinants that foster exports diversification and complexity can be simply and effectively addressed by focusing directly on the evolution of the export products that lead to diversification and export complexity. Since export diversification is commonly sought in countries that are dependent on a handful of HM exports (such as Chile), the relevant dependent variable is the value of NHM exports.

Similarly, when aiming to foster export complexity the dependent variable can be directly defined as the value of exports of high complexity. Doing this filters out any effect of low-complexity HM export values, which policy makers have little influence over. For cross-country comparability the value of NHM and complex exports can be normalized by population or labor force to control for size. Thus, the following sections analyze complexity through the value of *complex exports* per capita, hereby defining as *complex exports*

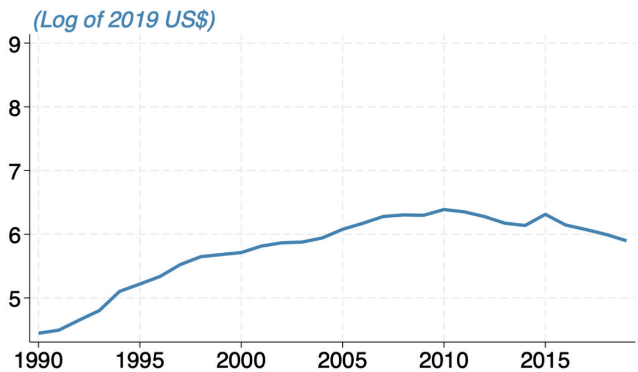
7 Another illustrative case of the limitations of the ECI as a measure of complexity due to natural resource abundance is the U.S. state of Texas. Despite being a global technology leader its ECI is only 0.29, similar to the Philippines. This evident inconsistency likely results from Texas superlative petroleum endowments and the extremely low (-2.57) Product Complexity Index (PCI) of Petroleum Oils in Hausmann and others (2013).

those products with Product Complex Index (PCI) above zero (the top half of the product complexity range in Hausmann and others (2013) categorization).

Assessments change substantially when focusing directly on the evolution of the targeted export groups per capita. As seen above, although Chile's HHI pointed to declining diversification in the early 2000s, NHM exports per capita continued to increase during that period. The picture similarly changes when looking directly at the value of per capita *complex exports*. Unlike the ECI, the value of Chile's *complex exports* per capita continued to grow during the copper boom (Figure 5) and, as expected, *complex exports* per capita is higher in Australia than in Honduras and El Salvador and, unlike the ECI, the complex exports per capita ratio is broadly in line with the GCR's Technological Readiness index (Fugure 6).[8 9]

FIGURE 5

COMPLEX EXPORTS PER CAPITA

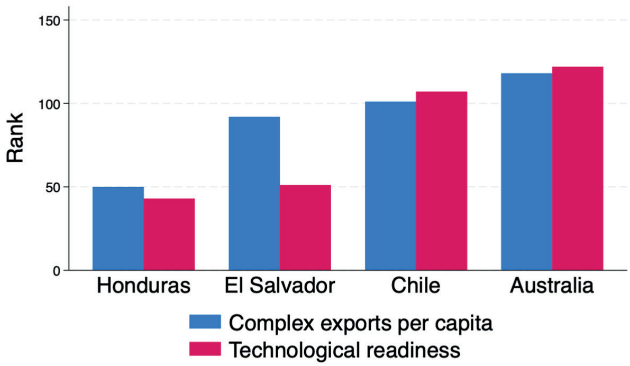


Source: UN Comtrade and authors calculations.

8 The upper half of PCI includes products with a PCI above 0. Similar results as those described in this paper are observed when focusing on products with PCI above 1 (about a quarter of all tariff lines) or when focusing on complex exports per worker instead of complex exports per capita. Note that complex exports per capita measure neglects intra-temporal and cross-country variations in the average PCI of each country. An alternative approach that would capture PCI heterogeneity and filter out exogenous commodity related developments would be to calculate the average PCI only for NHM exports. However, that would not a be an accurate measure of complexity (productive capability of a society) as it does not give a sense of the scale of complex exports production. Hence, countries with a small share of complex products that have a high PCI would appear more complex than countries with a large share of complex products but with a lower average PCI, no matter how minuscule the share of complex products would be.

9 Relatedly, according to Haver Analytics data, the volume of industrial exports grew faster than the volume of copper exports over the last two decades, also suggesting that the declining ECI during that period was driven by copper prices not by weakness to develop more complex exports.

FIGURE 6
WORLD RANK OF COMPLEX EXPORTS AND TECHONOLOGY 2016-19



Source: UN Comtrade; World Economic Forum and Harvard University (2020); and author's calculations.

Independent Variables

Because the proposed dependent variables are levels of exports, independent variables can be defined based on traditional modelling of trade (exports and imports) levels. Specifically, regression specifications with export levels as dependent variables can be based on the empirically effective gravity equation specification. This is particularly convenient as Arkolakis and others (2012) have shown that a large class of international trade models generate isomorphic gravity equations, and therefore the results of gravity equation-based estimates should be significantly robust to model selection.

For selection of covariates, in addition to standard gravity equation variables we consider the main variables of an EK02 (Eaton and Kortum, 2002) Ricardian general equilibrium model. We can relate the target export categories (NHM, manufacturing, complex, and services) to the manufacture sector in EK02's two-sector setting of manufactures and non-manufactures (equation 17 in EK02):

$$\frac{X_{ni}}{X_n} = T_i \left(\frac{\gamma d_{ni} w_i^{\beta} p_i^{1-\beta}}{p_n} \right)^{-\theta} \tag{2}$$

where the fraction of total expenditure of country n on manufacturing goods from country i (X_{ni}) divided by its total expenditure (X_n), is a function of country i's state of technology (T_i), wages in country i (w_i), and prices in both countries *i* and *n*.[10] Note that while distance-related variables are mostly exogenous, those related to technology and wages are largely determined by public policies of the exporting economy. Other empirical studies on the determinants of export diversification and complexity include covariates related to productivity/technology (T-variables) of the exporting country (*i*), but do not include wage and gravity equation variables.[11]

Regression specifications in most related studies include T-variables such as institutional development, educational attainment, trade policy openness, and infrastructure development.[12] These four variables appear significantly (though not robustly) associated with diversification, sophistication, and complexity in several studies (for example, Hausmann and others, 2006; Weldemicael, 2012; Ding and Hadzi-Vaskov, 2017), including through Bayesian identification (Giri and others, 2019).

Within its gravity equation methodological framework, Salinas (2021) also identifies these four policy variables as the most economically and statistically significantly related to NHM exports (including exports of manufacturing, services, and complex products), in addition to a country's distance to other markets. An implementation of those regression specifications with updated data (Table 1) confirms that distance is particularly relevant, as reducing it by half is associated with an 80 percent increase in NHM exports. Note that the distance of the remote SCC and OCE regions is about twice that of CAM, EE, and East Asian regions and therefore the exogenous distance factor on its own can substantially explain the lower level of exports per capita in these remote regions.

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10 Parameter γ is a measure of the sensitivity of local prices to foreign cost structures and geographic barriers. θ represents product homogeneity across countries, which governs comparative advantage. A low θ implies high product variability and in that case comparative advantage exerts a bigger force for trade. β is labor's share in production, while $(1-\beta)$ is intermediate inputs' share in production.

11 Empirical findings from the GVC literature also hint at the importance of distance to large markets and other gravity equation variables in the development of complex exports. Raei and others (2019) and Kowalski and others (2015) identify gravity variables as key determinants of Global Value Chain (GVC) participation. Since participation in GVCs is seen as a major force behind the growth of more complex, manufacturing products, it is very likely that gravity-related variables are significant determinants of export complexity.

12 Trade policy openness and transport infrastructure can be alternatively considered proxies for effective distance between countries.

TABLE 1
DETERMINANTS OF EXPORTS BY EXPORT TYPE

Variables	Non-hydrocarbon/ mineral	Complex	Manuf.	Services	Hydrocarb. & Mineral
Log GDP reporter	0.584***	0.664***	0.545***	2.070***	0.889***
Log GDP partner	0.899***	0.766***	0.761***	0.639***	0.841***
Log distance	-1.328***	-1.687***	-1.526***	-0.18	-1.744***
Common currency dummy	0.410**	0.570***	0.494**	0.807***	0.429*
Common border dummy	1.813***	1.417***	1.735***	1.687**	1.628***
Common language dummy	0.605***	0.521***	0.474***	0.51	0.292**
Common colonizer dummy	0.655***	0.363**	0.411***	4.628***	0.457***
Post colonial link dummy	1.302***	1.446***	1.562***	-0.21	1.283***
Log of hydrocarbon/ mineral assets	0.078***	0.119***	0.092***	0.06	0.334***
Landlockedness	-1.690***	-1.749***	-1.605***	5.345***	-0.687***
Log GDP per capita	-0.10	-0.427***	-0.08	-2.073***	0.22
Governance (WB Index)	0.297***	0.426***	0.324***	4.069***	-0.498***
Education (UN Index)	5.868***	6.788***	5.300***	-5.703***	0.78
Infrastructure (GCR Index)	0.212***	0.344***	0.336***	-0.04	0.616***
Average Tariff	-0.0281***	-0.044***	-0.0570***	0.011	-0.025***
Labor market flexibility (GCR Index)	-0.05	-0.0825*	-0.03	-0.189**	0.244***
Constant	5.249*	9.535***	10.07***	-62.56***	6.860*
Observations	37,866	35,649	35,903	4,279	32,332
Rho	0.92	0.91	0.92	0.98	0.86

Source: Author's elaboration.

Note: * p<0.1, ** p<0.05, *** p<0.01. Panel regressions based on Hausman and Taylor (1981) technique with groups consisting of all combinations of reporter and partner countries in UN Comtrade database. Observations are non-overlapping 5-year averages within the 1962-2017 period, depending on data availability. Regression specification based on equation (7). Multilateral resistance terms and partner country's policy variables included (coefficients not reported). Non-hydrocarbon/mineral exports include SITC2 codes 0-2999, 4000-6772, 6900-8999. Manufactured exports include SITC2 6900 to 8999 products. Complex exports are products with a Product Complexity Index (PCI) above zero according to Hausmann and others (2013).

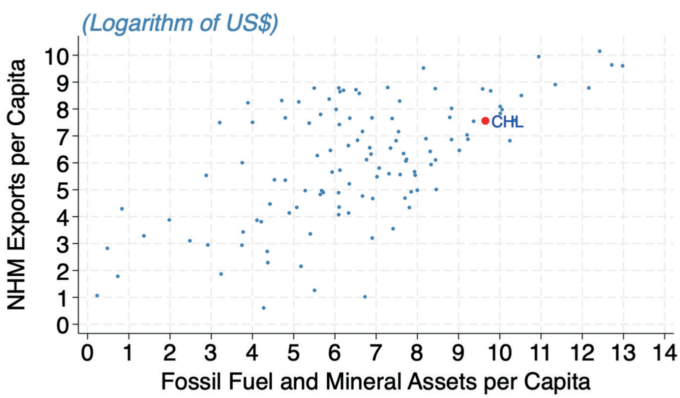
Landlockedness, another geographic exogenous regressor, has a major impact on NHM exports too, as being landlocked is associated with an 80 percent lower level of NHM exports. Interestingly, higher HM assets is associated with higher NHM exports, as many NHM products are derived from raw HM products.

Education appears as the most influential policy determinant of NHM exports. A one standard deviation increase in educational attainment is associated with a 215 percent increase in Complex exports. One standard deviation increases in governance and infrastructure quality each increase NHM exports by 30 percent, and reducing the average import tariff from 15 to 5 percent is also associated with a 30 percent increase in NHM exports. The impact of these policy variables and distance is even more important for Complex and Manufacturing Exports.

As seen in the last column of Table 1 and in Figure 7, hydrocarbon and mineral (HM) exports are significantly determined by available assets per capita of these products, and not much by the strength of its policies. In fact, governance appears negatively associated with HM exports, a surprising result that may reflect causality from HM wealth to governance erosion related to the natural resource curse (see a related review in Busse and Gröning, 2019).

FIGURE 7

NHM EXPORTS VS ASSETS PER CAPITA



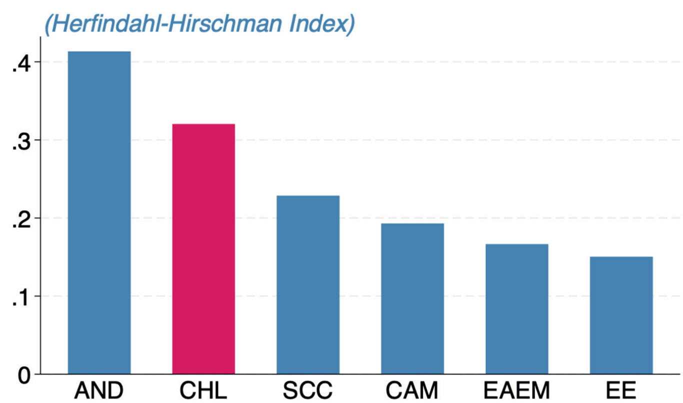
Source: UN COMTRADE; World Bank's Wealth of Nations database; and author's calculations.

Note: Annual average of years 2016-2018

3. Reassessing Chile's Export Diversification Performance

Within this framework, we reassess Chile's success in promoting export diversification. Traditional quantitative measures of export concentration are high for Chile relative to the average in other emerging market regions (Figure 8). With a Herfindahl-Hirschman index of exports concentration above 0.3 in 2015, Chile's export basket appears less diversified than those of the manufacturing powerhouse countries of Central America and Mexico (CAM), and East Asian Emerging Markets (EAEM). As suggested above, this seems a result of Chile's strong dependence on copper exports, as copper represents about half of Chile's goods exports. This, in turn, is a natural consequence of Chile's superlative copper wealth, which results in Chile having hydrocarbon/mineral assets per capita among the top 20 countries worldwide, and much above its comparators in this study (Figure 9).

FIGURE 8
EXPORT CONCENTRATION INDEX IN 2016-19

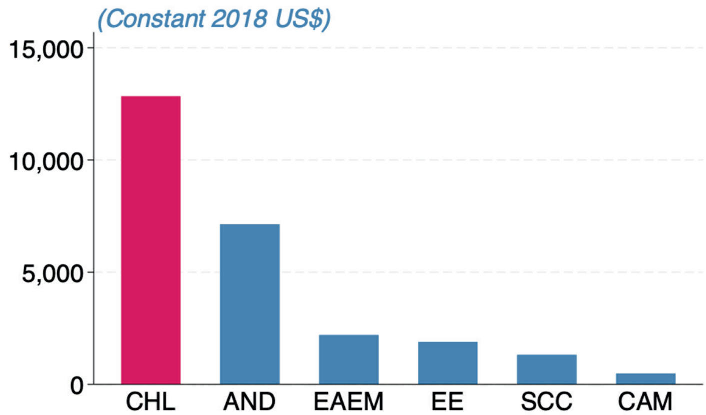


Source: UN COMTRADE

Note: AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Subregional grouping described in Table A.1.

FIGURE 9

FOSSILE FUEL AND MINERAL ASSETS PER CAPITA IN 2016-18



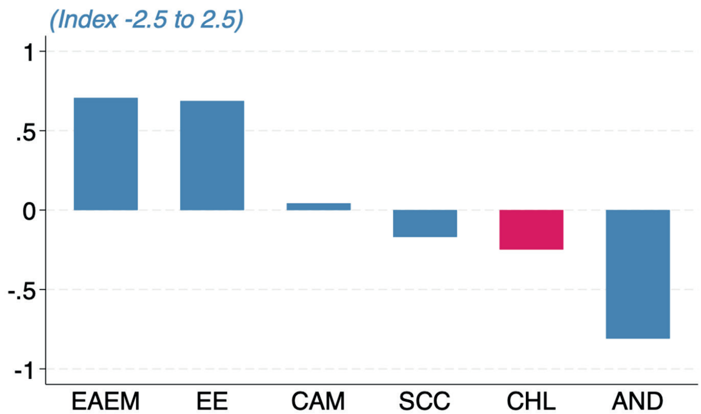
Source: World Bank's Wealth of Nations database; and author's estimates

Note: AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Subregional grouping described in Table A.1.

Also, partly because of copper dominance, Chile ranks low in the Economic Complexity Index (ECI).[13] Since copper appears in the bottom 5 percent of the Product Complexity Index (Hausmann and others, 2013), Chile's ECI is lower than in most other emerging market regions (Figure 10). This is the case although Chile performs strongly in factors that are statistically related to exports diversification and complexity identified in Giri and others, (2019), Ding and Hadzi-Vaskov (2017), and Salinas (2021) such as educational attainment, institutional strength, and infrastructure development.

[13] The ECI of a country is calculated in Hidalgo and Hausmann (2009) based on the diversity of exports a country produces and their ubiquity, or the number of the countries able to produce them (and those countries' complexity). According to its authors, this index aims to measure the *productive capabilities* and knowledge in a society as expressed in the products it exports.

FIGURE 10
ECONOMIC COMPLEXITY INDEX IN 2016-19

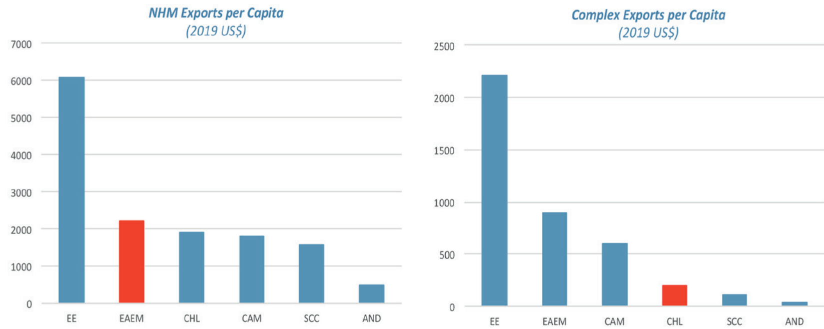


Source: Hausmann and others (2013)

Note: AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Subregional grouping described in Table A.1.

Switching the unit of analysis from indices to levels of relevant exports considerably improves Chile's relative standing (Figure 11). Following its success in developing non-copper export products in recent decades, Chile's NHM exports per capita now is similar to those of the manufacturing powerhouse regions of CAM and EAEM.

FIGURE 11
CHILE AND COMPARATORS IN 2016-19



Source: UN COMTRADE; Hausmann and others (2013); and author's calculations.

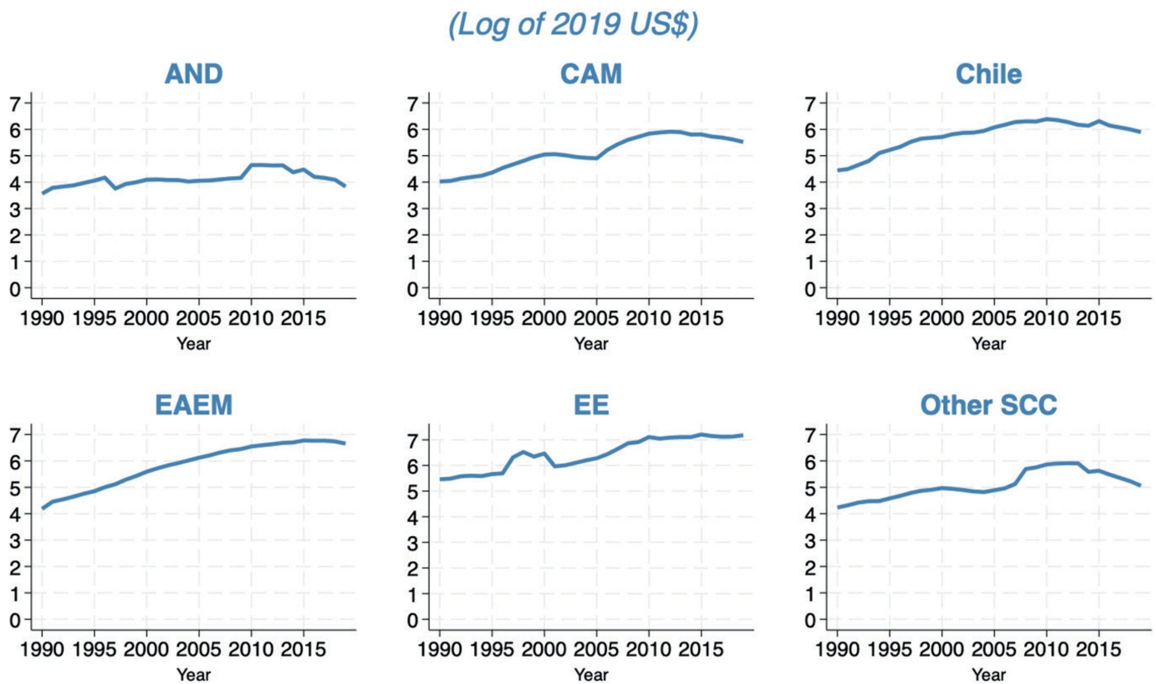
Note: NHM exports exclude SITC rev 2 codes 3000-4999; 6772-6999, and 9000-9999. Complex exports are goods with Product Complexity Index (Hausmann and others, 2013) above Zero. AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Subregional grouping described in Table A.1.

Because some of Chile's NHM exports are of natural resource-based products with low complexity, the country does lag CAM and EAEM in terms of complex exports per capita. But it is also noteworthy that the growth rate of Chile's complex exports per capita is not too different from the average in emerging market regions with successful manufacturing export sectors (Figure 12). Growing by a factor of eight in the last three decades since the mid-1980s, Chile's complex exports per capita performance has been more similar to the average in CAM and EAEM countries, than to nearby Andean (Bolivia, Colombia, Peru, and Venezuela) and Southern Cone (Argentina, Brazil, Paraguay and Uruguay) subregions, which increased exports complexity by factors of two and three, respectively.[14] Thus, by 2014-16 Chile's complex exports per capita were six times higher than in Andean countries (AND) and three times higher than in the average in other Southern Cone countries (SCC).

[14] Besides Central American countries (Costa Rica, Guatemala, Honduras, Nicaragua, and El Salvador) CAM includes Mexico. EAEM includes China, Indonesia, Malaysia, Thailand, and Vietnam.

FIGURE 12

COMPLEX EXPORTS GROWTH IN CHILE AND COMPARATORS



Source: UN COMTRADE; Hausmann and others (2013); and author’s calculations.

Note: Complex exports are goods with Product Complexity Index (Hausmann and others, 2013) above zero.AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Subregional grouping described in Table A.1.

At least two methodological issues help explain CAM's and EAEM's higher complex exports per capita. One is that even though the production of copper is not particularly labor-intensive, the share of labor it demands directly and indirectly is not negligible. With less labor force available to non-copper sectors, the per capita level of complex exports is expected to be lower than in the absence of such large copper production. CAM countries do not have significant HM exports and although EAEM countries also have significant HM exports per capita, in 2017, Chile had a ratio about four times higher.

A second issue is that CAM and EAEM countries participate more intensively in GVCs than Chile, so that their gross NHM exports overstate their domestic value added. According to the OECD Trade in Value Added (TIVA) database (OECD, 2019), in 2018 the domestic value added of NHM exports of Mexico, Malaysia and Thailand, the CAM and EAEM economies with highest complex exports per capita, was around 60 percent.[15] In comparison, the domestic value added of NHM exports of distant Australia and Chile was 81 and 88 percent of their gross exports, respectively. Thus, the difference in the value added of complex level per capita between EAEM and Chile is likely much lower (about 2 to 1) than the difference in gross complex exports per capita shown in the chart above (about 3 to 1).

While some of Chile's complex exports are linked to its abundant natural resources, many others are not. Looking at a list of Chile's top ten complex exports we see that only few (Processed Copper and Converted Paper), are products that industrialize natural resources (Table 2). Most are manufacturing products, such as telecommunications products, vehicles, machinery and medicaments, that are not linked to natural resource abundance. This is a positive sign that Chile's comparative advantage is not solely related to its natural resources but also to its strength in policies that nurture export complexity (which we discuss below). Noteworthy also, Chile produces many highly complex products, with PCIs above two, such as medical equipment, electrical instruments, and metal working machine tools.

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15 Data on exports value added is not available for most countries, therefore the rest of the analysis centers on gross exports. Note that all indices of diversification and export superiority are subject to this caveat.

TABLE 2

LIST OF TOP 10 COMPLEX EXPORTS FROM CHILE, 2016-19

Product	**US$ m (annual average)**
Rubber tyres & tubes for vehicles and aircraft	312.1
Paper and paperboard in rolls or sheets nes	311.7
Copper and alloys of copper, worked	258.3
Bodies & parts motor vehicles ex motorcycles	166.2
Alcohols, phenols, phenol alcohols, glycerine	162.1
Medicaments	153.2
Other artificial resins and plastic materials	121.8
Construction and mining machinery, nes	119.7
Iron and steel forgings in the rough state	97.7
Rail & tram. freight cars, not mechanically propd.	90.1

Source: UN Comtrade.

Note: Complex exports are goods with Product Complexity Index (Hausmann and others, 2013) above zero.

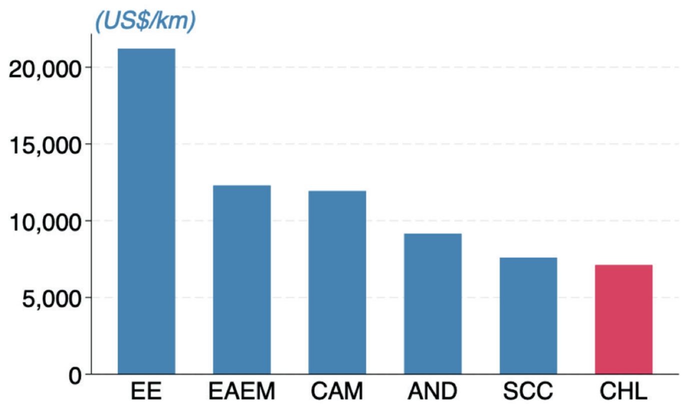
4. Chile's Diversification Hampered By Remoteness

Chile's major limitation in developing complex and non-mineral exports in general is most likely its remotenesss from the main centers of global economic activity or its low Proximity to other Markets as defined in Salinas (2021) (Figure 13).[16] Far from the large Asian, European, and North American markets, the costs of transporting Chile's exports are considerably higher than for countries that are located in the close periphery of these regions. This limits its potential to join GVCs and therefore it is not surprising that its level of complex exports per capita is considerably lower than in other regions that are closer to the major world economic centers.

16 In that study, GDP per capita is added as an independent variable acknowledging that it can also approximate wage costs, but mainly to control for potential endogeneity between NHM exports per capita and T-variables. Higher NHM exports can foster GDP and higher GDP can help strengthening T-variables (for example, higher output can facilitate/finance higher educational attainment). Note though that GDP per capita is not included in the calculation of goodness of fit when estimating the predictive power of policy variables.

FIGURE 13

PROXIMITY TO MARKETS IN 2016-19



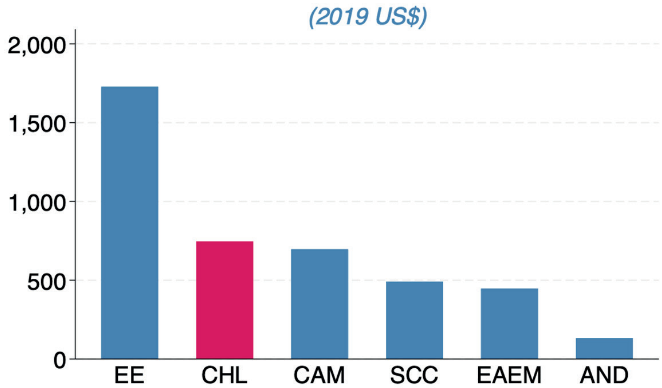
Source: UN COMTRADE; and author's estimates.

Note: Proximity to Markets is the sum of GDP of partner countries weighted by their distance to the country. AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Subregional grouping described in Table A.1.

Interestingly, because non-tourism services are less sensitive to the distance factor, Chile's per capita exports of services compares favorably to other regions including EAEM (Figure 14). Chile's service exports include those of its largest airline (the largest in Latin America), as well as Business, Information Technology, and Financial Services (Table 3). These are skill-intensive products which show that the Chilean economy has the capabilities to produce high value-added exports especially when distance is a less limiting factor.

FIGURE 14

SERVICE EXPORTS PER CAPITA IN 2016-17



Source: EBOPS; Hausmann and others (2013); and author's calculations.

Note: Complex exports are goods with Product Complexity Index (Hausmann and others, 2013) above zero. AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Subregional grouping described in Table A.1.

TABLE 3

SERVICE EXPORTS FROM CHILE, 2016-19

Product	**US$ m (annual average)**
Transportation	3152
Travel	2853
Other business services	2545
Computer and information services	357
Insurance services	301
Financial services	298
Royalties and license fees	56
Personal, cultural, and recreational services	43

Source: EBOPS Database in UN Comtrade.

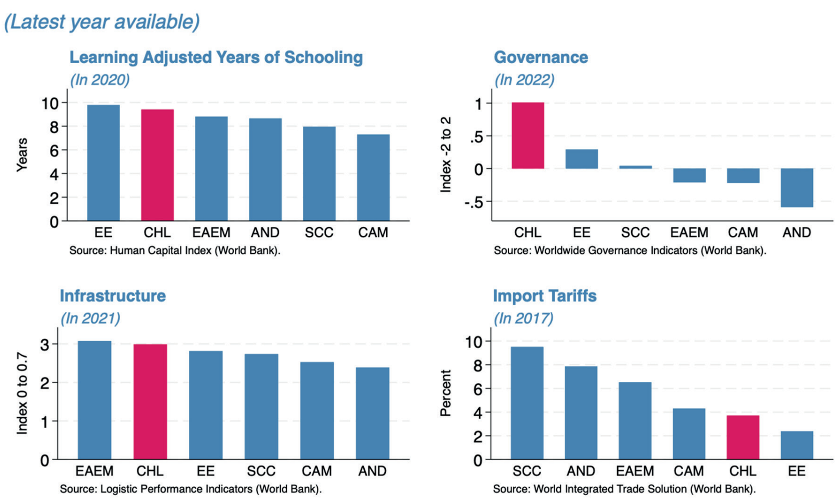
Statistical estimates of the impact of geographic remoteness on export development in Salinas (2021), predict a large difference in complex exports per capita between Chile and less remote emerging market regions. Specifically, as Chile's PM index is about half of the average of EAEM countries, these statistical estimates predict that its complex exports per capita should be about a third of the EAEM average level only due to distance.

Strengthening connectivity to other markets is thus crucial for Chile's efforts to increase export diversification and complexity. Although geographic distance is a fixed variable, "effective" distance can be lowered through investments in transports and communications infrastructure that lower the cost of goods and knowledge exchange.[17]

For sure, Chile's exports can also be fostered by strengthening diversification policy fundamentals discussed above. In fact, Chile's diversification policy framework appears relatively strong in comparisons to other emerging market countries (Figure 15).

FIGURE 15

DETERMINANTS OF COMPLEX EXPORTS IN CHILE AND COMPARATORS IN 2016-19



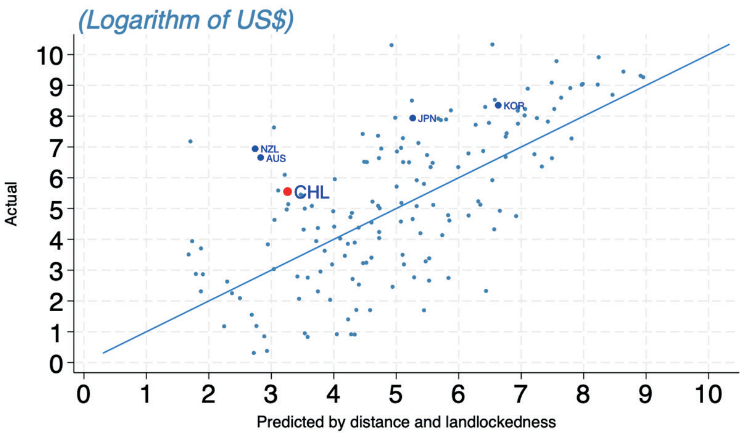
Note: Country acronyms are ISO3. AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern Europe; SCC=Southern cone countries. Regional subgroupings described in Table A.1.

17 Proximity to markets can also increase with higher GDP of nearby trading partners, but this is of course largely out of control of local policy makers.

Another indication of Chile's strong diversification policy fundamentals is that its complex exports per capita are much higher than predicted only by the PM index (distance) and landlockedness (Figure 16a) or by the PM index, landlockedness, and HM assets (Figure 16b). This suggests that Chile's policy framework help it offset its distance disadvantage. In general, all countries that are significantly above the fitted line very likely have strong export diversification policy frameworks that allow them to surpass expectations anchored in geographic determinants and therefore hint at "role models" of export development policies.

FIGURE 16a

COMPLEX EXPORTS PER CAPITA - ACTUAL VS PREDICTED

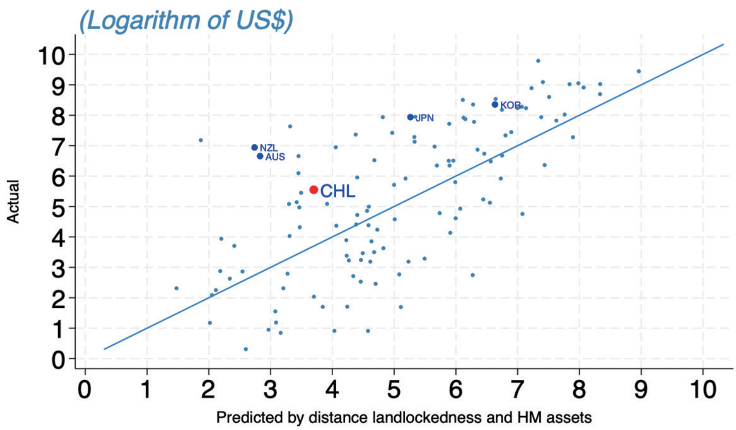


Source: Salinas (2021)

Note: Adjusted R-squared 0.35. Acronyms are ISO3. Annual average of years 2016-19. Predicted by distance and landlockedness.

FIGURE 16b

COMPLEX EXPORTS PER CAPITA - ACTUAL VS PREDICTED



Source: Salinas (2021)

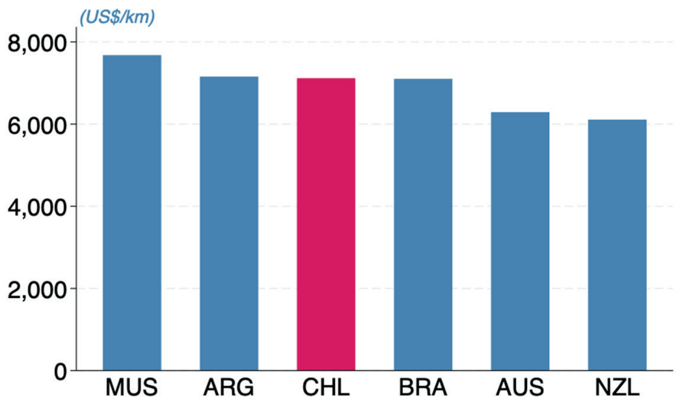
Note: Adjusted R-Squared 0.38. Acronyms are ISO3. Annual average of years 2016-19. Predicted by distance, landlockedness, and hydrocarbon/mineral assets.

The world maps in Panel Figure A.1 similarly indicate deviations from distance-predicted complex and NHM exports per capita. Countries in darker blue are those with higher upward deviation and those in darker red have higher downward deviation. In the case of complex exports, superlative countries include well known models of export development in East Asia, such as Japan, Malaysia, South Korea, and Thailand. Remarkably, the upward deviation of Chile's complex exports per capita with respect to the level predicted by distance is also among the highest in the world, as is the case of also remote Australia (AUS) and New Zealand (NZL). Chile's upward deviation in NHM exports per capita is even higher, reflecting its success in promoting some natural resource based products (fisheries, agroexports, forestries).

Acknowledging Chile's remoteness, its export promotion success is better judged by comparing it with other remote countries (Figure 17 and 18). In such comparison, Chile has the highest level of per capita complex exports among emerging market regions and only trails high-income Australia and New Zealand.[18]

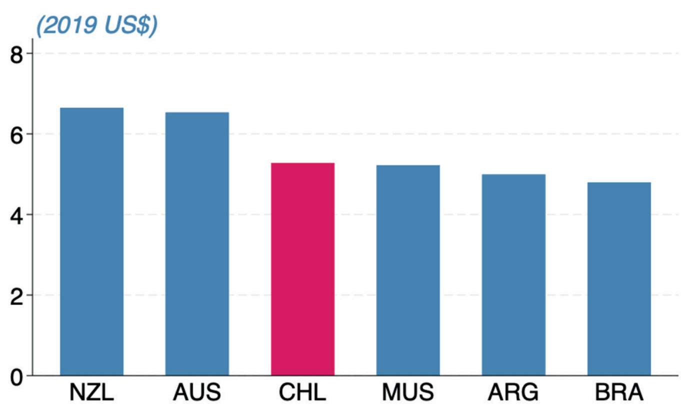
[18] The comparator remote countries include those with an income per capita above 8,000 US dollars per capita, population above 1 million, and located at a southern latitude similar to Chile's.

FIGURE 17
PROXIMITY TO MARKETS IN 2016-19



Source: UN Comtrade; and author's estimates.
Note: Proximity to Markets is the sum of GDP of partner countries weighted by their distance to the country. Country acronyms are ISO3.

FIGURE 18
COMPLEX EXPORTS PER CAPITA IN 2016-19

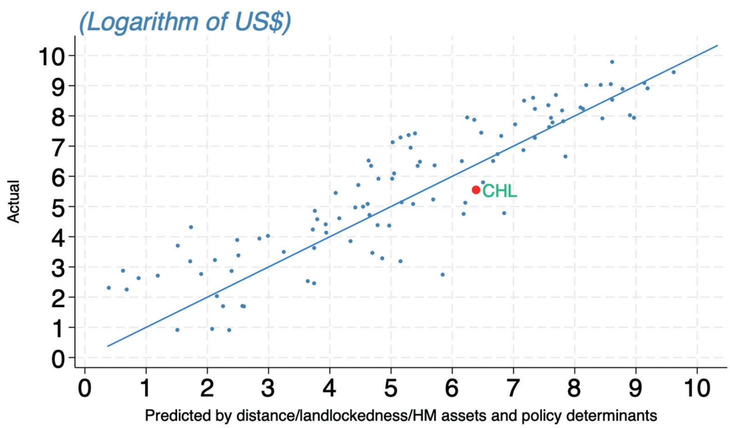


Source: UN Comtrade; and author's estimates.
Note: Country acronyms are ISO3.

A scatter plot comparing the level of complex export per capita predicted by distance plus policy variables (governance, education, infrastructure, and import tariffs) does a much better job at predicting Chile's complex exports (Figure 19). This improvement in fit when adding policy variables is further evidence that Chile's strong diversification policy fundamentals considerably improve its complexity.

FIGURE 19

COMPLEX EXPORTS PER CAPITA - ACTUAL VS. PREDICTED



Source: Salinas (2021)

Note: Acronyms are ISO3. Annual average of years 2016-19.

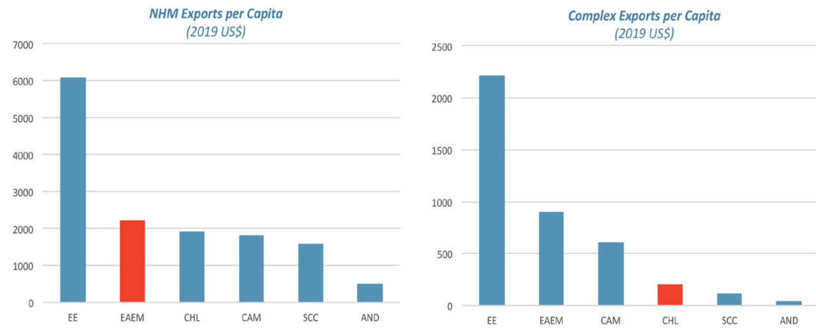
5. Chile's Strengthening Of Diversification Policies in Recent Decades

Additional corroboration of the effectiveness of Chile's diversification policy framework is that, in recent decades, its NHM and complex exports have increased relative to other regions at the same time as its policies have also significantly improved, particularly in the areas of governance and trade policy openness.

Chile's NHM exports per capita among comparator regions was only above the average of Andean countries back in 1980 (Figure 20). Since then, it has gradually reached the average level of high performing EAEM and CAM regions, despite its remoteness to the large economic centers. Its progress in fostering complex export development has not been as impressive, only surpassing SCC countries and lagging the EAEM average (Figure 21).

FIGURE 20

NHM EXPORTS PER CAPITA

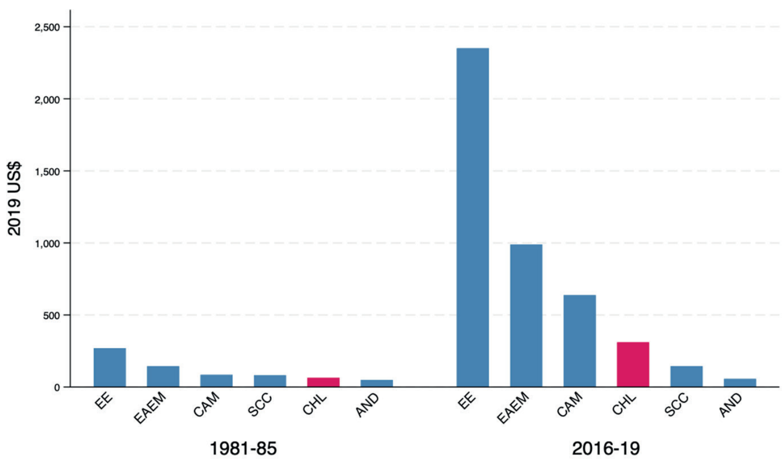


Source: UN Contrade; and author's calculations.

Note: AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Subregional grouping described in Table A.1.

FIGURE 21

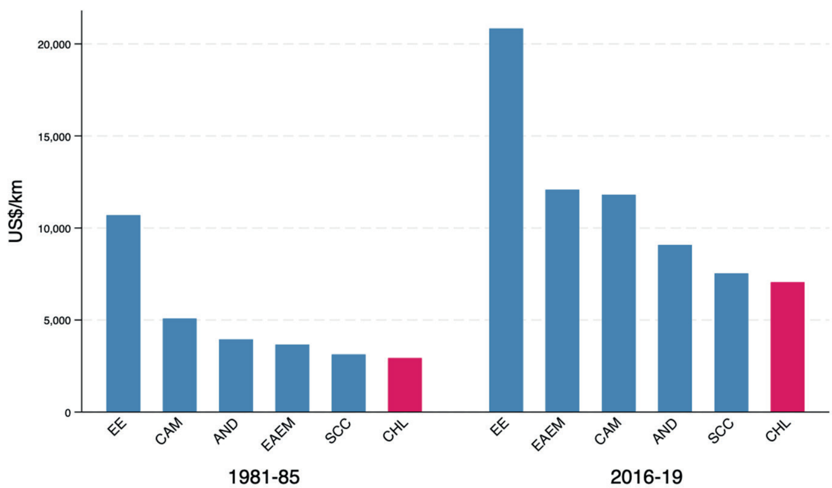
COMPLEX EXPORTS PER CAPITA



Note: AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Subregional grouping described in Table A.1.

Chile's less impressive development of complex exports relative to EAEM is likely related to its remoteness, as these exports commonly develop within GVCs, which are strongly dependent on proximity to large economies. Importantly, Chile's distance disadvantage relative to EAEM's has increased, as its PM index relative to this region decreased from two thirds in 1980 to one half in 2017 (Figure 22). This is likely because the large East Asian economic agglomeration (efficiently linked through sea-based transportation) benefits from a virtuous circle through which the high initial PM of these countries fosters their intraregional exports and economic activity, and this in turn increases the regions PM. As many of these countries still have significant room to converge to the income per capita of advanced countries this virtuous circle will surely continue in coming decades.

FIGURE 22
PROXIMITY TO MARKETS

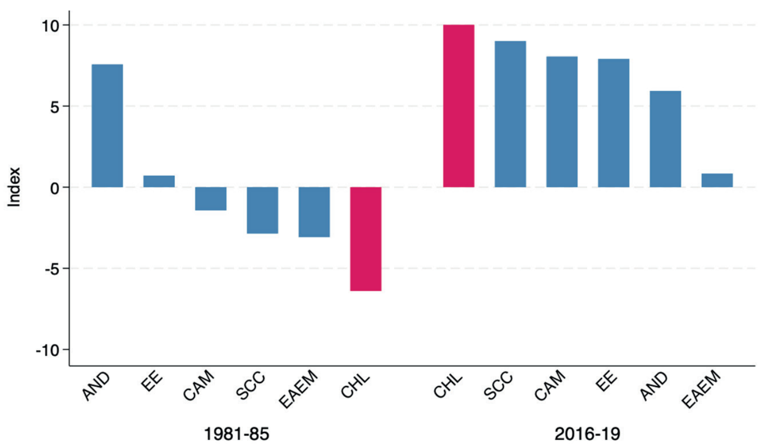


Note: Proximity to Markets is the sum of GDP of partner countries weighted by their distance to the country. Regional acronyms described in Table A.1.

In contrast, Chile's relatively isolated South American neighbors have low PMs and this limits their potential for intraregional export development and economic growth. Without the impulse from a nearby and fast-growing economic agglomeration, Chile's development of non-copper exports has hinged on the strength of its policy determinants of export diversification and complexity.

An important area of progress has been the strengthening of political stability and governance (Figure 23). After a politically unstable period that included an almost two-decade long military government, Chile returned to a democratic system and experienced a long period of uninterrupted development of political and economic institutions. This is reflected in an improvement in its Polity IV index from a negative to the maximum score, reaching the same score as for Australia and New Zealand. And by 2016-19, the World Bank's overall governance index indicates that Chile is considerably ahead of the average in comparator emerging market country groups, as seen in Figure 15.

FIGURE 23
POLITICAL STABILITY INDEX

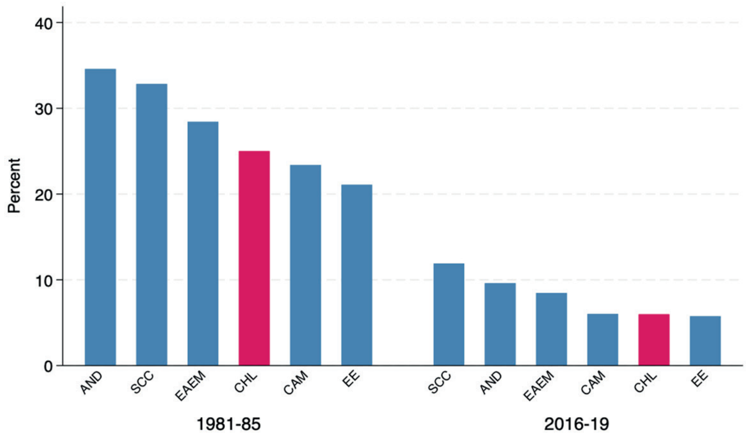


Note: Polity IV Governance Index. AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Regional grouping described in Table A.1.

Chile's progress in liberalizing its trade policies has been particularly outstanding too. Its average Most-Favored-Nation (MFN) tariff has been reduced from about 100 percent in the 1970s to about 25 percent in 1980, and to low single-digit in 2017 (Figure 24). This 95-percentage point reduction in Chile's average tariff on its own is statistically associated to a twenty-fold expansion in complex exports per capita according to estimates in Salinas (2021). Chile is also one of few countries that wiped out non-tariff barriers, and did it ahead of most developing countries, in the 1970s. Moreover, Chile has been notably active in signing Free-Trade Agreements, especially with its largest trading partners, including the United States, East Asian countries, the European Union, Oceanic countries, and other South American countries. Hence, most of Chile's exports and imports are subject to the relatively open trade conditions established in these agreements.

FIGURE 24

AVERAGE IMPORTS TARIFF

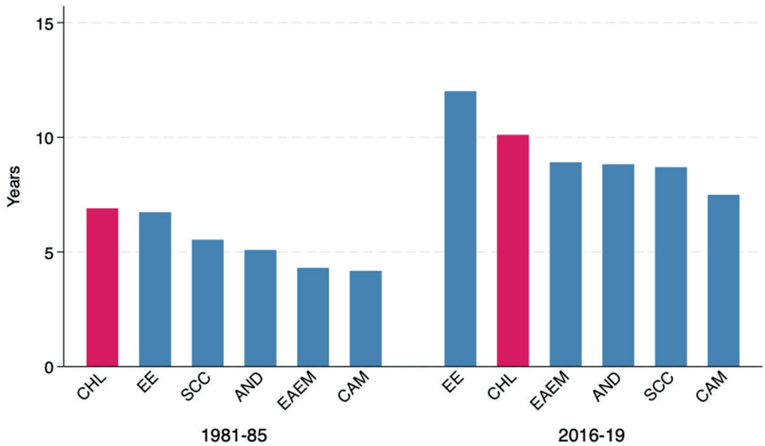


Source: World Development indicators (World Bank)

Note: Simple average imports tariff. AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Regional grouping described in Table A.1.

Chile's educational attainment has been an important contributor to its export's development for several decades. Although its educational attainment has been recently surpassed by the EE region, it remains above that of other emerging market regions, including EAEM (Figure 25). A comparison of Harmonized Test Scores (the measure of quality of learning in the World Bank's School Years Adjusted by Learning Indicator) suggests the quality of learning in Chile is also above other emerging market regions except EE countries (Figure Panel A.2).

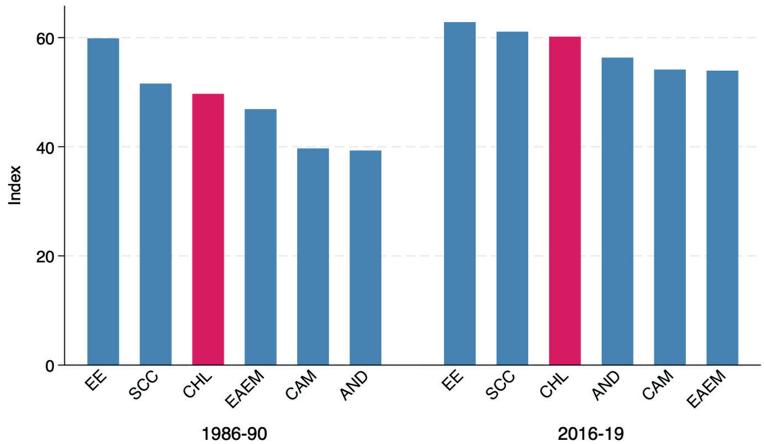
FIGURE 25
EDUCATION ATTAINMENT



Note: Barro-Lee average years of education attainment. AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Regional grouping described in Table A.1.

Infrastructure coverage in Chile has rapidly expanded in recent decades and its quality is superlative in some areas (Figure 26). An index of infrastructure coverage that factors in electricity and phone line infrastructure going back to 1985, shows that Chile's coverage has remained about average among emerging market regions but has closed the gap with respect to Eastern Europe. In addition, the Infrastructure Pillar of the Global Competitiveness Index (World Economic Forum), which factors in quality for a wider set of infrastructure areas, indicates that Chile infrastructure excels in most areas (see Panel Figure A.3). This is particularly the case of ports and electricity quality, identified in Salinas (2021) as the areas of infrastructure most strongly associated with export development.

FIGURE 26
INFRASTRUCTURE



Note: Infrastructure index based on electricity and fixed phone line coverage from World Development indicators (World Bank). AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Regional grouping described in Table A.1.

In light of its geographic disadvantage Chile should aim to foster its exports diversification and complexity by strengthening its policy framework to reach Australia and New Zealand, remote countries that have successfully developed NHM and complex exports way above EE and EAEM countries. Except for trade policy openness, Chile has significant room to catch up with these two advanced countries in all the other three factors associated with export development.

According to regression analysis in Salinas (2021), strengthening these factors could increase Chile's complex exports subtantially. From these estimates it is infered that eliminating the significant gap in the education attaintment gap with respect to, for example, New Zealand is associated with 113 percent increase in complex exports (Table 4). Eliminating the gap in governance and infrastructure relative to New Zealand could increase complex exports by 27 and 26 percent, respectively. And lowering average tariffs to New Zealand's level could increase complex exports by 11 percent. Attaining all these improvements would quadruple Chile's complex exports, considerably nearing the average in EAEM although not attaining EE's average largely because of remoteness (Figure 27).

TABLE 4

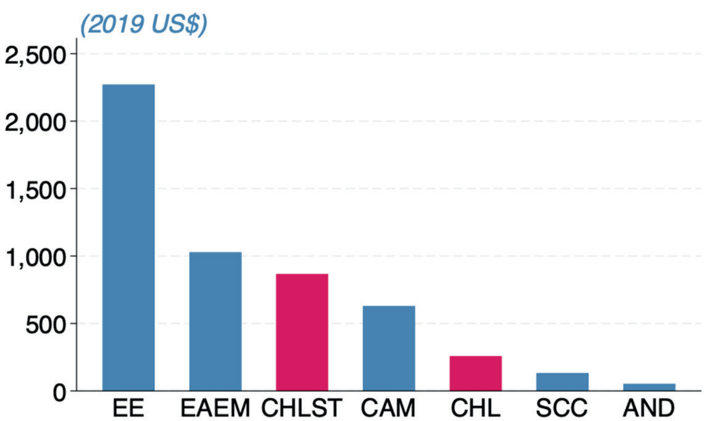
CHILE COMPLEX EXPORTS PER CAPITA IN 2016-19 WITH NEW ZEALAND POLICIES

Description	**US$**
Actual	215
Predicted with New Zealand Policies	
Educational attainment	480
Governance	275
Infrastructure quality	273
Average import tariff	239
Combined policies	867

Source: EBOPS; Hausmann and others (2013); and author's calculations.

FIGURE 27

COMPLEX EXPORTS PER CAPITA IN 2016-19



Source: Hausmann and others (2013).

Note: CHLST stand for Chile Strengthened, the predicted level of Chile with the level of education, governance, and infrastructure of New Zealand.AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern European; SCC=Southern Cone Countries. Regional grouping described in Table A.1.

A simple cross-country analysis suggests that despite its strong performance in export diversification determinants, Chile can still substantially further strengthen them. Figure Panel A4 includes scatter plots with log of GDP per capita in the x-axes and horizontal policies in the y-axes. Countries that appear above (below) best fit lines have stronger (weaker) horizontal policies than expected given their income level. Chile's governance is way above what would be predicted from its GDP per capita, so it is harder to expect more significant improvements in the short run. On education, Chile appears to have as strong education as expected given its GDP per capita, but Eastern European countries like Poland or Ukraine have education levels significantly above the best fit line and broadly like those of much wealthier Western European countries. Chile's infrastructure quality is also about what is expected from its GDP per capita, but those of East Asian countries like China, Malaysia, or Thailand are much higher than predicted, considerably above those in similarly wealthy countries in Latin America. Therefore Eastern Europe and East Asian countries can be thought of as role models of education and infrastructure development, respectively.

6. Conclusions

Chile's development of non-mineral and complex exports has been more successful than implied by commonly used diversification and complexity indices. When observing the level and long term growth of NHM and complex export categories, Chile's performance appears as strong as its overall economic performance and more similar to the average in the high performing East Asian region than to other South American countries. This has been the case despite Chile's remoteness from the large global economic centers and likely a result of its well-recognized efforts to strengthen its institutional development, educational attainment, trade policy openness, and physical infrastructure.

If Chile has low diversification and ranks low in terms of the ECI it is because of exogenous copper abundance and distance to large international markets, not because of an ineffective policy framework. In fact, among remote countries, Chile has seen the fastest growth in exports complexity per capita, owing to its strong horizontal policy framework.

For sure, as described in Lebdioui (2019), Chile has also relied on vertical policies for export promotion, but it did so decades ago and avoiding the now controversial industrial policies that generated major macroeconomic imbalances in many developing countries, such as SOEs or trade protectionism. In contrast, it relied on now widely recommended policies, such as technology transfer and diffusion, R&D support, and export marketing, which are unlikely to lead to macroeconomic disarray. In the 1970s and 1980s, it relied on more controversial credit subsidies, but less so in later decades without apparent impact on its development of NHM exports. Nowadays, with a much larger global capital pool and its very low sovereign spread, financing is not a bottleneck to Chile's exports development.

Going forward, this analysis underscores the need to preserve Chile's leadership in strengthening its economic fundamentals and redouble its efforts to overcome the hurdles imposed by distance to large markets. Australia and New Zealand are role models of high complexity development despite long distance from large international markets. With these countries and other advanced economies as benchmarks, Chile should continue to strengthen governance, education, and infrastructure to reach higher degrees of complexity. Transports infrastructure is particularly important, as this can help reduce the cost imposed by remoteness.

Sectorally, Chile can focus on the development of exports of services and of high value-to-weight products, which are less affected by transportation costs. Improving telecommunications and electricty infrastructure towards the quality level of advanced countries would be key to foster exports of services. In general, technology will clearly be Chile's best ally in overcoming its distance hurdle.

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Appendix

APPENDIX 1: EXPORT COMPLEXITY AND COMPLEX EXPORTS

Although not part of mainstream economic growth or international trade theory, the concept of *Economic Complexity* presented in Hidalgo and Hausmann (2009) has attained a significant impact in the empirical public policy literature, with this paper having over three thousand citations to date (according to J-STOR). More importantly, the concept of *Economic Complexity* is now widely acknowledged and used in policy analyses in think tanks (for example, Escobari and others, 2019; Mealy and Colyle, 2021), flagship publications of international organizations (for example, World Bank, 2019; International Monetary Fund, 2015), and in governmental analytical units some of which, as mentioned in Hidalgo (2021), have created complexity data observatories in ministries of economy or production, and national innovation or statistics agencies. *Economic Complexity* data observatories have been set up in Harvard University and MIT.

The *Economic Complexity Indicator* (ECI) that is produced under this conceptual framework aims to measure the complexity of an economy through its export basket, using an algorithm that produces an ECI that is higher for export baskets that are more diverse and have higher exports of goods that are produced by fewer countries. See Hidalgo (2021) for a recent technical description of the ECI. Also under this framework, a Product Complexity Index (PCI) is elaborated, which assigns higher scores to goods that are produced by fewer countries.

Although not directly rooted in conventional economic theory, this indicator is broadly related to the well-established empirical facts that (i) advanced economies tend to produce a large variety of products, and (ii) more complex products (for example, iPhones or airplanes) are produced by a small number of countries.

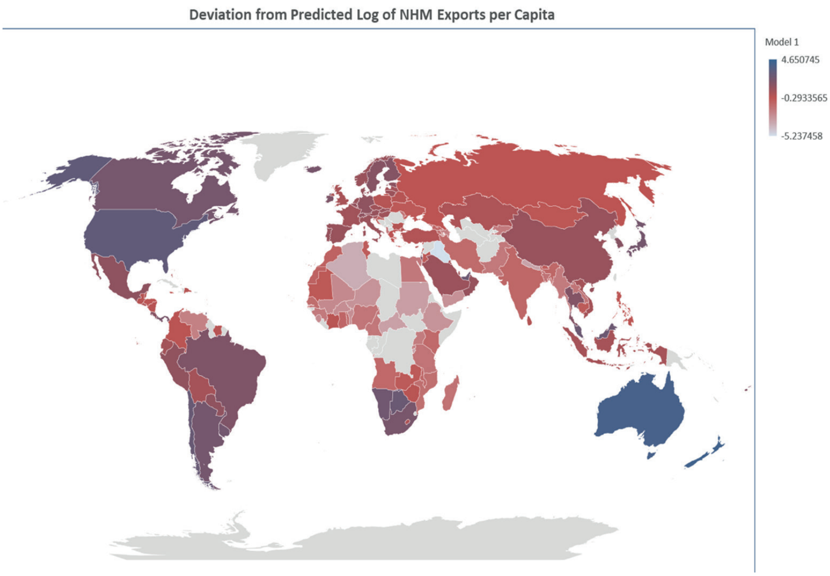
As indeed, more complex goods are produced in only few countries, the PCI does rank highest those products that are widely considered more complex (for example, machinery for specialized industries) and lowest products like raw hydrocarbon and mineral commodities that are widely considered less complex. However, as is explained in the main text of this paper, the ECI is determined exogenously by stocks and prices of hydrocarbon and mineral products, which is not related to a country's capabilities to produce and export complex products that the creators of the ECI intend to measure.

TABLE A1
LIST OF COUNTRIES BY REGIONAL GROUP

Region	Region Code	Countries
Andean	AND	Bolivia, Colombia, Ecuador, Peru, Venezuela
Arab	ARB	Algeria, Bahrain, Djibouti, Egypt, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tunisia, UAE, Yemen
Central Asia	CA	Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan
Central Am & Mexico	CAM	Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama
Caribbean	CAR	Antigua & Barbuda, Bahamas, Barbados, Belize, Cuba, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, St. Kitts & Nevis, St. Lucia, St. Vincent, Suriname, Trinidad & Tobago
East Asia Emerging	EADM	Cambodia, China, Fiji, Indonesia, Lao PDR, Malaysia, Mongolia, Myanmar, Philippines, Thailand, Timor-Leste, Vietnam
East Asia High Income	EAIH	Brunei, Hong Kong, Japan, Korea, Macau, Singapore, Taiwan
East Asia Others	EAOHT	Australia, New Zealand, Papua New Guinea
Eastern Europe	EE	Albania, Bosnia Herz., Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Kosovo, Latvia, Lithuania, Moldova, Montenegro, North Macedonia, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, Ukraine
EU	EU	European Union
Pacific Isl.	PAC	Tonga, Tuvalu, Vanuatu
South Asia	SAR	Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka
Southern Cone	SCC	Argentina, Brazil, Chile, Paraguay, Uruguay
Scandinavia	SCN	Denmark, Finland, Iceland, Norway, Sweden
Sub-Saharan Africa	SSA	Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Rep, Chad, Comoros, Congo, Dem. Rep. Congo, Côte d’Ivoire, Djibouti, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, São Tomé & Príncipe, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Tanzania, Togo, Uganda, Zambia, Zimbabwe

FIGURE A1

DEVIATION OF ACTUAL EXPORTS FROM PREDICTED-BY-DISTANCE EXPORTS



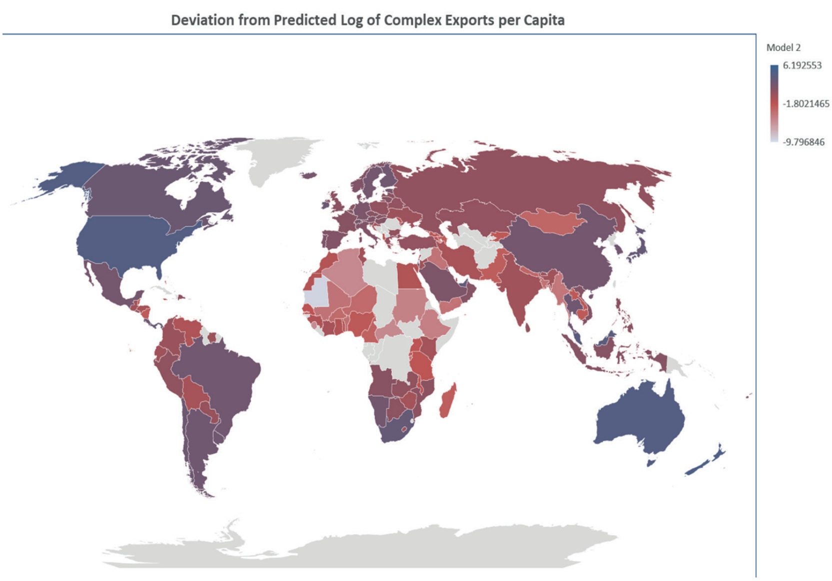
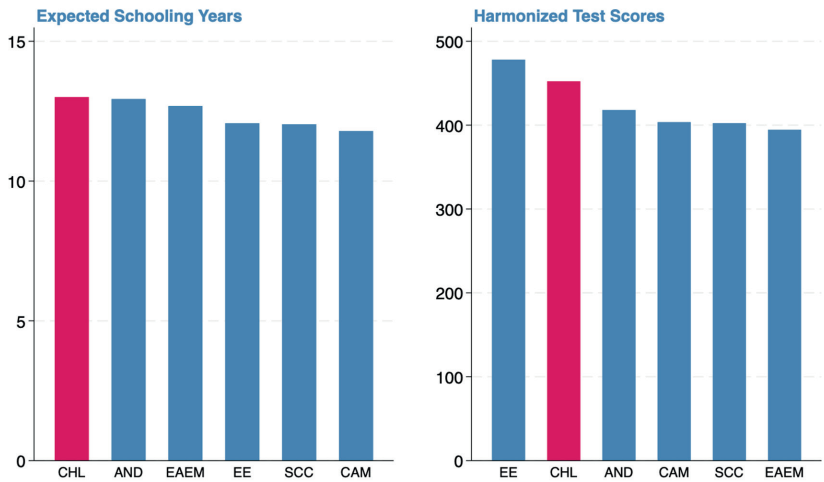


FIGURE A2

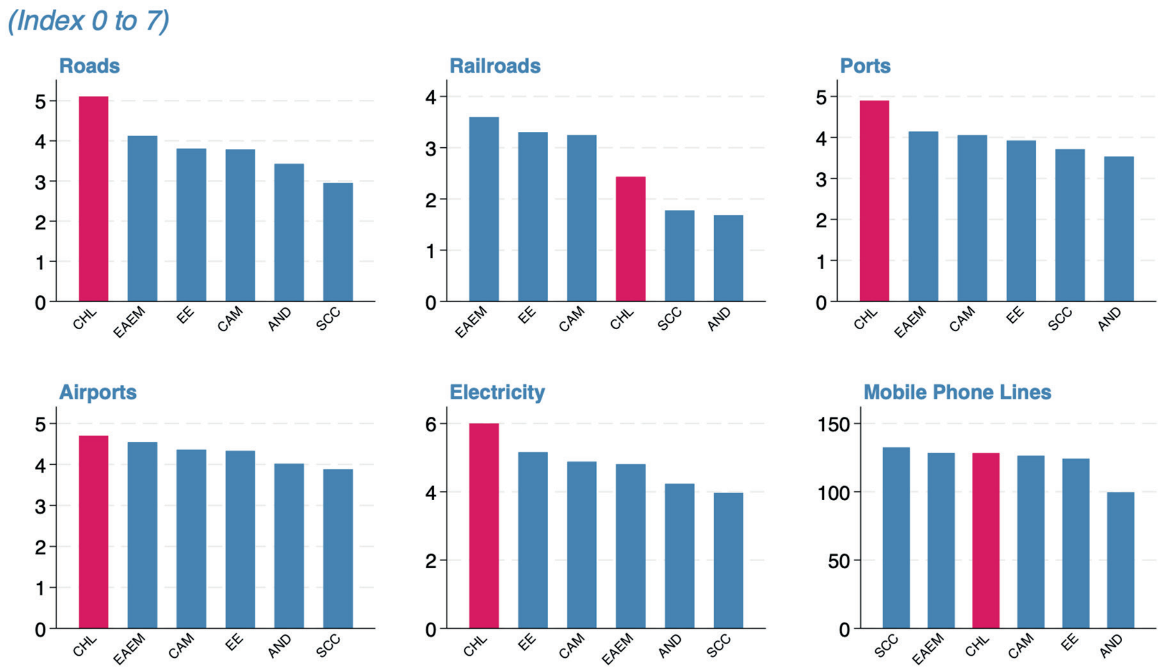
HUMAN CAPITAL COMPONENTS IN CHILE AND COMPARATORS



Note: Country acronyms are ISO3. AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern Europe; SCC=Southern cone countries. Regional subgroupings described in Table A.1.

FIGURE A3

INFRASTRUCTURE SUBINDICES IN CHILE AND COMPARATORS IN 2017

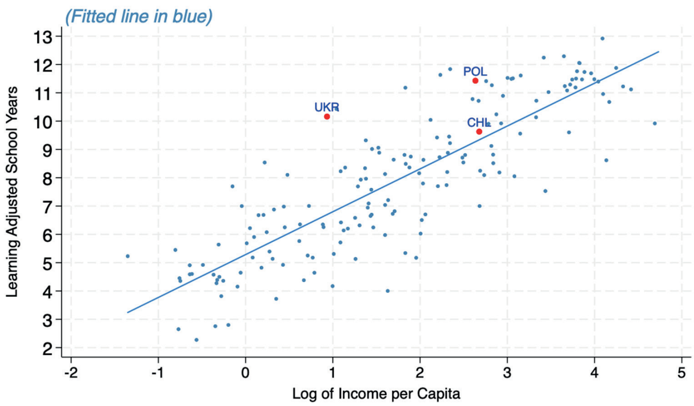


Source: Global Competitiveness Report (World Economic Forum).

Note: Country acronyms are ISO3. AND=Andean countries; CAM=Central America and Mexico; EAEM=East Asia Emerging Markets; EE=Eastern Europe; SCC=Southern cone countries. Regional subgroupings described in Table A.1.

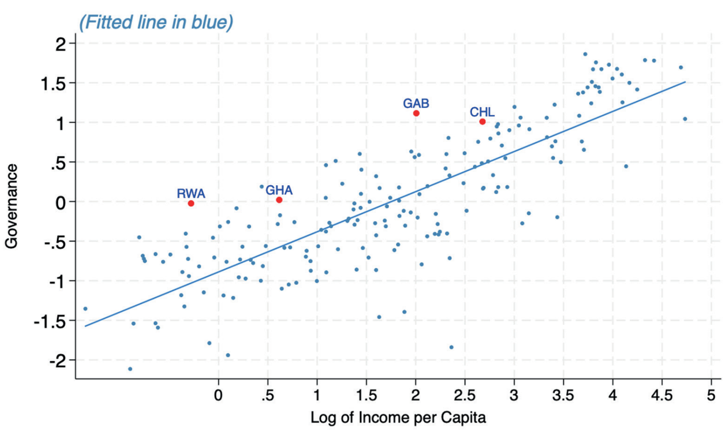
FIGURE A4
EXPORTS DETERMINANTS AND GDP PER CAPITA

LEARNING ADJUSTED SCHOOL YEARS VS. INCOME PER CAPITA



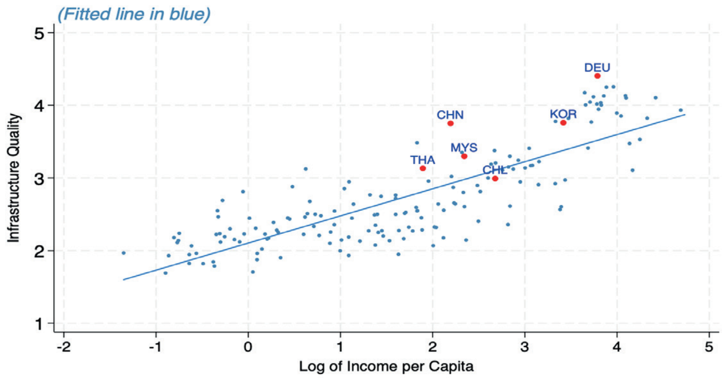
Source: Human Capital Indicators and World Development Indicators (World Bank).
Note: Acronyms are ISO3. Values are averages of available years in 2016-19.

GOVERNANCE VS. INCOME PER CAPITA



Source: Worldwide Governance Indicators and World Development Indicators (World Bank).
Note: Acronyms are ISO3. Values are averages of available years in 2016-19.

INFRASTRUCTURE VS. INCOME PER CAPITA



Source: Logistics Performance Indicators (World Bank).

Note: Acronyms are ISO3. Values are averages of years 2016-19.

Exploring the Effects of FTAs on Chilean Exports: Heterogeneous responses and Financial Constraints*

Explorando los Efectos de loa ALCs en las Exportaciones Chilenas: Respuestas Heterogéneas y Restricciones Financieras

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EUGENIA ANDREASEN***

Abstract

In this paper, we examine the influence of Free Trade Agreements (FTAs) on Chilean exports during the past thirty years. Over the last three decades, Chile has entered into 31 FTAs with 65 countries, encompassing nearly 90% of global GDP. Despite this, there's a notable absence of empirical evidence regarding the extent and nature of the impact of these agreements on export volumes and product diversification. With a rich dataset encompassing bilateral trade flows at the product-level and key financial indicators, we employ a difference-in-differences approach to provide robust evidence of the positive impact of these FTAs on export levels and the variety of products exported. Our analysis also reveals variations in these effects based on the industries' initial export share and trading partners' income levels. Furthermore, we investigate how FTAs interacted with the financial development and capital control policies of trading partners, demonstrating their role in mitigating financial constraints on trade.

Key words: *International trade, Free trade arrangements, Heterogeneous effects, financial frictions.*

JEL Classification: *F1, F13, F14, F63*

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Resumen

En este trabajo se examina la influencia de los Acuerdos de Libre Comercio (ALCs) en las exportaciones chilenas durante los últimos treinta años. A lo largo de las últimas tres décadas, Chile ha suscrito 31 ALC con 65 países, que representan cerca del 90% del PIB mundial. A pesar de esto, existe poca evidencia empírica respecto al alcance y naturaleza del impacto de estos acuerdos en volúmenes exportados y diversificación de las exportaciones. Usando una base de datos de flujos bilaterales de comercio a nivel de producto complementada con información de variables claves de desarrollo financiero, se emplea un análisis de diferencias en diferencias para proporcionar evidencia robusta del impacto positivo de estos ALCs en los niveles de exportación y el número de productos exportados. Nuestro análisis revela diferencias en estos efectos dependiendo de la importancia inicial del sector y de los niveles de ingreso del socio comercial. Además, se investiga el efecto interactivo de ALCs con desarrollo financiero y controles de capitales en el socio comercial, mostrando que los acuerdos son útiles para mitigar el impacto de las restricciones financieras en el comercio internacional.

Palabras clave: *Comercio internacional, acuerdos de libre comercio, efectos heterogéneos, fricciones financieras*

Clasificación JEL: *F1, F13, F14, F63*

1. Introduction

Chile, as an early adopter of progressive economic reforms in Latin America, has been a pioneer in pursuing Free Trade Agreements (FTAs) as a strategic trade policy. Since the restoration of democracy in 1990, successive democratic governments have pursued this strategy with the primary objective of expanding access to foreign markets and bolstering export diversification. This approach builds upon Chile's earlier experiment with unilateral trade liberalization in the 1970s and 1980s, rendering Chile an interesting setting for studying the effects of selective trade policies. While some studies have explored the effects of certain agreements, a comprehensive evaluation of their overall impact is still missing.

The existing literature has identified large and positive effects of FTAs on international trade (Rose, 2004; Baier and Bergstrand, 2007, 2009; Eicher and Henn, 2011). This is in contrast to unilateral trade liberalization, where the increase in exports may not be as pronounced, except for potential second-round or indirect effects of tariff reductions on inputs (Eicher and Henn, 2011). Additionally, the literature has found that the magnitude of the increase in exports triggered by FTAs depends on various factors, such as the price elasticity of export demand and the presence of fixed costs in exporting. Baier et al. (2019) show evidence of heterogeneous effects of the FTAs depending on distance, ex-ante trade frictions and the ability to influence the trading partners' terms of trade.

For the case of Chile, several papers have studied specific FTAs, finding overall positive effects in terms of volume of exports but with heterogenous findings with regards to product differentiation (Chumacero et al., 2004; Jean et al., 2014a; Malhotra and Stoyanov, 2008; Wehner, 2011). However, a comprehensive evaluation capturing the heterogeneous impacts of these agreements is still missing. In light of the varied and sometimes contradictory findings in the literature, this paper aims to provide a comprehensive evaluation of the effects of FTAs on Chilean exports and product differentiation, examining not only the overall effects but also the substantial heterogeneity within.

Our central investigation focuses on whether FTAs have indeed led to a significant increase in the value of Chilean exports and a broader range of exported products. Furthermore, we aim to uncover which industries have benefitted the most from these agreements and whether the effects of FTAs are moderated or accentuated by specific characteristics of our trading partners, such as their income levels and financial development. We also explore whether FTAs can act as a counterbalance, mitigating the adverse consequences of low levels of financial development and capital account restrictions.

One of the key debates regarding the effectiveness of FTAs in Chile revolves around the issue of export diversification and sophistication. Some argue that these agreements have not succeeded in diversifying the Chilean economy, which remains heavily dependent on commodities like copper (Peres-Cajías et al. (2021); Dingemans and Ross (2012)). However, others contend that, after decades of varying emphasis on trade policy, Chile's performance has exceeded expectations based on its fundamentals. Lebdioui (2019) indicates that: "Chile has managed to diversify and develop new competitive sectors by being proactive". A similar view is shared by Salinas (2021), highlighting the increase in export diversification and sophistication in spite of the distance to world markets. Our paper contributes to this debate by providing evidence of positive effects of FTAs not only on the value of exports but also on the number of exported products.

To explore these issues, we make use of a rich dataset that encompasses bilateral trade flows at the product level, supplemented by standard gravity indicators and financial data. We apply a robust difference-in-differences approach, capitalizing on the timing differences in the implementation of FTAs with various countries. Our primary aim is to uncover the diverse impacts of these agreements across different industries and characteristics of our trading partners, thus enriching our comprehension of Chile's overarching trade policy.

Our findings provide valuable insights into the varied effects of FTAs across different industries and attributes of trading partners. We demonstrate that the impact of FTAs varies significantly at the industry level, depending on the initial export share of each industry. Interestingly, this effect follows a non-linear pattern, with a more substantial positive impact observed for industries with lower and intermediate initial export shares. In contrast, industries with export shares in the higher range of the distribution experienced a negative impact, both in terms of the value of exports and the number of exported products. This pattern aligns with the notion that high initial export shares were associated with traditional exports, where Chile (supposedly) possessed significant comparative advantages. It suggests that these sectors, with well-established comparative advantages, had already experienced growth before the FTAs, while the FTAs played a crucial role in facilitating the expansion for new products/sectors.

Furthermore, we delved into the role of financial development and the presence of capital control restrictions in shaping the repercussions of FTAs on exports. This analysis is related to the literature exploring the relationship between exports and financial constraints. In these theories, limited access to financing can prevent the entry of firms into international markets (Chaney (2016); Manova (2013) and Feenstra et al. (2014)). Our findings unveiled that FTAs tend to exert a more pronounced positive impact when linked with countries with relatively lower levels of financial development. Moreover, the existence of capital control restrictions appeared to amplify the positive effects of FTAs.

All in all, our study contributes to the literature by providing a comprehensive analysis of the multifaceted impacts of FTAs on Chilean exports. Our findings highlight the substantial positive effects of FTAs on Chilean exports, reinforcing the rationale behind Chile's strategic pursuit of these agreements. By shedding light on industry-specific impacts and elucidating the roles of financial development and capital controls, our findings enrich the broader comprehension of the implications of trade liberalization. This research can provide valuable guidance to policymakers as they design and implement effective trade policies to stimulate export growth and economic development.

The paper is structured as follows: Section 2 presents the related literature. Section 3 presents the data and describes the identification strategy used in this study. In Section 4, we present the main findings of our analysis. Section 5 explores the role of additional margins of heterogeneity in shaping the effects of the FTAs. Section 6 provides several robustness checks and extensions to validate the robustness of our results. Finally, Section 7 concludes the paper, summarizing the key insights and discussing their implications.

2. Related Literature

Within the context of Chilean trade policy, a multitude of studies have examined the influence of Free Trade Agreements (FTAs) on the country's export dynamics. For instance, Malhotra and Stoyanov (2008) found that the FTA between Chile and Canada led to a significant 35 percent increase in Chilean agricultural exports to Canada, a result consistent with the observations of Wehner (2011), who conducted a descriptive analysis demonstrating export expansion in several sectors following the Chile-Canada FTA. Wehner (2011) also extended this analysis to other FTAs, revealing that Chile's exports similarly increased in the wake of agreements with countries such as the U.S., Mexico, Panama, South Korea, Japan, and China.

In the Chilean context, several ex-ante evaluations have been conducted (Chumacero et al., 2004; Nowak-Lehmann D. et al., 2007). For instance, Chumacero et al. (2004) postulate that the FTA with the U.S. would not only elevate trade flows and welfare but also diminish risk premiums for the Chilean economy. Examining the FTA with the European Union, Nowak-Lehmann D. et al. (2007) predict positive effects, especially in the fruit industry. However, López Giral et al. (2022) conclude that the FTA with Korea did not significantly contribute to diversifying Chile's export portfolio.

Turning to computable general equilibrium models, Jean et al. (2014b) employ this methodology to estimate the impact of the FTA with the European Union, revealing a positive influence on Chilean exports. Employing a similar approach but with a focus on environmental effects, O'Ryan et al. (2010) also document an expansion of Chilean exports resulting from agreements with the European Union and the United States. Furthermore, Heine (2016) delve into the repercussions of the FTA with China, uncovering a substantial surge in Chilean exports.

Our paper is more related to the literature of heterogeneous effects of FTAs. Several works have looked at differences on impact depending on variables such as trade elasticities, distance, the existence of previous agreements, the ex-ante trade barriers. and the ability of affecting terms of trade (Jung (2023); Baier et al. (2018); Baier et al. (2019))

While existing research provides valuable insights into the impacts of specific FTAs, this paper contributes to the literature by offering a comprehensive evaluation of the effects of FTAs on Chilean exports, encompassing diverse industries and trading partner attributes. It extends beyond a single FTA to provide a broader understanding of Chile's overall trade policy strategy and its implications for export growth and diversification.

3. Data and Empirical Strategy

For the purpose of this paper, we merge two data sets. The first data set contains information on bilateral trade flows at the 6-digit product level obtained from the "International Trade Database at the Product-Level (BACI)" provided by the Centre for Prospective Studies and International Information (CEPII). This comprehensive database encompasses trade information for more than 200 countries and 5,000 products spanning the period from 1994 to 2007. Using this dataset, we construct our variables of interest, including the total value of Chilean exports in dollars and the number of exported products, categorized by two-digit industry for each trading partner.

We merge the BACI database with the "Gravity" database, also sourced from CEPII, which includes standard gravity indicators such as income per capita and population. Additionally, we incorporate data on the ratio of credit to the private sector to GDP from the Global Financial Database and the bilateral exchange rate with Chile from the WEO database, both provided by the World Bank.

Finally, we incorporate to the export database, information on the FTAs signed by Chile from the Subsecretaría de Relaciones Económicas Internacionales de Chile. Since the return of democracy, Chile has signed 31 FTAs, covering 65 countries that together represent almost 90% of the world GDP. Using this information, we construct a dummy that takes the value of 1 from the year after the agreement has been signed onwards.

Table 1 presents a summary of the FTAs signed by Chile by country and specifying the year in which it was implemented. Table 2 presents the summary statistics of the main variables at the industry/country level. Our final sample has 112,867 observations.

TABLE 1

FTAS SIGNED BY CHILE SINCE 1995

Year	Countries
1997	Urnguay, Paraguay, Brazil. Argentina
1998	Canada
2000	Mexico
2002	Slovenia, Crimea
2003	Sweeden, Portugal. Netherlands, Luxemburg, Italy, Ireland. Greece, Great Brit-ain,France. Finland, Spain. Denmark Deutschland, Belgium, Austria
2004	USA, Slovenia, Slovakia, Poland, Malta, Latvia, Lithuania, Korea, Hungary, Estonia, Chezc Republic, Cyprus
2005	Norway, Iceland, Switzerland
2006	Singapur, New Zealand, Brunci Darussalam
2007	China, Bulgaria
2008	Panama, Japan
2009	Peru, Honduras, Colombia, Australia
2010	Guatemala
2011	Turchia
2012	Malaysia
2013	Nicaragua, Croatia
2014	Vietnam
2013	Hong Kong
2020	Indonesia

TABLE 2

SUMMARY STATISTICS

Variables	(1) N	(2) Mean	(3) SD	(4) Min	(5) Max
FTA	112,867	0.440	0.496	0	1
Products	112,867	1.212	1.146	0	5.919
Exports	112,867	4.154	3.633	-6.908	16.27
Population	112,867	9.591	1.813	1.506	14.16
Income p.c.	112,867	9.715	1.018	5.455	11.70
Share_1996	112,867	0.015	0.038	0.000	0.269
High Income(Dummy)	112,867	0.481	0.500	0	1
Low Fin. Dev. (Dummy)	112,867	0.701	0.458	0	1
Cap.Control (Dummy)	112,867	0.786	0.410	0	1

Note: Exports and products are expressed in logs. The original unit of the variable is thousands of dollars for exports and units for products.

3.1 Empirical Strategy

The primary objective of this study is to explore the effects of FTAs on the value of exports and the number of exported products. Then our baseline regression considers a difference in differences approach for bilateral exports:

$$(1) \qquad Y_{s,c,t} = \alpha + \beta FTA_{c,t} + \gamma X_{c,t} + \omega_s + \omega_c + \omega_t + \mu_{s,c,t}$$

where s,c,t stands for industry, country (trade counterpart) and time respectively. Ys,c,t are the specific dependent variables of interest: value of exports and number of products in logs, FTAc,t is a dummy that takes the value of one for the period after the agreement was signed. Xc,t is a group of time-varying country control variables based on the gravity model that include income per capita and population.[1] The ω represent fixed effects by industry s, country c and time t. Errors are clustered at the country-time level.

Additionally, we explore whether the ex-ante relative importance of each sectors' exports in total exports-which it is considered as a proxy for comparative advantage- plays a significant role in shaping the industry's response to the FTA. Few papers have explored whether comparative advantage enhances or ameliorates the effects of reduction in trade barriers. Similar to our estimations, Ahmed (2023) finds some weak evidence of this heterogeneous impact in the case of the FTA between China and Pakistan. To this end, we construct the variable Shares which is the average share of exports of the sector with respect to the total in 1996, i.e., before any of the FTAs in our sample was signed.

Traditional industries may potentially experience a differential (lower) impact from the FTAs due to their pre-existing low tariffs in destination markets. However, it is also plausible that the impact could be higher in these industries if there is an opportunity to introduce new products in sectors where the Chilean economy holds a comparative advantage. To discern which of these two channels is more relevant, we also estimate the following regression:

$$(2) \qquad Y_{s,c,t} = \alpha + \beta_1 FTA_{c,t} + \beta_2 FTA_{c,t} * Share_s + \beta_3 FTA_{c,t} * Share2_s + \gamma X_{c,t} + \omega_s + \omega_c + \omega_t + \mu_{s,c,t}$$

Where we include $Share_s$ and $Share2_s$ to allow for non-linearities on the impact of the interaction. Our baseline regression includes industry, trading partner and year fixed effects.

[1] In Table 7 we show that these results are robust to including also private credit to GDP and the bilateral exchange rate as additional controls. However, since by doing so we lose almost half of the observations of the baseline.

4. Main Results

Columns (1) and (5) of Table 3 present the results of our baseline regression for value of exports and number of products, respectively. Results show that the impact of FTAs is positive and significant, with exports growing about 7,1% and the number of exported products growing by about 4,5%. The gravity control variables show the expected relationship with Chilean exports, i.e., exports increase on the population and income of the trading partner.

Columns (2) and (6) incorporate the interaction of the FTA with the industry level variable Shares and Share2s. Panel (a) of Figure 1 complements the analysis by showing the magnitude of the impact of the FTA on exports across industries with different participation in total exports, by calculating the partial effect of the FTA at different levels of the variable Shares:

$$\frac{\partial Y_{s,c,t}}{\partial FTA} = \beta_1 + \beta_2 Share_s + \beta_3 Share2_s \quad (3)$$

Both the table and the figure suggest that the effect of the FTAs is heterogeneous on the relative importance of the sector on overall exports. In particular, we find that there is a significant increase in the volume of exports and number of exported products for industries with a positive but relatively low ex-ante share in total exports, while the positive effect shades away and even becomes negative in terms of the number of products for sectors with an ex-ante participation close to 30%. As a result, our findings support the notion that FTAs tend to benefit industries with a pre-existing export presence, but the magnitude of these effects seems to be reduced for industries in the far-right tail of the export share distribution. This pattern is considerably more pronounced is for the value of exports than for the number of exported products.

While the inclusion of income per capita, population of the trading partner, and time fixed effects allows us to control for some aggregate factors other than the FTAs that might influence the response of exports, there is still a possibility of unobservable variables at the aggregate level that could be correlated with the FTA, potentially introducing bias in our estimation (see also Table 7 for a version of the baseline with additional macroeconomic controls). To address concerns about the impact of macro-level variables on the heterogeneous results, we incorporate country-time-fixed effects in columns (3) and (7) of our baseline regression. Notably, the coefficients of the interaction term β2 maintain their sign and significance levels, and their magnitudes remain very similar. This suggests that our baseline regression effectively controls for relevant aggregate confounding factors

TABLE 3

EFFECTS OF FTAS ON VALUE OF EXPORTS AND NUMBER EXPORTED PRODUCTS

Variables	**(1) Exports**	**(2) Exports**	**(3) Exports Country-year FE**	**(4) Exports Add. margins**	**(5) Products Full Sample**	**(6) Products Full Sample**	**(7) Products Country-year FE**	**(8) Products Add. Margins**
FTA	0.071** (0.032)	-0.072** (0.035)		-0.070 (0.062)	0.045*** (0.015)	0.027* (0.016)		-0.029 (0.026)
FTA*Share_1996		17.017*** (1.612)	17.177*** (5.759)	17.096*** (1.612)		3.017*** (0.412)	2.489*** (0.411)	3.008*** (0.412)
FTA*Share_1996^2		-53.237*** (6.148)	-53.283* (20.282)	-53.542*** (6.148)		-13.600*** (1.586)	-11.707*** (1.577)	-13.578*** (1.586)
FTA*High				-0.257*** (0.058)				-0.005 (0.025)
FTA*Low_FinDev				0.097* (0.050)				0.074*** (0.022)
CC				-0.043 (0.050)				0.016 (0.019)
FTA*CC				0.194*** (0.053)				0.047* (0.023)
Population	1.104*** (0.148)	1.102*** (0.148)		1.007*** (0.155)	0.469*** (0.076)	0.469*** (0.076)		0.484*** (0.079)
Income p.c.	1.115*** (0.082)	1.094*** (0.082)		1.015*** (0.085)	0.362*** (0.048)	0.360*** (0.048)		0.372*** (0.051)
Observations	112,867	112,867	112,867	112,867	112,867	112,867	112,867	112,867
R-squared	0.530	0.532	0.550	0.532	0.614	0.615	0.642	0.615
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	NO	NO	YES	YES	NO	YES
Year FE	YES	YES	NO	NO	YES	YES	NO	YES
Country-Year FE	NO	NO	YES	YES	NO	NO	YES	NO

Robust standard errors in parentheses ***p<0.01,**p<0.05,*p<0.1

Note: This table examines the effect of F T As and the interaction of F T A with Shares on the value of exports and number of exported products at the industry level. Columns (4) and (8) also include the interaction with additional margins of heterogeneity: trading partner's income and level of financial development and whether capital controls are in place. All regressions include industry-fixed effects, and either country and time-fixed effects or country-time fixed effects. Robust errors clustered at the country-year level are reported in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

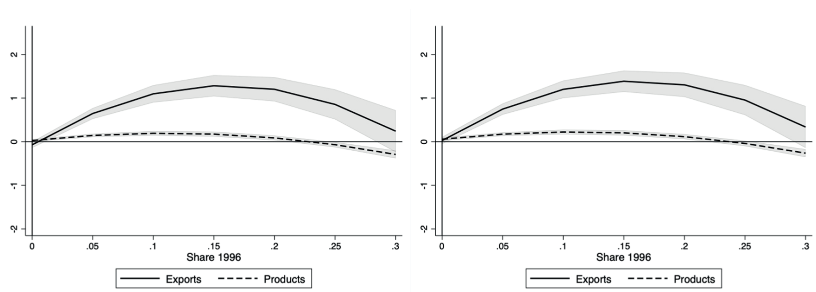
5. Additional Margins Of Heterogeneity

In addition to the participation of the industry in total exports, other factors may potentially shape FTAs' impact. The existing literature underscores the significant influence of both income levels and financial development in shaping international trade patterns and consequently the heterogeneous impact of FTAs (Baier et al. (2019) and Yamanouchi (2019)).

Income levels play a pivotal role in shaping the impact of FTAs as they are closely linked to a country's trade patterns and product composition. When signing an FTA with higher-income countries, characterized by diverse and technologically advanced industries, it can be challenging for a country like Chile to shift its exports towards higher-value-added goods and services. In contrast, when engaging in FTAs with lower-income countries, which are often reliant on primary commodities or lower-skilled manufacturing, Chile may gain competitiveness in new industries and develop a comparative advantage in non-traditional sectors. Therefore, we hypothesize that the effects of FTAs on the volume of exports and product differentiation can vary depending on the income level of the trading partner, leading to heterogeneous trade outcomes.

FIGURE 1

HETEROGENEOUS EFFECT OF FTAS SAMPLE



(a) Baseline (b) Additional margins of heterogeneity

Note: Panel (a) depicts graphically the regression results from columns (2) and (6) of Table 3. Panel (b) depicts graphically the regression results from columns (4) and (8), i.e., when including the additional margins of heterogeneity. The vertical axis measures the percentage change in the corresponding dependent variable triggered by the FTA for each level of Share, which is measured on the horizontal axis. The solid and dotted lines show the estimated effect of the FTA for each level of Share for the value of exports and number of products, respectively. The shaded areas are the corresponding 95 percent confidence intervals.

Financial development, a fundamental driver of international trade facilitation, also plays a crucial role in this context. Approximately 40 percent of global trade transactions rely on bank-intermediated trade finance, while the remainder is facilitated by interfirm trade credit (Bank for International Settlements (2014)). As such, it becomes imperative to investigate whether the effects of FTAs on exports are influenced by the trading partner's level of financial development or by its imposition of capital control restrictions. Additionally, exploring whether FTAs can potentially mitigate the negative consequences in terms of trade arising from weaker financial systems or capital account restrictions can provide interesting insights.

To investigate these hypotheses, we adopt two complementary approaches. Firstly, we introduce these additional dimensions of heterogeneity by incorporating interaction terms between the FTA and a set of dummy variables in our baseline regression in Table 3. This enables us to examine the effects of these additional factors while corroborating the robustness of our baseline results when accounting for these considerations. Secondly, we conduct a more detailed exploration of each specific channel in Sections 5.1 and 5.2. Here, we analyze how our findings react across different relevant subsamples, i.e., in terms of income level and financial development.

Columns (4) and (8) of Table 3 and Panel (b) of Figure 1 present the results of the first approach. The interaction with each dummy explores how the effect of FTAs is affected by these additional margins. The High dummy takes the value of one when the trading partner belongs to the High-income group of countries, according to the definition of the World Bank, and zero otherwise. The Low FinDev dummy takes the value of one when the ratio of domestic credit to the private sector to GDP in the trading partner is on the left 75% tail of the distribution in the three years before the signing of the FTA.[2] Finally, the dummy CC takes the value of one when capital controls are in place in the country.[3] The results of this first approach show that FTAs are more beneficial when signed with countries that do not have a high income level that have lower levels of financial development and that have capital controls in place. Additionally, the comparison of the coefficients of the interactions with the

[2] The data on credit is from the Global Financial Database of the World Bank.

[3] For the CCs measures we use the database of Fernandez et al. (2016). This database contains information on a comprehensive set of indicators on capital account restrictions using the information provided in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) from to 1995 to 2021. This database provides information on restrictions on international inflow and outflows of equity, bonds, money market, collective investment, derivatives, commercial credits, financial credits, guarantees, direct investment and real estate. Whenever a restriction is active in any of these categories, the individual indicator takes the value of 1 and zero otherwise.

Share variable shows that this effect remains basically unchanged with the introduction of the additional margins. In the next sections, we explore each of these margins in more detail.

5.1 Terading Partners With Different Income Levels

In this section, we dig deeper on the role of different income levels of the trading partner in shaping the effect of the FTA. To this end, Table 4 presents the results of our baseline regression when dividing the sample of trading partners into three groups: High Income (columns 1 and 4), Upper middle income (columns 2 and 5) and Lower middle income (columns 3 and 6).[4] Additionally, Figure 2 illustrates the magnitude of the FTA's impact on the value of exports and the number of exported products across industries with different export shares for each subsample.

The table and the figure offer interesting insights into our analysis. In terms of the value of exports, the overall impact diminishes when we shift our focus to high-income countries, yet the heterogeneous pattern persists. Conversely, for upper-middle-income countries, the effect loses significance for industries with low shares, and the heterogeneity pattern undergoes a reversal, with industries boasting larger export shares experiencing more positive impacts. Finally, for lower-middle-income countries, the original pattern remains, but the negative effect of the interaction with Share2 becomes significantly larger, neutralizing the positive impact and generating a significant negative effect on industries with larger shares.

In terms of product differentiation, we observe a similar pattern reversal when considering upper-middle-income countries. This implies that the effect on the number of products for industries with relatively larger shares is negative for high and lower-middle-income countries but marginally positive for upper-middle-income countries. These findings provide valuable insights into how FTAs have varying effects on different industries and countries, depending on their income levels and existing export shares.

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4 We have not included regression results for countries with low income due to the limited number of observations (4,000 aprox.), which makes it impractical to estimate the coefficients.

TABLE 4

HETEROGENEOUS EFFECTS OF FTAS: COUNTRIES WITH DIFFERENT INCOME LEVELS

Variables	**(1) Exports High inc..**	**(2) Exports Upper middle inc.**	**(3) Exports Lower middle inc.**	**(4) Products High income**	**(5) Products Upper middle inc**	**(6) Products Lower middle inc.**
FTA	0.020 (0.048)	0.195*** (0.063)	0.023 (0.098)	-0.046* (0.024)	0.071*** (0.025)	0.096** (0.038)
FTA*Share_1996	13.544*** (1.777)	-11.058*** (3.238)	13.636*** (3.580)	0.043 (0.484)	-3.915*** (0.778)	4.491*** (0.958)
FTA*Share_1996^2	-50.969*** (7.303)	61.371*** (11.627)	-104.361*** (14.596)	-4.919*** (1.886)	14.564*** (2.862)	-25.812*** (3.798)
Observations	54,285	36,610	19,854	54,285	36,610	19,854
R-squared	0.568	0.592	0.414	0.611	0.697	0.560
Controls	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES

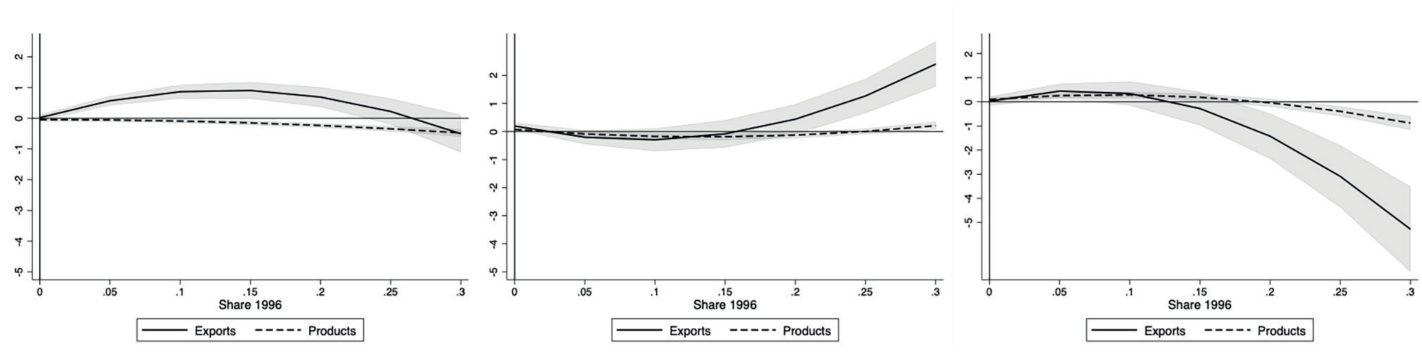
Note: This table examines the effect of F T As and the interaction of F T A with Shares on the value of exports and number of exported products at the industry level while dividing the sample between countries with High- Income level, columns (1) and (4), Upper middle-income level, columns (2) and (5), and Lower middle income level, columns (3) and (6). All regressions include industry country and time-fixed effects. Robust errors clustered at the country-year level are reported in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

5.2 Can FTAs Help Compensate for Low Levels of Financial Development or Capital Account Restrictions?

In this section, we explore in more detail the role of financial development and the presence of capital controls in shaping the effects of the FTA. As argued by Manova (2013), exporting firms face fixed costs related to R&D, product development, marketing, and investment in equipment. Additionally, international trade is subject to export entry costs, fixed export costs, and variable trade costs. Since many of these costs need to be paid upfront, international trade is more financially intensive than domestic sales (Leibovici (2021)). In this context, a pertinent question arises: Can FTAs effectively mitigate the adverse consequences arising from weaker financial systems or capital account restrictions on trade, as discussed by Manova (2008)?

FIGURE 2

HETEROGENEOUS EFFECTS OF FTAS: COUNTRIES WITH DIFFERENT INCOME LEVELS



(a) High income (b) Upper middle income (c) Lower middle income

Note: Panel (a) depicts graphically the regression results from columns (1) and (4) of Table 4 while Panel (b) depicts the regression results from columns (2) and (5) and Panel (c) depicts the regression results from columns (3) and (6) of the same table. The vertical axis measures the percentage change in the corresponding dependent variable triggered by the FTA for each level of Share, which is measured on the horizontal axis. The solid and dotted lines show the estimated effect of the FTA for each level of Share for the value of exports and number of products, respectively. The shaded areas are the corresponding 95 percent confidence intervals.

5.2.1 Financial Development and FTAs

To complement the analysis of Table 3, Table 5 and Figure 3 present the results of our baseline regression when dividing the sample between trading partners with high and low levels of financial development.[5]

In the context of the value of exports, our analysis reveals that the detrimental impact on industries representing a larger share of exports is predominantly associated with FTAs signed with countries with high levels of financial development. Conversely, when FTAs are established with countries having lower levels of financial development, the positive and significant effect on the value of exports persists across the entire range of the Share distribution. Furthermore, this segmentation highlights that the favorable impact of FTAs on the number of products is primarily driven by agreements with trading partners characterized by lower levels of financial development. In contrast, the effect on the number of products turns negative across the entire Share distribution when FTAs are signed with countries possessing high levels of financial development.[6]

TABLE 5

HETEROGENEOUS EFFECTS OF FTAS: FINANCIAL DEVELOPMENT

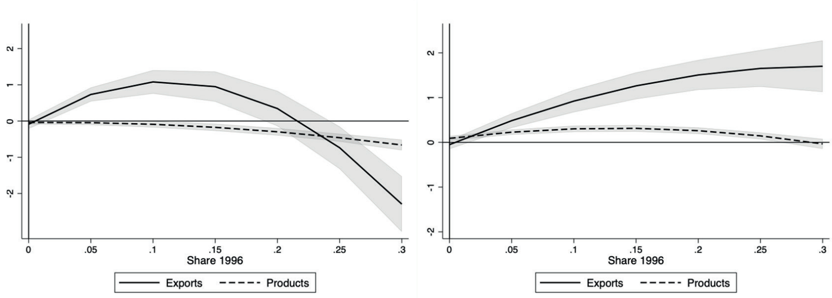
Variables	**(1) Exports H. Fin. Dev**	**(2) Exports L. Fin. Dev**	**(3) Products H. Fin. Dev**	**(3) Products L. Fin. Dev**
FTA	-0.088 (0.063)	-0.052 (0.050)	-0.039 (0.025)	0.090*** (0.025)
FTA*Share_1996	21.193*** (2.613)	11.684*** (2.000)	0.277 (0.677)	3.389*** (0.520)
FTA*Share_1996^2	-95.137*** (9.407)	-19.483** (7.668)	-7.828*** (2.473)	-12.676*** (2.029)
Observations	33,695	79,172	33,695	79,172
R-squared	0.570	0.519	0.632	0.613
Controls	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Note: This table examines the effect of FTAs and the interaction of FTA with Shares on the value of exports and number of exported products at the industry level while dividing the sample between countries with High-Financial development, columns (1) and (2), and Low-Financial development, columns (3) and (4). All regressions include industry country and time-fixed effects. Robust errors clustered at the country-year level are reported in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

5 For this purpose, (as in Table 3) we utilize the ratio of domestic credit to the private sector as a percentage of GDP, sourced from the Global Financial Database of the World Bank. We classify countries with high financial development as those falling within the top quartile of the distribution of this indicator at the time the FTA was signed, while the remaining countries form the low financial development group.

6 It's worth noting that these results remain robust when considering alternative measures of financial development.

FIGURE 3
FTAS AND FINANCIAL DEVELOPMENT



(a) High financial development (b) Low financial development

Note: Panel (a) depicts graphically the regression results from columns (1) and (3) of Table 5 while Panel (b) depicts the regression results from columns (2) and (4) of the same table. The vertical axis measures the percentage change in the corresponding dependent variable triggered by the FTA for each level of Share, which is measured on the horizontal axis. The solid and dotted lines show the estimated effect of the FTA for each level of Share for the value of exports and number of products, respectively. The shaded areas are the corresponding 95 percent confidence intervals.

5.2.2 Capital Controls and FTAs

As pointed out by Tamirisa (1998), capital controls can have a negative influence on international trade by affecting transaction costs, exchange rates, foreign exchange risk hedging, and trade financing. We have already shown in a first approximation in Table 3 that FTAs seem to be more beneficial when signed with trading partners that had CCs in place. Table 6 and Figure 4 further explore this channel by replicating our baseline regression while dividing the sample between those countries with and without capital controls. In line with our findings when considering countries with different levels of financial development, we find that the beneficial effects of CCs are mostly concentrated in those FTAs signed with countries that had CCs in place.

TABLE 6

EFFECTS OF FTAS AND CAPITAL CONTROLS

Variables	**(1) Exports Without CC**	**(2) Exports With CC**	**(3) Products Without CC**	**(4) Products With CC**
FTA	-0.112 (0.076)	0.009 (0.044)	-0.099*** (0.030)	0.059*** (0.018)
FTA*Share_1996	12.734*** (3.754)	17.162*** (1.798)	-1.508 (0.934)	4.085*** (0.464)
FTA*Share_1996^2	-55.406*** (13.062)	-48.029*** (6.975)	3.167 (3.442)	-17.496*** (1.795)
Observations	24,123	88,743	24,123	88,473
R-squared	0.534	0.535	0.652	0.610
Industry FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES

Note: This table examines the effect of F T As and the interaction of F T A with shares on the value of exports and number of exported products at the industry level. All regressions include industry-fixed effects, and either country and time-fixed effects or country-time fixed effects. Robust errors clustered at the country-year level are reported in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Our interpretation of these findings aligns with the notion that international trade, inherently burdened by trade costs and delayed payments, is more susceptible to financial constraints compared to domestic transactions. This insight leads us to anticipate that trade expansion faces limitations imposed by financial frictions. Let’s consider a scenario where a Chilean product receives a trade preference. The question arises: In which country should we anticipate a more substantial increase in exports?

We hypothesize that trade preferences disproportionately impact exports destined for countries facing higher financial constraints. This is grounded in the idea that, in countries with better credit access, exporters encounter fewer limitations from financial frictions, resulting in exports being less benefitted by tariff reductions. Our empirical findings align with this rationale. The positive effects of Free Trade Agreements (FTAs) are more pronounced when established with countries experiencing greater financial constraints. This suggests that FTAs, by reducing costs and enhancing financial linkages, play a crucial role in facilitating trade with more constrained economies.

6. Robustness And Extensions

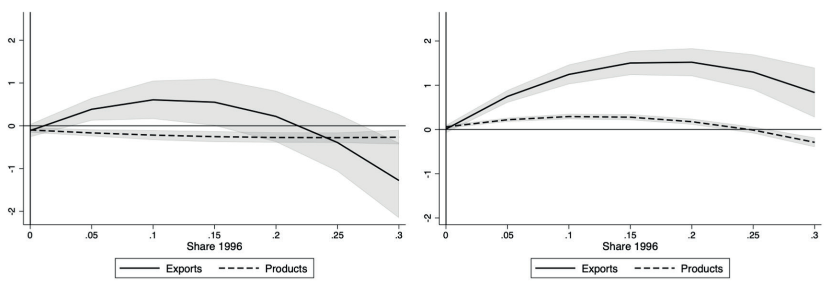
6.1 Excluding Copper and Main Export Destinations

Chile stands as the world's foremost exporter of copper. Given this significant contribution, copper represents a substantial portion of Chilean exports, accounting for approximately 40% to 50% of the country's total export value in recent years. To ensure that our findings are not driven by copper exports, we conduct an additional analysis by excluding copper from our sample. Columns (1) and (2) of Table 7, demonstrate that our baseline results remain qualitatively unchanged when copper is excluded from the industries in the sample. This robustness check validates the reliability of our findings and confirms that copper exports alone do not influence our conclusions.

Following the same logic, columns (3) and (4) of the same table replicate our baseline regressions while leaving out Chile's main trading partners: China and the US, which together represent over 50% of Chile's exports. The estimations show that our results are not driven by these countries either.

FIGURE 4

FTAS AND CAPITAL CONTROLS



(a) Without capital controls (b) With capital controls

Note: Panel (a) depicts graphically the regression results from columns (1) and (3) of Table 5 while Panel (b) depicts the regression results from columns (2) and (4) of the same table. The vertical axis measures the percentage change in the corresponding dependent variable triggered by the FTA for each level of Share, which is measured on the horizontal axis. The solid and dotted lines show the estimated effect of the FTA for each level of Share for the value of exports and number of products, respectively. The shaded areas are the corresponding 95 percent confidence intervals.

6.2 Additional Controls

In our baseline regressions, we incorporated control variables such as income per capita and the trading partner's population. Additionally, we conducted a robustness check by introducing country-time fixed effects into our model, which had no impact on the point estimates of the interaction. However, in Columns (5) and (6) of Table 7, we extend our analysis by including supplementary controls, specifically private credit to GDP and the bilateral exchange rate with the trading partner. Although these controls do not affect the point estimate of the interaction, they result in a significant reduction in the number of observations, with almost half of our data being lost. Consequently, we made the decision to exclude these additional controls from our baseline regression to maintain a larger sample size, ensuring the robustness and reliability of our results.

6.3 Pretrends

One of the essential assumptions for a difference-in-difference estimation is that pre-existing trends are comparable between the treatment and control groups, which, in this context, corresponds to countries with an FTA and those without. We can assess this assumption by incorporating lagged dummy variables for the FTAs. If exports and product trends were evolving similarly for both groups, the coefficients for the lagged variables should not significantly differ from zero. The results in Columns (7) and (8) of Table 7 indicate that previous trends are indeed similar. We find no significant evidence to reject the hypothesis that each parameter for the lagged FTA variable equals zero. Therefore, it appears reasonable to conclude that the identification assumption is satisfied.

TABLE 7

ROBUSTNESS

Variables	(1) No Copper Exports	(2) No Copper Products	(3) No CHN-USA Exports	(4) No CHN-USA Products	(5) Extra Controls Export	(6) Extra Controls Products	(7) Pretend Exports	(8) Pretend Products
FTA	-0.083** (0.036)	0.016 (0.016)	-0.087** (0.036)	0.029* (0.016)	-0.067 (0.047)	-0.000 (0.019)	-0.100* (0.051)	0.040* (0.022)
FTA*Share_1996	27.054*** (2.664)	6.363*** (0.608)	16.475*** (1.641)	3.153*** (0.423)	16.380*** (2.122)	2.331*** (0.529)	17.013*** (1.612)	3.018*** (0.0412)
FTA*Share_1996^2	-150.793*** (19.447)	-46.037*** (4.393)	-52.210*** (6.339)	-14.209*** (1.635)	-39.122*** (8.117)	-10.825*** (2.021)	-53.223*** (6.149)	-13.608*** (1.586)
FTA_1							0.008 (0.063)	0.024 (0.029)
FTA_2							-0.043 (0.061)	-0.015 (0.028)
FTA_3							-0.095 (0.069)	0.03 (0.031)
FTA_4							-0.047 (0.075)	0.037 (0.028)
FTA_5							-0.009 (0.065)	0.046 (0.029)
Priv. Credit/GDP					-0.001** (0.001)	-0.001*** (0.000)		
Bilateral ExR					0.455*** (0.107)	0.143*** (0.039)		
Observations	111,465	111,465	108,928	108,928	68,825	68,825	112,867	112,867
R-squared	0.530	0.615	0.519	0.608	0.512	0.631	0.532	0.615
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	YES	YES	YES	YES	YES
Country FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

Note: This table examines the effect of F T As and the interaction of F T A with shares on the value of exports and number of exported products at the industry level. All regressions include industry-fixed effects, and either country and time-fixed effects or country-time fixed effects. Robust errors clustered at the country-year level are reported in parenthesis. ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

7. CONCLUSION

In this paper, we examine the impacts of Free Trade Agreements (FTAs) on Chilean exports. Chile's extensive engagement in FTAs with various nations has been strategically aimed at increasing exports, bolstering product diversification and expanding market access. However, until now, a comprehensive evaluation of the collective impact of these agreements on Chilean exports was largely absent.

To explore these issues, we make use of a rich dataset that encompasses bilateral trade flows at the product level, supplemented by standard gravity indicators and financial data. We apply a robust difference-in-differences approach, capitalizing on the timing differences in the implementation of FTAs with various countries.

Our findings provide valuable insights into the varied effects of FTAs across different industries and attributes of trading partners. We demonstrate that the impact of FTAs varies significantly at the industry level, depending on the initial export share of each industry. Interestingly, this effect follows a non-linear pattern, with a more substantial positive impact observed for industries with lower and intermediate initial export shares.

Furthermore, we delved into the role of financial development and the presence of capital control restrictions in shaping the repercussions of FTAs on exports. The findings unveiled that FTAs tend to exert a more pronounced positive impact when inked with countries possessing relatively lower levels of financial development. Moreover, the existence of capital control restrictions appeared to amplify the positive effects of FTAs.

In conclusion, our study highlights the substantial positive effects of FTAs on Chilean exports, reinforcing the rationale behind Chile's strategic pursuit of these agreements. By shedding light on industry-specific impacts and the roles of financial development and capital controls, our findings contribute to improve our understanding of the implications of trade liberalization. This research can provide valuable guidance to policymakers.

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Collective Savings Pension Policy in an Economy with Heterogeneity and Informality*

Sistema de pensiones de ahorro colectivo en una economía con heterogeneidad e informalidad

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Abstract

We compare the macroeconomic effects of a fully funded individual defined contribution (IDC) pension scheme, an unfunded pay-as-you-go (PAYG) system, and a collective defined contribution (CDC) regime. Under the latter, contributions of workers from a given cohort are invested in capital markets and repaid to that cohort upon retirement; its collective nature arises from an intragenerational progressive redistributive rule. Our results from an overlapping generations model calibrated for Chile show that the CDC scheme has similar macroeconomic effects as an IDC plan, including a moderate positive effect on the formal labor market, aggregate savings, and output. The PAYG system has negative effects on all these dimensions. Critical for the success of the CDC scheme is conditioning benefits on contributions, to incentivize formal labor status. We conclude that a CDC policy stands as a sustainable alternative for countries with significant labor informality and income inequality.

Key words: *Overlapping generations models; Pension system; Informal labor market; Heterogeneous agents.*

JEL Classification: *E26, E27, H55, J46.*

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Resumen

Se comparan los efectos macroeconómicos de sistemas de pensiones de capitalización individual, reparto y de capitalización colectiva. Bajo este último, las contribuciones de los trabajadores de una cohorte determinada son invertidas en los mercados de capitales y utilizados para pagar las pensiones de esa misma cohorte una vez que esta se retira. Su naturaleza colectiva surge de una regla de redistribución intrageneracional progresiva. Nuestros resultados basados en un modelo de generaciones solapadas calibrado para Chile muestran que este sistema tiene efectos macroeconómicos similares al régimen de capitalización individual, incluyendo un efecto positivo moderado sobre el mercado laboral formal, el ahorro agregado y la actividad. El sistema de reparto tiene efectos negativos en todas estas dimensiones. Central para el desempeño exitoso del sistema de capitalización colectiva es el condicionar pensiones en las contribuciones de los trabajadores, de manera de incentivar el trabajo formal. Concluimos que la implementación de un sistema de capitalización colectiva es una política sostenible para países con significativa informalidad laboral y desigualdad de ingreso.

Palabras clave: *Modelos de generaciones solapadas; Sistema de pensiones; Mercado laboral informal; Agentes heterogéneos.*

Clasificación JEL: *E26, E27, H55, J46.*

1. Introduction

In many countries, demographic changes, economic transformations and social demands for better living conditions put increasing pressure on existing pension regimes. Although these challenges are faced by both developed and developing countries, the latter often need to cope with them in an environment of high-income inequality, significant degrees of labor informality and fiscal sustainability concerns in the midst of ageing populations and changing international interest rates. Given this context, this paper examines the effects of alternative pension system reforms in an economy with large labor heterogeneity in terms of income and employment status. We set up a general equilibrium overlapping generations model (OLG) featuring heterogeneous agents and a dual labor market calibrated to the Chilean economy, which serves as our case study, and we use this model to quantitatively evaluate the long-term macroeconomic effects of alternative pension reforms, comparing individual capitalization with collective pension schemes with a redistributive component.

Collective defined contribution (CDC) schemes are one sort of collective pension policy. Under such a scheme, contributions of workers from a given cohort are pooled into one common fund and invested in capital markets, and the proceeds are repaid to the same cohort upon retirement. This type of scheme has been proposed as an alternative to individual defined contribution (IDC) programs, where contributions are deposited into individual accounts, in order to improve risk sharing. CDC schemes are often considered a "third way" between IDC schemes, where all risks are taken on individually, and defined benefit (DB) schemes such as many pay-as-you-go (PAYG) systems that propose a secure retirement income but are more difficult to maintain, especially in the face of slowing population growth. A similarity of CDC schemes with IDC schemes is that they are fully funded, contrary to unfunded PAYG systems. However, unlike IDC schemes, CDC schemes imply some intragenerational redistribution. The properties of collective pension schemes have been analyzed from different perspectives in the literature, including risk-sharing or stability of participation if participation is voluntary (see Gordon and Varian, 1988; Shiller, 1999; Ball and Mankiw, 2007; Gollier, 2008; Cui et al., 2011; Chen et al., 2016, 2017; Kurtbegu, 2018). However, to our knowledge no existing study has attempted to quantify the macroeconomic effects of such schemes, which are critical to evaluate their overall costs and benefits in comparison to alternative pension policies. In addition, no study has analyzed these issues, nor the design of intragenerational redistributive rules for pension benefits, for economies with large informal labor markets and income heterogeneity, such as in many developing countries.

Hence, in this paper we study the long-term macroeconomic effects of implementing alternative pension system reforms in an economy with a significant informal sector and income heterogeneity. To understand these effects, and to quantitatively evaluate them, we construct an OLG model with specific features relevant for developing and emerging economies. We calibrate the model for Chile, a country whose individual retirement pension accounts system has been a model for many countries.[1] We consider four different pension schemes, all financed through an identical increase of pension contributions taking the form of a payroll tax, that solely differ from each other in the way they treat the additional funds and allocate them among retirees. In particular, we consider two versions of a CDC scheme that differ in whether they make pension benefits depend upon the degree of labor effort during working life,

[1] Chile has switched to a private retirement accounts system in the early 1980s. Many other Latin American countries have followed the Chilean model. These include (with years of adoption in parentheses): Peru (1993), Colombia (1994), Argentina (1994), Uruguay (1996), Bolivia (1997), Mexico (1997), El Salvador (1998), Costa Rica (2001), the Dominican Republic (2003), Nicaragua (2004), and Ecuador (2004) (see Krasnokutskaya et al., 2018).

i.e., a conditional (C-CDC) scheme and an unconditional (U-CDC) scheme, and compare their macroeconomic performance to an IDC scheme and a PAYG alternative.[2] The collective nature of the CDC schemes arises from a progressive redistributive rule that allocates proportionally more benefits to lower-income workers. These are also the workers with more participation in informality. Conditioning the receipt of benefits on employment status within a redistributive design is the key aspect that incentivizes a strong formalization of labor supply at low-income levels, which are those who make for the largest share of informal work, surpassing the effects found under the IDC plan.

Our results show that the C-CDC scheme has similar macroeconomic effects as an IDC plan, including a moderate positive effect on the formal labor market, which together with the rise of compulsory savings and the capital stock, generates and expansion of output. Moreover, the C-CDC scheme produces a stronger reduction of informality than the IDC plan. While the C-CDC scheme also induces opposite incentives at higher wages, the lower formal sector participation at the low end of the skill distribution delivers an overall increase of labor formality in the economy. The macroeconomic performance of the C- CDC policy is significantly better than that of the PAYG system, which has a strong negative effect on all dimensions. The conditionality of pension benefits upon labor effort under the C-CDC plan is critical for these positive results, as a comparison with the U- CDC scheme shows. Furthermore, the C-CDC plan shares with the IDC alternative the ability to cope with deterioration of the old-age dependency ratio, contrary to the PAYG system.

Structural models, as the one we develop here, are well suited for the analysis of pension policies, as well as for other public policies, for several reasons. First, they allow for consistent exercises, in the sense that if a given policy has, for instance, an impact on the labor supply of households but this effect depends, in turn, on how the policy affects their saving decision, a structural model will be able to capture the interaction between the decisions on both margins, something that cannot be addressed in models where these decisions are taken separately. Among other benefits, this consistency allows understanding the general equilibrium effects of a given policy. For example, changes in agents' propensities to save implied by alternative pension reforms have different effects on capital accumulation in equilibrium, and through this channel, on wages and labor market outcomes. Without a structural model, it would be impossible to determine how these second-round effects operate, or whether they are relevant. In addition, a structural model permits a quantitative evaluation of the effects of alternative policies, as long as its parameters are appropriately calibrated (estimated) to capture the main characteristics of agents and of the relevant markets at play.

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2 All of these options — IDC, CDC and PAYG schemes — have been under discussion as part of the proposals to reform the Chilean pension system over the last years.

Since a finite life-time horizon for households is critical to capture the labor, saving and consumption decisions of agents over both a working and a retirement period, we depart from a standard OLG model with three generations. Into that framework we incorporate an informal sector, which can be thought of as home production, and where workers are exempt of paying pension contributions and taxes. The introduction of this dimension responds to the significance that informality has in many developing and emerging economies; in Chile, for example, the informal economy accounts for about a third of total employment. Faced with higher pension contributions, agents will have incentives to switch to informality to avoid paying a perceived tax — an incentive particularly relevant for low-productivity households.[3] We also allow for different skill groups and discount factors, as well as different productivities across sectors, permitting us to better match the income distribution, the observed saving rates, and labor market participation in the economy. These sources of heterogeneity in the model are crucial for understanding the distributional implications of the different pension reforms that we consider, as well as for capturing the differential effects that a given policy can have on distinct agents. Finally, the model features certain small open economy characteristics that allow us, for example, to capture the weighted dependency of pension founds' returns on both the domestic and the international interest rate; following the observation that about 40% of the total founds' resources are invested abroad.[4]

Pension policies work mainly through mandatory contributions and, therefore, their effects depend on the ability of agents to revert forced savings

3 Attanasio et al. (2011), when analyzing the 2008 pension reform in Chile, found that even though pensions increased, the probability of paying into the pension system of workers older than 40 years decreased by 4.1%. Camacho et al. (2014) found that the component corresponding to a 10% tax increase in Colombia in 1993 to finance a health plan led to an increase of 4% in informality.

4 Our model features a single investment instrument, precluding agents from choosing among different investment portfolios for their pension funds. In Chile, under the current IDC pension system, agents can opt between 5 alternatives, which differ from each other in their domestic/foreign, fixed/variable-income composition. The implementation of an additional contribution may affect this composition and, thus, the funds' returns. For simplicity and tractability, we abstract from this dimension. However, it is worth noticing that a CDC scheme is not suited for an individual choosing the portfolio composition. It could be assumed that the investment strategy that such a scheme would follow would be similar to the default strategy of the current system, i.e., when agents do not actively choose a portfolio, their funds are invested following an age-dependent default strategy. Evidence suggests that allowing agents to move their funds between portfolio types — under an IDC scheme — is detrimental for the funds' performance; see Contreras et al. (2022). As such, our results may be biased in favor of the IDC scheme. Our main goal is to study the structural differences between the different pension schemes considered. The investment strategies they would follow lie beyond the scope of this paper.

by reducing voluntary ones. In this regard, empirical evidence suggests that agents do face both financial and informational frictions that limit their access to credit or the degree in which they associate current contributions with future pension payments and, consequently, their ability or willingness to reduce private savings. To this end, we include a simple mechanism that proxies for informational frictions that lead to an incomplete internalization of future pension benefits. Akin to the role of borrowing constraints, this mechanism prevents mandatory savings from being completely offset by higher indebtedness throughout working life. Indeed, the literature suggests that, though significant, substitution of mandatory savings is not perfect. This mechanism is crucial for our results, as it makes agents react to pension contributions as if they were, partially, taxes. Attanasio and Rohwedder (2003), exploiting the temporal and cross-sectional variation of three pension reforms, find that this substitution is somewhere between 0.65 and 0.75 for men older than 45, weaker for younger men, and non-existent for basic pensions, which suggest liquidity constraints or lack of information. Attanasio and Brugiviani (2003) find similar results for Italy. Botazzi et al. (2006) further find that substitution is higher for more informed individuals. For Chile, Morandé (1998) finds results in the same line, with a degree of substitution of about 0.5.

Regarding the degree to which agents comprehend pension systems and their own need to save, the literature shows a large dispersion among individuals, and that many workers ignore how their pension plans actually work. Lusardi (1999) shows how household savings in the United States are typically insufficient when retirement arrives. Gustman and Steinmeier (2005), also for the U.S., find that, on average, workers' expectations on their future pensions are not strongly aligned with reality. Other empirical evidence shows how individuals use costly credit sources even though they have access to less expensive credits, or how they simultaneously hold liquid assets with low returns and credit card debts. The explanations for this kind of behavior range from lack of financial education to inconsistent intertemporal preferences; see, for example, Laibson (1997), Angeletos et al. (2001) and Campbell et al. (2011). These reasons are consistent, in turn, with the so-called retirement consumption puzzle (or retirement savings puzzle), which describes the significant drop in consumption after retirement (Attanasio and Weber, 2010). Other explanations include a problem to process information, which is not the result of lack of information and cannot be overcome by public education; see New (1999).

A salient point of this paper is the study of the interaction of the different pension schemes with the informal sector. As mentioned above, the introduction of a new pension system creates incentives for agents to move into informality where they can avoid the payment of those contributions. However, we find that under both the IDC and the C- CDC plans informality actually decreases, and that this effect is stronger for the second scheme. This differs from the conclusions presented in Joubert (2015), who finds that rising the pension contribution paid by workers from 10 to 15% in Chile would increase informality by about 10%. The reason for the different results is the framework, in particular, the presence of two features. First, in our model agents internalize — though imperfectly — that the newly introduced pension contributions will translate into future pensions. This has a lower effect on the total net return of formal labor than a plain tax that is used by a government to, say, pay expenses, affecting labor supply decisions less. Second, our general equilibrium model — Joubert (2015) uses a partial equilibrium one — allows for second-round effects that operate expanding the economy and creating incentives to move into formality, whenever the introduction of a pension plan increases total savings. These two differences explain why the ultimate result we find is a reduction of informality under the IDC and the C-CDC plans.

The strand of literature that addresses the effects that social security reforms tend to concentrate on particular aspects, such as job mobility, retirement timing, savings, capital market development, and economic growth; see Thomas and Spataro (2016) for a review of econometric works that consider the effects of pension funds, and Kohl and O'Brien (1998) for a survey on the empirical literature on the effects of PAYG systems, mostly on savings. In this group of studies, Holzmann (1997), using a Solow residual specification of TFP, finds that the 1981 pension reform in Chile had a positive effect on economic growth through the improvement of financial markets. In the same line, Schmidt-Hebbel (1998) concludes that the same reform boosted private investment, the average productivity of capital and TFP. Encina (2013), using the pension reform of 2008 in Chile as a treatment and panel data, finds that the improvement of the pension conditions to the poorest individuals in Chile induced a higher withdrawal from the labor market and less periods contributing to the pension system by these individuals. This is to be expected, as the mechanism determining those agents' pensions depends negatively on their pension level (stemming from their actual contributions). We feature such a mechanism in our U-CDC scheme, and a similar force is at play, though other complementary specifications and initial conditions deliver different results in some dimensions. Davis and Hu (2008), in turn, using a panel of 38 OECD and emerging economies find that the pension-assets- to-GDP ratio has a significant positive effect on growth. Our study contributes to this literature through an analysis of the general equilibrium effects of alternative pension schemes in a model with a dual labor market and income heterogeneity.

Parallel and independent work by Frassi et al. (2019) is closely related to our paper. They study the effects on the labor market and on capital accumulation of three different pension plans: a PAYG system, and two fully funded ones, including an intragenerational redistributive component. However, we differ from their work in several dimensions: first, we set up a richer calibrated model, providing an empirically realistic quantification of the effects of introducing different pension plans. Second, we show the importance that incorporating informational and/or financial frictions has on the conclusions reached; for example, contrary to their findings, an IDC scheme is no longer neutral on capital, consumption, GDP and the labor market when agents do not fully internalize future pensions. Finally, and most importantly, we consider the effects that pension plans have on informality, a margin that supports a C-CDC-type scheme.

Overall, our results are especially relevant for developing and emerging economies similar to Chile, which present significant labor informality and income inequality. These results show that properly designed CDC schemes may be an economically sustainable and politically viable pension policy in such a context.[5]

The rest of the paper is organized as follows. In the next section we present the details of the model, including the main equations that describe the problems faced by the different agents and their optimal decision rules.[6] In section 3, we discuss the calibration of the model. In section 4, we present the results of the quantitative analysis of the different reform scenarios, together with some robustness analysis. In section 5, we present an exercise to analyze how the different schemes perform when the population growth rate decreases. Finally, section 6 concludes.

2. The Model

The model is based on the neoclassical growth models with overlapping generations following the works of Samuelson (1958) and Diamond (1965). To capture aspects relevant to developing or emerging economies and in particular the Chilean case, we add several features to an otherwise standard OLG model with three generations. These extensions include, first, endogenous labor supply with heterogeneous productivities, as in Brunner (1996) and Somma-

5 A limitation of our model is that it largely abstracts from fiscal policy, since the only fiscal instrument is a tax rate on formal labor income to create a wedge between net and gross income. A richer tax structure, including other instruments such as taxes on firms or consumption, its interaction with informality and its role in the financing of pension systems — partially or totally, directly or through debt — could be a relevant extension. While this is an important topic that deserves attention, it lies outside the scope of this paper. Additionally, for simplicity, we abstract in the model from the current solidarity pillar in Chile.

6 A detailed description of the model and the steady state computation is provided in the appendix.

cal (2006), among others. This allows for an asymmetric income distribution among the agents. Second, we introduce heterogeneous discount factors which are decreasing in the income level and that allow us to match the saving rates observed in the data. Third, we add an informal sector based on the works of Busato and Chiarini (2004), Busato et al. (2012) and Orsi et al. (2014), with the purpose of capturing variations along the extensive margin of the labor supply between the formal and informal sectors. The informal sector captures possible unemployment situations associated with self-provision of goods as well as employment that does not pay contributions into the social security system. Fourth, we model a social security policy that captures, in a simplified manner, the current pension system in Chile, which is an individual defined contribution scheme. Fifth, we incorporate a reduced-form mechanism that limits the degree in which agents internalize the benefits of pensions, so as to allow for financial and/or informational frictions, that the different income groups may face. Sixth, we consider a financially open economy, where foreigners own a fraction of the domestic capital stock and where national savers invest abroad. Finally, we also add a series of minor extensions throughout the following sections.

Before deriving the model, let us spend a few lines trying to understand the main mechanism operating in this economy. For this, imagine a two-period economy without any frictions, growth and with infinitely patient agents and a zero interest rate, where agents' optimal consumption plan is to consume the same real amount in both periods. In addition, assume agents receive an endowment of 100 consumption units at the beginning of the first period and must decide how much to save for their second life period, in which they can only consume what they have saved. The optimal decision of these agents is simply to consume 50 units in their first period and to save the other 50 to consume in their second one.

Suppose now that the government introduces mandatory savings of 20 consumption units (i.e., a pension). Since agents still would like to consume the same amount in both their life periods and they know they are saving 20 units through mandatory savings, their optimal response will be to consume 50 units the first period and to save the remaining 30 for the second one. Clearly, all that has happened, because of the introduced pension, is a change in the composition of total savings. Consumption has not changed, nor have total savings. Instead of saving 50 units voluntarily, as in the previous case, agents now have reduced their private savings in 20 units to account for the new mandatory savings. Now, what happens if agents further face financial or informational restrictions? Assume agents only internalize 50% of their future pension, meaning that for each unit they contribute, they believe only 0.5 units will be paid out to them in the second period of their lives.[7] In this scenario, agents then believe that their future pension — paid out in period 2 — will be of 10 units, not of 20. Therefore, since they still want to consume the same amount in both periods of their lives, they will consume 45 units the first period and save 35 for the second one, which added to the 10 units (perceived) pension, will allow them to consume another 45 units the second period. And that is the core mechanism of the model: agents, as a consequence of not being able to fully internalize their future pensions or not being able to fully undo their mandatory savings, will reduce their consumption during their first life period and, by doing so, increase total savings in the economy. In other words, financial or informational frictions, together with mandatory savings, increase total savings, generating an expansionary effect that operates through an increase in capital accumulation. The following table summarizes the cases illustrated above.

TABLE 1
CONSUMPTION AND SAVINGS EXAMPLE

	No mandatory savings	**Mandatory savings**	
	No frictions	**No frictions**	**Frictions**
Endowment period 1	100	100	100
Consumption period 1	50	50	45
Consumption period 2	50	50	55
Voluntary savings	50	30	35
Mandatory savings	0	20	20
Total savings	50	50	55

7 This could respond to a lack of understanding of how the system works or lack of trust in the survival of the system among other reasons. Alternatively, if agents were forced to save more than what they optimally wanted — say, in a case where agents have hyperbolic preferences and thus a present bias — we could think of agents facing a borrowing constraint which prevents them from undoing part of those forced savings. This is a realistic assumption insofar borrowing against future pensions is generally not possible.

The different pension systems we will later consider will act mainly through this channel and, in a second degree, by altering labor incentives. Informality in this set up, will play an important role as a means of evading pension contributions. The model, introduced next, will allow us to better understand these mechanisms, how they interact with each other, and ultimately, their relative importance.

2.1 General Assumptions

We assume a perfect foresight economy where agents live for three periods. In each period, lasting T years (where T is later set to 20), there are three different generations alive, a young (y), a middle-aged (m), and an old (o) one, such that members of the generation born in period t are young in period t, middle-aged in $t+1$, and old in $t+2$. Agents work when young and middle-aged and, during that time, they decide how much to spend on consumption and one-period savings. These voluntary savings, in turn, are transformed into physical capital that is rented out to perfectly competitive firms in the formal sector. At the beginning of the following period, the remaining capital — net of depreciation — together with the gained rent is returned back to the agents, and so wealth is transferred intertemporally in the model.[8] Agents retire when old, at which point they only consume, financed by both their savings and their pensions. In addition, workers choose how much to work in the formal and in the informal sector, where the latter is modelled as home production without capital. Agents are further divided into n_l different skill groups denoted by the index $i=1,\ldots,n_l$, ordered from least skilled ($i=1$) to most skilled ($i=n_l$). The total population of young workers N_t is assumed to grow at a constant rate n, such that $N_t = N_{t-1}(1+n)$. We assume that the relative proportions of the skill groups are constant over time, such that in period t there are $N_{i,t} = \lambda_i N_t$ workers in group i with $\lambda_i \in (0,1]$ and $\sum_{i=1}^{n_l} \lambda_i = 1$. We now describe the model in more detail, starting with the firms in the formal sector. We then proceed to describe the four alternative pension schemes that we consider and the households' problem, before finalizing with the aggregation.

2.2 Formal Sector Firm

We consider a representative firm that demands capital (K_t) and labor (L_t) to produce a homogeneous good, used for consumption and investment, by means of a standard Cobb-Douglas technology,

$$Y_t = K_t^{\alpha} \left(A_t L_t\right)^{1-\alpha} \tag{1}$$

8 Financial openness will alter this setup slightly.

with $\alpha \in (0,1)$, and where A_t denotes the labor-augmenting technology level which is assumed to grow at a constant rate g, such that $A_t = A_{t-1}(1+g)$.[9] The labor input is specified as follows:

$$L_t = \left(\sum_{i=1}^{n_l} a_i L_{i,t}^{\rho} \right)^{1/\rho} \tag{2}$$

where $L_{i,t}$ denotes the demand for workers from skill group i, the parameters $a_{n_l} \geq a_{n_l-1} \geq \ldots \geq a_1 > 0$ measure the productivities of the different worker types, and $\rho < 1$ determines the elasticity of substitution between the different worker types, which is equal to $1/(1-\rho)$. For $\rho = 1$ the workers from the different skill groups are perfect substitutes and as $\rho \to -\infty$ they become perfect complements. Total labor in period t of skill i, is then

$$L_{i,t} = L_{i,t}^{y} + L_{i,t}^{m} \tag{3}$$

The representative firm maximizes its profits subject to the above three equations, treating the rental rate of capital r_t^k and the skill-specific wages, $W_{i,t}^{y}$ and $W_{i,t}^{m}$ as given. Substituting out the constraints, the firm's optimization problem can be written as

$$\max_{K_t, L_{i,t}^{y}, L_{i,t}^{m}} K_t^{\alpha} A_t^{1-\alpha} \left(\sum_{i=1}^{n_l} a_i \left(L_{i,t}^{y} + L_{i,t}^{m} \right)^{\rho} \right)^{\frac{1-\alpha}{\rho}} - r_t^k K_t - \left(1+\tau^F\right) \sum_{i=1}^{n_l} W_{i,t}^{y} L_{i,t}^{y} + W_{i,t}^{m} L_{i,t}^{m} \tag{4}$$

Here $\tau^F \in [0,1]$ denotes the new pension contributions that take the form of a payroll tax paid by the firms. These contributions are the ones financing the different pensions schemes whose effects we analyze. The first-order conditions for this problem are,

$$K_t : r_t^k = \alpha \frac{Y_t}{K_t} \tag{5}$$

$$L_{i,t}^{y} : W_{i,t}^{y} = a_i W_t \left(\frac{L_t}{L_{i,t}} \right)^{1-\rho} \tag{6}$$

$$L_{i,t}^{m} : W_{i,t}^{m} = a_i W_t \left(\frac{L_t}{L_{i,t}} \right)^{1-\rho} \tag{7}$$

where $W_t = \dfrac{1-\alpha}{1+\tau^F} \dfrac{Y_t}{L_t}$. Equation (5) shows that, at the optimum, capital is rented at its marginal return as is standard, while equations (6) and (7) equate

---

9 Throughout, upper-case letters denote variables that are non-stationary, due to population growth, productivity growth, or both, while lower-case letters denote stationary variables.

the salaries of each skill group and age with their respective marginal returns. Note that young and middle- aged workers receive the same wage. In particular, it is worth noticing that salaries increase with the specific productivities of each skill group, a_i, and with the degree of complementarity between the different skill groups (determined by ρ); all salaries decrease with the payroll tax τ^F. One can easily check that the first-order conditions guarantee that the zero-profit condition is satisfied in equilibrium.

2.3 Pension Systems

We assume a social security system with two components. The first component, common to all the alternatives we consider, is financed through a labor income tax on formal workers. Each worker pays a constant fraction, $\tau^W \in [0,1]$, of its formal wage to the government both when young and middle-aged. The government invests these proceeds on each workers behalf and, when the workers retire, they receive their original investment plus the respective accumulated interests. This component accounts, in a simplified way, for the existing mandatory pension system in Chile based on individual defined contributions.

In formal terms, let $S_t^{PW,y} = \sum_{i=1}^{n_l} \tau^W W_{i,t}^y L_{i,t}^y$ and $S_t^{PW,m} = \sum_{i=1}^{n_l} \tau^W W_{i,t}^m L_{i,t}^m$ denote the mandatory social security contributions levied, each period, from young and middle-aged formal workers, respectively. Then, the component of the aggregate pension payments financed through employees' contributions, due in period $t+2$, is defined as

$$P_{t+2}^W = R_{t+2}\left(S_{t+1}^{PW,m} + R_{t+1} S_t^{PW,y}\right) \tag{8}$$

where $R_t = 1 + (1-\gamma) r_t^k - \delta + \gamma r^\star$ denotes the net return on savings in the economy.[10] Here we introduce financial openness in a simplified manner, by assuming that an exogenous fraction $\gamma \in [0,1]$ of savings is invested abroad at a fixed net interest rate $r^\star$, while the remaining savings are invested in domestic capital with net rate of return $r_t^k - \delta$, where $\delta \in [0,1]$ denotes the depreciation rate of capital. The fraction of the individual pension paid to each worker when retired that is financed through workers' contributions is then given by

$$P_{i,t+2}^W = R_{t+2}\left(S_{i,t+1}^{PW,m} + R_{t+1} S_{i,t}^{PW,y}\right) \tag{9}$$

Note that τ^W becomes inconsequential for consumption, labor supply and total savings as soon as agents understand how this pension component works

---

10 We are somewhat flexible with some terminology and refer to $S^{i,j}$ as public savings, where $i = PW, PF$ and $j = y, m$.

and as long as they have no financial constraints, since they can simply modify their voluntary savings in order to offset any mandatory pension contribution they are asked to pay. We relax this assumption later.

The second component of the social security system is financed through a constant payroll tax on employers, τ^F, and can be implemented following one of four alternative schemes considered in this paper:[11]

First, $\mu_1 = 1$, called individual defined contribution (IDC), treats the firms' contributions in the same way as the first component of pensions described above treats the workers' contributions. Under this scheme, we assume that all retirees receive the benefit.

Second, $\mu_2 = 1$, called conditional collective defined contribution (C-CDC), treats the aggregate funds collected from the firms' pension contributions on behalf of each generation in the same way as the previous scheme (and in the same way as in the first component). However, it allocates those funds between the members of each generation, when they retire, by paying higher pensions to those retirees who worked more in the formal sector. This scheme imposes an intragenerational redistribution.

Third, $\mu_3 = 1$, called unconditional collective defined contribution (U-CDC), is similar to the second one, except that the allocation rule among retirees does not depend on how much they worked. Instead, under this scheme, only the retirees of the $i < \bar{i}$ skill groups are entitled to this pension (i.e., the least skilled). Additionally, the pension benefits are decreasing in the first component of the pension, $P_{i,t}^W$. Therefore, this scheme captures part of the spirit of the existing solidarity pillar currently in place in Chile.

Fourth, $\mu_4 = 1$, is a pay-as-you-go (PAYG) system. Under this scheme, all funds collected each period from the firms' contributions, that is, those paid out by the firms on behalf of both young and middle-aged formal workers, are distributed among the existing retirees that very same period, in a way that ensures a constant replacement ratio among the beneficiaries of the pension within each generation.

In formal terms, let us first define the fraction of the aggregate pension found financed by the firms and associated to their young and middle-aged workers as $S_t^{PF,y} = \sum_{i=1}^{n_I} S_{i,t}^{PF,y}$ and $S_t^{PF,m} = \sum_{i=1}^{n_I} S_{i,t}^{PF,m}$, respectively. Here, $S_{i,t}^{PF,y} = \tau^F W_{i,t}^y l_{i,t}^y$ and $S_{i,t}^{PF,m} = \tau^F W_{i,t}^m l_{i,t}^m$ denote the fractions corresponding to each skill group. Then, the component of the aggregate pension payments financed through employers' contributions satisfies,

$$(10) \quad P_{t+2}^F = \left(\mu_1 + \mu_2 + \mu_3\right) R_{t+2} \left(S_{t+1}^{PF,m} + R_{t+1} S_t^{PF,y}\right) + \mu_4 \left(S_{t+2}^{PF,m} + S_{t+2}^{PF,y}\right)$$

11 We set up the model so that it nests all four cases and use parameters μ_j with $j = 1,\ldots,4$, taking values 0 or 1 and satisfying $\sum_{j=1}^{4} \mu_j = 1$, to activate any particular scheme.

while the individual pension paid out to each individual when retired can be written as

$$
\begin{aligned}
P_{i,t+2}^{F} &= \mu_1 R_{t+2}\left(S_{i,t+1}^{PF,m} + R_{t+1} S_{i,t}^{PF,y}\right) \\
&+ \left(\mu_2 \sigma_{i,t+2} + \mu_4 \eta_{i,t+2}\right) P_{t+2}^{F} + \mu_3 \max\left(0, P_{t+2}^{BS} - \frac{1}{3} P_{i,t+2}^{W}\right) 1_{i<\bar{i}}
\end{aligned} \tag{11}
$$

where $1_{i<\bar{i}}$ is an indicator function taking the value 1 when $i < \bar{i}$ and 0 otherwise, and where P_{t+2}^{BS} denotes a basic solidarity pension — expressed in per capita terms — defined as

$$
P_{t+2}^{BS} = \left(P_{t+2}^{F} + \frac{1}{3}\sum_{i=1}^{\bar{i}-1} P_{i,t+2}^{W} N_{i,t}\right) \frac{1}{\sum_{i=1}^{\bar{i}-1} N_{i,t}} \tag{12}
$$

The latter is relevant only for the third scheme ($\mu_3 = 1$). Notice P_{t+2}^{BS} is defined so as to exhaust P_{t+2}^{F} among all retirees in $t+2$.[12] For the second scheme (μ2 = 1), we define

$$
\sigma_{i,t+2} = \frac{pts_{i,t+2}}{PTS_{t+2}} \tag{13}
$$

as the fraction of the funds of the component financed by the firms' contributions, P_{t+2}^{F}, that each retiree of skill group i receives. Here $PTS_{t+2} = \sum_{i=1}^{n_l} pts_{i,t+2} N_{i,t}$ are the total aggregated points assigned under this scheme and where the individual points, $pts_{i,t+s}$, are assigned according to the following rule (actuarially fair), which agents know and internalize in their decisions:

$$
\begin{aligned}
pts_{i,t+s} &= R_{t+2}\left(pts_{i,t+1}^{m} + R_{t+1} pts_{i,t}^{y}\right) \\
&= R_{t+2}\left\{\alpha_0 + l_{i,t+1}^{m}\left(\frac{W_{i,t+1}^{m}}{\overline{W_{t+1}^{m}}}\right)^{\alpha_1} + R_{t+1}\left[\alpha_0 + l_{i,t}^{y}\left(\frac{W_{i,t}^{y}}{\overline{W_{t}^{y}}}\right)^{\alpha_1}\right]\right\}
\end{aligned} \tag{14}
$$

The parameters $\alpha_0 \geq 0$ and $\alpha_1 \in R$ control the redistribution intensity of the rule, and $\overline{W_t^y} = (1/N_t)\sum_{i=1}^{n_l} W_{i,t}^{y} N_{i,t}$ and $\overline{W_{t+1}^{m}} = (1/N_t)\sum_{i=1}^{n_l} W_{i,t+1}^{m} N_{i,t}$

12 Following the logic behind the solidarity pillar in place in Chile until recently, under the third scheme ($\mu_3 = 1$), we assume that those agents for whose self-financed pension, $P_{i,t+2}^{W}$, is lower than a certain upper bound $P_{i,t+2}^{MAS}$ — from Pensión Máxima con Aporte Solidario in Spanish — are entitled to a pension according to the formula $P_{i,t+2}^{F} = \max\left\{0, \left(P_{t+2}^{MAS} - P_{i,t+2}^{W}\right) P_{t+2}^{BS} / P_{t+2}^{MAS}\right\}$, where P_{t+2}^{BS} is the highest pension that any agent could receive under this pillar, i.e., when $P_{i,t+2}^{W} = 0$. As a simplifying assumption, we implement this scheme assuming a constant ratio, $P_{t+2}^{BS} / P_{t+2}^{MAS} = 1/3$.

denote the average salaries of both age groups.[13] For the fourth scheme ($\mu_4 = 1$) we define two auxiliary variables, $\eta_{i,t+2}$ and x_{t+2}, where the first variable denotes the fraction of P^F_{t+2} corresponding to each worker and where the second variable denotes a replacement rate. The latter emerges as the solution to the following system of equations:

(15) $$\frac{\eta_{i,t+2} P^F_{t+2}}{R_{t+2} W^m_{i,t+1} l^m_{i,t+1}} = x_{t+2} \ \forall i$$

(16) $$\sum_{i=1}^{n_l} \eta_{i,t+2} N_{i,t} = 1$$

Equation (15) ensures that P^F_{t+2} is distributed such that all retirees get the same replacement rate with respect to their formal middle-aged labor income, while the second equation further guarantees that all funds are used. The solution to this system of equations is given by

(17) $$\eta_{i,t+2} = \frac{R_{t+2} W^m_{i,t+1} l^m_{i,t+1}}{WL^m_{t+1}}$$

(18) $$x_{t+2} = \frac{P^F_{t+2}}{WL^m_{t+1}}$$

where $WL^m_{t+1} = R_{t+2} \sum_{i=1}^{n_l} W^m_{i,t+1} N_{i,t}$.[14]

Total and individual pensions paid out each period are the sum of both pension components and are, respectively, given by:

(19) $$P_t = P^W_t + P^F_t$$

(20) $$P_{i,t} = P^W_{i,t} + P^F_{i,t}$$

Public savings (in the form of the pension found) are defined as

(21) $$S^P_t = S^{PW,m}_t + R_t S^{PW,y}_{t-1} + S^{PW,y}_t + (\mu_1 + \mu_2 + \mu_3)\left(S^{PF,m}_t + R_t S^{PF,y}_{t-1} + S^{PF,y}_t\right)$$

---

13 One can show that in the special case where $g = 0$, implying $W^y_{i,t} / A_t = W^m_{i,t} / A_{t-1}$, the second scheme ($\mu_2 = 1$) with parameters $\alpha_0 = 0$ and $\alpha_1 = 1$ is equivalent to the first scheme of individual defined contribution ($\mu_1 = 1$) since, under these special conditions, one has that $\sigma_{i,t+2} P^F_{t+2} = R_{t+2}\left(S^{PF,m}_{i,t+1} + R_{t+1} S^{PF,y}_{i,t}\right)$. Relaxing the conditions on e and g, i.e., when $e < 1$ and/or $g > 0$, both schemes are only approximately equivalent when α_0 and α_1 are set to 0 and 1 respectively.

14 Depending on the definition of the replacement rate, R_{t+2} could be removed from the above equations and from the definition of WL^m_{t+1}. The presence of the term R_{t+2} is to express income in terms of its value in the period in which pensions are paid.

and the budget constraint of the aggregate pension found in period t is given by

$$P_t + S_t^P = R_t S_{t-1}^P + \underbrace{S_t^{PW,m} + S_t^{PW,y} + S_t^{PF,m} + S_t^{PF,y}}_{\textit{levied taxes}} \tag{22}$$

2.4 Workers of Skill Group I

We address now the problems faced by the households in this economy. Each worker's life-time utility is a function of their consumption when young, $C_{i,t}^y$, middle-aged, $C_{i,t+1}^m$, and old, $C_{i,t+2}^o$, of the labor they supply in the formal sector when young and middle-aged, $l_{i,t}^y$ and $l_{i,t+1}^m$, and of the labor they dedicate to home production, also when young and middle-aged, $h_{i,t}^y$ and $h_{i,t+1}^m$. For $i = 1,\ldots,n_l$, it takes the following form:

$$\begin{aligned} U_{i,t} &= \frac{\left(C_{i,t}^y\right)^{1-\theta}}{1-\theta} + \beta_i \frac{\left(C_{i,t+1}^m\right)^{1-\theta}}{1-\theta} + \beta_i^2 \frac{\left(C_{i,t+2}^o\right)^{1-\theta}}{1-\theta} \\ &-\Theta_{i,t}^y \frac{\left(l_{i,t}^y + h_{i,t}^y\right)^{\phi} + \kappa\left(h_{i,t}^y\right)^{\phi}}{\phi} - \beta_i \Theta_{i,t+1}^m \frac{\left(l_{i,t+1}^m + h_{i,t+1}^m\right)^{\phi} + \kappa\left(h_{i,t+1}^m\right)^{\phi}}{\phi} \end{aligned} \tag{23}$$

where A $\theta > 0$ is the inverse of the elasticity of intertemporal substitution, $\phi \geq 1$ determines the wage elasticity of labor supply, which equals $1/(\phi - 1)$, $\beta_i \in (0,1)$ is the subjective discount factor of skill group i, and $\kappa > 0$ stands as a specific cost for working at home.[15] The variable $\Theta_{i,t}^j$, with $j = y, m$, is an endogenous preference shifter based on Galí et al. (2012) that is taken as given by the workers and satisfies

$$\Theta_{i,t}^y = \chi_i A_t^{1-\theta} \left(\frac{C_{i,t}^y}{A_t}\right)^{-\theta\upsilon}$$

$$\Theta_{i,t+1}^m = \chi_i A_t^{1-\theta} \left(\frac{C_{i,t+1}^m}{A_t}\right)^{-\theta\upsilon}$$

with $\upsilon \in \{0,1\}$ and $\chi_i > 0$. The purpose of this preference shifter is to allow for an incomplete wealth effect on labor supply. When $\upsilon = 0$, we obtain $\Theta_{i,t}^j = \chi_i$, and, thus, the standard constant relative risk aversion (CRRA) utility function implying a non-zero wealth effect; instead, when $\upsilon = 1$, there is no wealth effect.[16]

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15 This specific cost can be justified, for instance, by the lack of health insurance, or by job insecurity.

16 In any case, the disutility of work is assumed to grow with the factor $A_t^{1-\theta}$ so that the model has a balanced growth path when $\theta \neq 1$.

Home production is implemented through a decreasing returns to scale production function, with labor as the only input; with $A_t b_i \left(\frac{h_t^{\xi-1}}{\eta} \right) a_i$ as the return for both the young and middle-aged workers, and with $b_{n_l} \geq b_{n_l-1} \geq \ldots \geq b_1 > 0$. This specification allows for labor productivity differences between the formal sector and the informal sector, while productivity growth is equal across sectors.

Letting $S_{i,t}^y$ and $S_{i,t}^m$ denote voluntary savings when young and middle-aged, respectively, a given generation's budget constraints for periods t, $t+1$, and $t+2$ satisfy:

$$C_{i,t}^y = \left(1-\tau-\tau^W\right) W_{i,t}^y l_{i,t}^y + A_t b_i \left(\frac{h_t^{\xi-1}}{\eta} \right) a_i h_{i,t}^y - S_{i,t}^y \tag{24}$$

$$C_{i,t+1}^m = \left(1-\tau-\tau^W\right) W_{i,t+1}^m l_{i,t+1}^m + A_{t+1} b_i \left(\frac{h_{t+1}^{\xi-1}}{\eta} \right) a_i h_{i,t+1}^m + R_{t+1} S_{i,t}^y - S_{i,t+1}^m \tag{25}$$

$$C_{i,t+2}^o = R_{t+2} S_{i,t+1}^m + P_{i,t+2} \tag{26}$$

where τ is an income tax used for the calibration of the informal labor supply.[17] Following Joubert (2015), we will set ξ so that a 5 percentage points income tax increase yields a 10% increase in informal work. The budget constraints can be combined into the perceived intertemporal budget constraint (IBC) that agents use to make their decisions:

$$\underbrace{C_{i,t}^y + \frac{C_{i,t+1}^m}{R_{t+1}} + \frac{C_{i,t+2}^o}{R_{t+1}R_{t+2}}}_{\textit{Present value of consumption}} =$$

$$\underbrace{(1-\tau-\tau^W)\left(W_{i,t}^y l_{i,t}^y + \frac{W_{i,t+1}^m l_{i,t+1}^m}{R_{t+1}} \right) + A_t b_i \left(\frac{h_t^{\xi-1}}{\eta} \right) a_i h_{i,t}^y + \frac{A_{t+1} b_i \left(\frac{h_{t+1}^{\xi-1}}{\eta} \right) a_i h_{i,t+1}^m}{R_{t+1}}}_{\textit{Present value of labor income}} \tag{27}$$

$$+ \quad \underbrace{\varphi_i \frac{P_{i,t+2}}{R_{t+1}R_{t+2}}}_{\textit{Present value of pension}}$$

Here, the parameter $\varphi_i \in [0,1]$ determines the fraction of the present value of the future pension, $\frac{P_{i,t+2}}{R_{t+1}R_{t+2}}$, that agents internalize in their consumption,

17 Note that the third equation incorporates the simplifying assumption that individuals have finite horizons and, therefore, choose to end up with zero assets when they die (i.e., they make no bequests).

saving and labor decisions. This is a simple, reduced-form strategy to capture two different types of frictions, financial and informational. For instance, φ_i can account for borrowing constraints, meaning that only a fraction of future pensions can be used as collateral. Alternatively, φ_i reflects the ignorance of agents about how the pension system works, capturing, for example, the perception that agents may have of pension contributions as taxes, without any beneficial counterpart. It could also capture, for instance, the confidence agents have on the future promised payments to actually materialize, which is not necessarily a negligible factor, at least in emerging economies. The practical purpose of this specification is to prevent a perfect substitution between mandatory savings — in the form of pension contributions — and voluntary savings, which is achieved for those agents with $\varphi_i < 1$.[18]

Workers, then, face the problem of maximizing their life-time utility (23) subject to (27), (20), (9), (11), (13) ,(14), (17) and the definitions for $\overline{S_{i,t}^{k,j}}$, for $k = PW, PF$ and $j = y, m$, treating $\Theta_{i,t}^{y}$, $\Theta_{i,t+1}^{m}$, $W_{i,t}^{y}$, $W_{i,t+1}^{m}$, P_{t+2}^{BS}, $\overline{W_t^y}$, $\overline{W_{t+1}^m}$, PTS_{t+2}, WL_{t+1}^{m}, P_{t+2}^{F}, R_{t+1}, and R_{t+2} as given.[19] Next, we present the first-order conditions associated with this problem. First, the equations for labor supply in the formal sector, $l_{i,t}^{y}$ and $l_{i,t}^{m}$ are given by

$$\Theta_{i,t}^{y}\left(l_{i,t}^{y}+h_{i,t}^{y}\right)^{\phi-1}=\left(C_{i,t}^{y}\right)^{-\theta}\widetilde{W_{l,t}^{y}} \tag{28}$$

$$\Theta_{i,t+1}^{m}\left(l_{i,t+1}^{m}+h_{i,t+1}^{m}\right)^{\phi-1}=\left(C_{i,t+1}^{m}\right)^{-\theta}\widetilde{W_{l,t+1}^{m}} \tag{29}$$

where net salaries are defined as

$$\widetilde{W_{l,t}^{y}}=W_{i,t}^{y}\left\{1-\tau-\left(1-\varphi_i\right)\tau^{W}+\varphi_i\left[\mu_1\tau^{F}+\mu_2\frac{\left(W_{i,t}^{y}\right)^{\alpha_1-1}}{\left(\overline{W_{l,t}^{y}}\right)^{\alpha_1}}\frac{P_{t+2}^{F}}{PTS_{t+2}}-\mu_3\frac{1}{3}\tau^{W}\right]\right\} \tag{30}$$

$$\widetilde{W_{l,t+1}^{m}}=W_{i,t+1}^{m}\left\{1-\tau-\left(1-\varphi_i\right)\tau^{W}+\varphi_i\left[\mu_1\tau^{F}+\mu_2\frac{\left(W_{i,t+1}^{m}\right)^{\alpha_1-1}}{\left(\overline{W_{l,t+1}^{m}}\right)^{\alpha_1}}\frac{P_{t+2}^{F}}{PTS_{t+2}}-\mu_3\frac{1}{3}\tau^{W}+\mu_4\frac{P_{t+2}^{F}}{WL_{t+1}^{m}}\right]\right. \tag{31}$$

The above equations show how, at the optimum, agents work up to the point where the disutility of working — both in the formal and informal sector — equals the marginal utility of consuming the perceived net returns on that

[18] See the introduction for a discussion of related literature.

[19] We assume here, for simplicity, that agents do not internalize the effects of their labor efforts on P_{t+2}^{F}. A similar assumption is made in Sommacal (2006).

work, which depends on the pension scheme in place. Second, the equations associated with labor supply in the informal sector, $h_{i,t}^{y}$ and $h_{i,t}^{m}$, are given by

$$(32)\quad h_{i,t}^{y}=\begin{cases}\left[\dfrac{\left(C_{i,t}^{y}\right)^{-\theta}}{\Theta_{i,t}^{y}}\left(\dfrac{A_t b_i\left(\dfrac{h_t^{\xi-1}}{\eta}\right)a_i-\widetilde{W_{i,t}^{y}}}{\kappa}\right)\right]^{\frac{1}{\phi-1}} & if\ A_t\left(\dfrac{h_t^{\xi-1}}{\eta}\right)b_i a_i>\widetilde{W_{l,t}^{y}}\\ 0 & otherwise\end{cases}$$

$$(33)\quad h_{i,t+1}^{m}=\begin{cases}\left[\dfrac{\left(C_{i,t+1}^{m}\right)^{-\theta}}{\Theta_{i,t+1}^{m}}\left(\dfrac{A_{t+1} b_i\left(\dfrac{h_t^{\xi-1}}{\eta}\right)a_i-\widetilde{W_{i,t+1}^{m}}}{\kappa}\right)\right]^{\frac{1}{\phi-1}} & if\ A_{t+1}\left(\dfrac{h_{t+1}^{\xi-1}}{\eta}\right)b_i a_i>\widetilde{W_{l,t+1}^{m}}\\ 0 & otherwise\end{cases}$$

Accordingly, at the optimum, agents spend time working in the informal sector only if the income they obtain from working in that sector is larger than what they perceive they could earn if they were to work in the formal sector.

Finally, we can derive the following consumption equations for $C_{i,t}^{y}$ and $C_{i,t}^{m}$:

$$(34)\qquad C_{i,t}^{y}=\frac{\left(1-\tau-\tau^{W}\right)\left(W_{i,t}^{y}l_{i,t}^{y}+\dfrac{W_{i,t+1}^{m}l_{i,t+1}^{m}}{R_{t+1}}\right)+A_t b_i\left(\dfrac{h_t^{\xi-1}}{\eta}\right)a_i h_{i,t}^{y}}{1+\beta_i^{1/\theta}R_{t+1}^{(1-\theta)/\theta}+\beta_i^{2/\theta}\left(R_{t+1}R_{t+2}\right)^{(1-\theta)/\theta}}+$$

$$\frac{\dfrac{A_{t+1}b_i\left(\dfrac{h_t^{\xi-1}}{\eta}\right)a_i h_{i,t+1}^{m}}{R_{t+1}}+\varphi_i\dfrac{P_{i,t+2}}{R_{t+1}R_{t+2}}}{1+\beta_i^{1/\theta}R_{t+1}^{(1-\theta)/\theta}+\beta_i^{2/\theta}\left(R_{t+1}R_{t+2}\right)^{(1-\theta)/\theta}}$$

$$(35)\qquad C_{i,t+1}^{m}=\frac{R_{t+1}S_{i,t}^{y}+\left(1-\tau-\tau^{W}\right)W_{i,t+1}^{m}l_{i,t+1}^{m}+A_{t+1}b_i\left(\dfrac{h_t^{\xi-1}}{\eta}\right)a_i h_{i,t+1}^{m}+\varphi_i\dfrac{P_{i,t+2}}{R_{t+2}}}{1+\beta_i^{1/\theta}R_{t+2}^{(1-\theta)/\theta}}$$

The consumption when old, $C_{i,t+2}^{o}$, is determined by equation (26). Therefore, young and middle-aged workers consume a fraction of the present value of their perceived total life-time income (which decreases as φ_i decreases, implying a larger friction), and save the rest. When old, the workers simply consume all their savings plus, if applicable, the pension received from the government.

2.5 Aggregation

We now close the model by specifying a number of definitions and aggregate conditions, that are required to hold in equilibrium. Total formal labor supply of each skill type and cohort needs to equal the corresponding labor demand, which requires

$$l_{i,t}^{y} N_{i,t} = L_{i,t}^{y} \tag{36}$$

$$l_{i,t}^{m} N_{i,t-1} = L_{i,t}^{m} \tag{37}$$

for $i = 1, \ldots, n_l$.[20] Aggregate voluntary private saving is defined as

$$S_t = S_t^{y} + S_t^{m} \tag{38}$$

where $S_t^{y} = \sum_{i=1}^{n_l} S_{i,t}^{y} N_{i,t}$ and $S_t^{m} = \sum_{i=1}^{n_l} S_{i,t}^{m} N_{i,t-1}$, while mandatory public saving, S_t^{P}, is defined in (21). Given that only a fraction $1-\gamma$ of total savings, $S_t^{T} = S_t + S_t^{P}$, is invested into capital, while the remaining fraction γ is invested abroad, capital each period satisfies

$$K_{t+1} = \left(1-\gamma\right) S_t^{T} + \gamma_t^{*} \tag{39}$$

Notice that we allow, in addition, for foreigners to own some exogenous fraction of the domestic capital stock, $\gamma_t^{*} = \gamma^{*} A_t N_t$, where $\gamma^{*} \geq 0$.[21] This last assumption, together with the assumption stating that part of domestic savings are invested abroad, amount — as already mentioned — to a simple and stylized strategy to model financial openness in a small open economy as the Chilean one.[22]

Finally, aggregate consumption in period t is defined as

$$C_t = C_t^{y} + C_t^{m} + C_t^{o} \tag{40}$$

where $C_t^{y} = \sum_{i=1}^{n_l} C_{i,t}^{y} N_{i,t}$, $C_t^{m} = \sum_{i=1}^{n_l} C_{i,t}^{m} N_{i,t-1}$ and $C_t^{o} = \sum_{i=1}^{n_l} C_{i,t}^{o} N_{i,t-2}$

20 Note that $N_{i,t}$ young individuals of type i are born each period t, while, also in period t, there are $N_{i,t-1}$ middle-aged individuals, and $N_{i,t-2}$ old individuals, both of type i.

21 We assume γ_t^{*} grows with $A_t N_t$, in order to have a balanced growth path.

22 It is possible to show that this way of modelling financial openness, implies that the interest rate differential is decreasing in the level of domestic savings.

are the corresponding aggregate consumption levels for each cohort. And, aggregate taxes amount to

$$T_t = \tau \sum_{i=1}^{n_l} W_{i,t}^y L_{i,t}^y + W_{i,t}^m L_{i,t}^m$$

3. Calibration

The model is calibrated to match a series of statistics of the Chilean economy. Table 2 summarizes the base calibration. The duration of a period, given by parameter T, is set to be 20 years. Therefore, the model implies that agents are retired for 20 years following a working life of 40. We assume there are 5 different skill groups in the economy, i.e., $n_l = 5$, that are representative of the income quantiles.[23] The subjective discount factors of the different skill groups, β_i for $i = 1,\ldots,n_l$, in turn, are calibrated to replicate the average saving rates for each income quantile, which are computed from the Family Budget Survey (Encuesta de Presupuestos Familiares — EPF) from 2012, using the methodology proposed by Madeira (2015, 2018).[24] The matched saving rates are 9%, -0.1%, 4.2%, 8.2% and 17% for the first to fifth quantile, respectively, computed as the average savings during active life. These rates imply an aggregated saving rate, weighted by income, of 7.7%.[25] The social security contribution rate paid by the workers, τ^W, is set at 10%, in line with the defined contribution of the current pension system in Chile. The social security contribution rate paid by the firms on behalf of workers, τ^F, is set to 0% in the initial steady state of the model and it is increased to 5% when the alternative pension reforms are implemented in the different exercises. The parameter that determines the disutility of work, χ_i, is calibrated so as to set relative total work — formal and informal — across ability groups to 0.48, 0.63, 0.74, 0.86, and 1, i.e. implied by the 36%, 47%, 56%, 65%, and 75% participation rates of each quantile (the model has no unemployment).[26]

The annual population growth rate, n, is set to 0.5%, and the technological growth rate corresponding to the growth rate of output per capita, wages and other per capita variables in the model, g, is set to 2%, in line with the

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23 Quantile number 1, represents the lowest income group, and, therefore, the less skilled group.

24 Source: National Statistics Institute (Instituto Nacional de Estadísticas — INE).

25 This number is close to the aggregate saving rate for Chile that was estimated to be between 8.3% and 9.8% since 2010 by the OECD (https://data.oecd.org/hha/household-savings.htm).

26 Source: the data is provided by the Ministerio de Desarrollo Social y Familia, Subsecretaría de Evaluación Social, based on information from the Encuesta Casen and the Encuesta Casen en Pandemia 2020. In a robustness exercise total labor participation is set equal accross skill groups; results hold.

average growth trend estimated for Chile until 2050 in the base projection scenario of Albagli et al. (2015).[27] Following the same study, the labor share in production, $1-\alpha$, is set to 52%, which corresponds to the 2008-2013 average of the ratio between salaries paid by the corporate sector and the aggregate value of that sector, net of taxes, according to National Accounts data for Chile.[28] The capital depreciation rate, δ, is set at 4% per year.

TABLE 2

BASELINE CALIBRATION, * QUANTILES $(Q_1, Q_2, Q_3, Q_4, Q_5)$

Parameter	Description	Value/Target	Source
T	Duration of a period	20 years	-
$\beta_i^{-1/T}-1$	Annual discount rates	Saving rates	Madeira (2018)
τ^W	Employee contribution rate	10%	Existing rate in Chile
τ^F	Employer contribution rate	$0 \rightarrow 5\%$	Exercise
τ	Income tax	30%	-
χ_i	Labor disutility	$l_i = [0.48, 0.63, 0.74, 0.86, 1]$	CASEN and CASEN en Pandemia 2020
n	Annual population growth rate	0.5%	Albagli et al. (2015)
g	Annual technological growth rate	2%	Albagli et al. (2015)
θ	Intertemp. elasticity of subs., inv	1	Literature
ϕ	Labor supply elasticity, inverse	3	Orsi et al (2014)
α	Capital share	0.48%	Albagli et al. (2015)
$1-(1-\delta)^{1/T}$	Annual depreciation	4%	Litearture
κ	Work at home specific cost.	1.3	informal return between gross-net formal return
ξ	Informal sector prod. fct.	0.53	10% informality increase $\tau: 30 \rightarrow 35\%$
η	Informal sector prod. fct	$\left(\frac{h_t^{\xi-1}}{\eta}\right) = 1\, in\ first\ s.s.$	Normalization

[27] This last estimation is based on data and estimations from the Central Bank of Chile, National Socioeconomic Characterization Survey (Encuesta de Caracterización Socioeconómica Nacional — CASEN), the INE and the OECD. Its methodology is based on the production function.

[28] Source: Central Bank of Chile.

φ_i	Friction	$[0.5, 0.5, 0.5, 0.5, 0.5]^*$	Literature
υ	Preference shifter	1	Greenwood et al. (1998)
ρ	Labor elasticity of subs. b/ skills	0.33	Ciccone and Peri (2005)
a_5	Productivity, F. sector, skill gr. 5	1	Calibration targets
a_4	Productivity, F. sector, skill gr. 4	0.48	Labor income quantiles
a_3	Productivity, F. sector, skill gr. 3	0.21	(CASEN 2015)
a_2	Productivity, F. sector, skill gr. 2	0.19	
a_1	Productivity, F. sector, skill gr. 1	0.05	$[4.2, 9.7, 14.5, 21.1, 50.5]^*$
$a_5 b_5$	Product. Inf. sector, skill gr. 5	0.21	Calibration targets aggregate
$a_4 b_4$	Product. Inf. sector, skill gr. 4	0.09	participation in informal sector
$a_3 b_3$	Product. Inf. sector, skill gr. 3	0.06	and quantile distribution
$a_2 b_2$	Product. Inf. sector, skill gr. 2	0.04	(NESI 2012)
$a_1 b_1$	Product. Inf. sector, skill gr. 1	0.02	$[57, 18, 18, 17, 14]^*$

The parameter that determines the specific utility cost of working at home, κ, is set to 1.3, so as to make the return in informality lower than the gross wage and larger than the net wage. The parameter ξ, in turn, is set so that a 5 percentage points income tax increase, yields a 10% increase in informal work following Joubert (2015), and η is set so that $\left(\frac{h_t^{\xi-1}}{\eta}\right)$ equals 1 in the first steady state. Joubert (2015) finds that informality increases 10% when a 5 percentage points increase in the pension contribution is introduced in a model for Chile, not as a consequence of an increase of the income tax. However, the model of Joubert (2015) is a partial equilibrium one where the pension contribution behaves more closer to an income tax as the one introduced here, than to a pension contribution. The parameter υ, which determines the size of the wealth effect on labor supply is set to 1. This specification favors the class of preferences that have a zero wealth effect, similarly to the preferences proposed by Greenwood et al. (1988). Consequently, when analyzing changes in labor supply, we emphasize the role played by wage fluctuations, and do not consider the effects that arise from an intertemporal substitution, with a labor supply schedule that has a positive slope with respect to the wage.

The productivity parameters in the formal sector, a_i for $i = 1,\ldots,n_l$, are calibrated to replicate the distribution of labor income (percentage of total income corresponding to each quantile) as reported by the CASEN 2015 survey.[29]

In turn, the parameters that determine how efficient home production is, b_i, are calibrated so as to obtain an aggregate participation in the informal sector of 25%, and participations, in that same sector, of 57%, 18%, 18%, 17% and 14% for quantiles 1 to 5, respectively. These statistics were computed using data from the New Supplementary Income Survey (Nueva Encuesta Suplementaria de Ingresos — NESI) from 2012, counting as informal workers employees without a contract and self-employed individuals that work at home or on the street, and counting workers with a university education as formal workers.[30] The parameter A, which determines the elasticity of substitution between the different skill groups, is set to 0.33, following Sommacal (2006). This value implies an elasticity of substitution between the different skill types of 1.5, in line with the empirical evidence for the U.S. reported by Ciccone and Peri (2005).

The fraction of domestic savings invested abroad, γ, is set to 40%. This number corresponds to the value of all foreign investment by the Pension Fund Administrators (Administradoras de Fondos de Pensiones — AFP), as a fraction of total assets, according to the data from the Chilean Superintendency of Pensions from August 2016. The foreign interest rate, r^*, is set to 3% annually, which corresponds to the global real return rate assumed by the OECD (2015). In turn, the fraction of foreign investment in Chile, γ^*, is set to 145% of GDP at the initial steady state. This number corresponds to the gross investment position of foreign entities in Chilean banks, other financial institutions, non-financial firms, and households, expressed as a ratio of GDP, according to National Accounts.

Regarding the parameters that determine the financial and/or informational frictions, we will use two different calibrations and complement these with two extreme cases (see the results). The baseline calibration assumes a homogeneous friction where $\varphi_i = 0.5$ for all i, which implies an incomplete degree of substitution between mandatory savings, in the form of pension contributions, and voluntary savings of approximately 0.5, in line with the interna-

29 According to this survey the fractions of total income corresponding to each quantile, starting with the first, i.e., skill group number 1, are 4.2%, 9.7%, 14.5%, 21.1%, and 50.5%.

30 Source: INE.

tional and Chilean evidence (e.g., Attanasio and Brugiavini, 2003; Attanasio and Rohwedder, 2003; Botazzi et al., 2006; Morandé, 1998). This imperfect substitution could be explained by both financial (e.g., because of borrowing constraints derived from limits to the usage of future pensions as collateral) or informational (e.g., because of a partial perception of pension contributions as taxes) frictions. The alternative calibration assumes $\varphi_1 = 0.18$, $\varphi_2 = 0.32$, $\varphi_3 = 0.43$, $\varphi_4 = 0.45$, and $\varphi_5 = 0.50$ which corresponds to the simple average of the number of right answers, for the respective income quantile, of a subset of questions of the Social Protection Survey (Encuesta de Protección Social — EPS) of 2009. This setup corresponds to an interpretation of the friction embodied in φ_i as an informational one.[31] This methodology follows Landerretche and Martínez (2011).

4. Comparative Statics

In this section we present the results obtained from the different comparative statics exercises that aim at understanding the effects that the different pension reforms would have on the economy, and in particular the effects of the C-CDC pension scheme. These exercises consist of comparing the initial and final steady states, where the former corresponds to the current state of the Chilean economy with its current pension system, and the latter to the one obtained after a given reform has been implemented. The tables presented show the long-run changes of the main variables of interest — expressed in efficiency adjusted per capita terms — following the introduction of an employer contribution of 5% under the different schemes previously described. The results are obtained using numerical methods that solve for the steady state of the non-linear model.[32]

One of the main uncertainty sources of our model is the financial and/or informational frictions; responsible for the main effects in the model. Therefore, for each pension scheme considered we compute the effects for the baseline scenario, with a degree of internalization of future pension benefits of 50%, constant across skill groups, i.e., $\varphi_i = 0.5\ \forall i$, together with three alternative scenarios, a case in which internalization is complete, i.e., $\varphi_i = 1\ \forall i$, a case where there is no internalization of future benefits, i.e., $\varphi_i = 0\ \forall i$, and a case in which the internalization degree is heterogeneous (see the calibration section). For these last three scenarios the model is re-calibrated to match the same

31 Source Centro de Encuestas y Estudios Longitudinales of the Pontificia Universidad Católica de Chile and Subsecretaría de Previsión Social of the Chilean Government.

32 In particular, we solve for the capital-labor ratio under a specific steady state (which involves solving a non-linear equation), and then rely on using homothopies to bring the model to the desired parametrization.

targets as the ones matched under the baseline model. Finally, we present a robustness scenario, where the fraction of domestic savings invested abroad, γ, is set to 0. For this last case, the model is not re-calibrated, and is left as a robustness exercise.

4.1 Individual Defined Contribution

Table 3 shows the effects of implementing the IDC scheme. We first discuss the case in which there are no frictions, i.e., $\varphi_i = 1 \; \forall i$ and no income tax $\tau = 0$ (case not shown). In that particular case the mechanism is rather simple. As τ^F is increased from 0 to 0.05, wages paid by the firms decrease by 4.8% and pensions increase accordingly.[33] The rest of the economy remains unaltered: as firms discount the new contribution from the workers' wages, workers accept this without changing their labor supply. This happens because workers' total net return for working in the formal sector — what they care about, the sum of the wage and the (discounted) future pension — remains unchanged. There is, however, a composition effect in total savings: the imposed new savings through firms' contributions on behalf of workers are exactly offset by a reduction in the amount of voluntary (private) savings.

This simple mechanism is disrupted when an income tax, τ, is allowed for. A positive τ makes the contributions paid by firms a mechanism to reduce the base on which the income tax paid by workers is computed. This happens because agents do not pay taxes on pensions. Therefore, with a positive income tax, the previous result does change. Agents experience an increase in net formal returns when the new firms' contributions are introduced; inducing an incentive to move into formality (see Table 3, column robustness $\varphi = 1$) and further reducing wages in the sector (relative to the previous case). As a counterpart of the increase in formal work, informality decreases by -2.7%. Finally, though voluntary savings do decrease, mandatory savings increase by more, yielding a marginal increase in total savings that produces, in turn, an increase in capital, which, together with the increase of formal labor, yields an increase of GDP and consumption.

33 Note that, $\dfrac{W^{final} - W^{initial}}{W^{initial}} = \dfrac{\dfrac{W^{initial}}{1+\tau^F} - W^{initial}}{W^{initial}} = -0.048$, when $\tau^F = 0.05$.

TABLE 3

LONG-TERM MACROECONOMIC EFFECTS, INDIVIDUAL DEFINED CONTRIBUTION SCHEME.

*: EXPRESSED IN PERCENTAGE POINT CHANGES. CONSUMPTION ENCOMPASSES TWO ROWS, THE UPPER ONE SHOWS THE PERCENTAGE CHANGE WHILE ACTIVE, WHEREAS THE LOWER ONE WHEN

Expressed in percentage changes	Baseline calibration						Friction sensibility			Openness robustness
	Aggregate	Skill groups					φ			γ
		5	4	3	2	1	1	0	Heteroge.	0
Wages	-2.5	-2.6	-2.5	-2.5	-2.5	-2.5	-5.2	0.1	-2.3	-1.6
Formal work	1.4	1.4	1.3	1.3	1.3	1.3	1.8	0.1	1.4	2.2
Informal work	-2.0	-4.2	-2.8	-2.7	-2.6	0.1	-2.7	-0.1	-1.7	-4.0
Formal net income	1.2	1.2	1.2	1.2	1.2	1.3	1.6	0.1	1.0	2.2
Voluntary savings/GGP*	-2.5	-1.3	-0.5	-0.3	-0.2	-0.1	-4.2	-0.8	-2.3	-2.7
Public savings/GDP*	4.2						4.4	4.0	4.1	4.2
Total savings/GDP*	1.7						0.2	3.1	1.8	1.5
Annual interest rate*	-0.1						0.0	-0.2	-0.1	-0.2
Capital	6.4						0.9	10.9	6.8	9.4
Consumption	6.1	1.4	1.6	1.6	1.7	1.5	2.6	7.9	6.3	7.1
		11.3	14.2	16.5	19.4	8.7				
Formal GDP	3.7						1.4	5.2	4.0	5.6

We address now the baseline parametrization, i.e. when $\varphi_i = 0.5 \ \forall i$. Under this scenario, agents view the new pension contribution, τ^F, partially as a tax. They fail to internalize that for every unit contributed, their future pension will increase in that unit plus the accumulated returns it produces until retirement. Instead, they behave as if only half of their contributions translate into future pensions; the other half, as already mentioned, is treated as a tax. Therefore, under this context, the introduction of τ^F induces a reduction of voluntary savings much lower than before and an increase in total savings in the economy; the mechanism illustrated at beginning of the model section. This increase is the main reason behind the significant increase of about 6.4% in the capital stock in the long run. The net formal income increases by 1.2% , making agents work more in the formal sector. At the same time the informal sector becomes less attractive, decreasing 2% in aggregate terms. Although the friction introduces a de facto tax on formal work inducing a negative effect on the labor market, the increase in capital (and the mechanism described above that allows for reducing taxes) generates higher salaries than otherwise. If half of the pension contributions were indeed taxes, and if these were, say, thrown into the sea, the impact would be worse than in the previous case. It is the higher total savings and, consequently, higher capital stock which, finally, push GDP upwards; about 3.7% in the long run.

Setting the friction to the largest possible value, i.e., $\varphi_i = 0 \ \forall i$, we obtain an even more expansionary effect on the economy. However, since agents do not realize that their pension contributions are going to be paid back to them as pensions when they retire, they do not change their labor choices as much as in the baseline scenario. Not allowing domestic households to invest abroad — i.e., setting $\gamma = 0$ — leads to a larger effect on capital, consumption, and output, while the labor market experiences, also, larger movements.

Let us also consider the case in which the friction is heterogeneous. In this case, the less skilled groups will internalize even less of the future pension than they did in the baseline calibration, therefore they will reduce their voluntary savings less, increasing total savings even more, around 1.8%. This will, in turn, lead to an even greater increase in activity and consumption.

4.2 Conditional Collective Defined Contribution

The effects of the C-CDC scheme that conditions on formal work are presented in Table 4. Contrary to the previous scheme, this pension reform imposes a redistribution of the additional funds collected from the firms among the different skill groups of the same generation. Their pension, or more precisely the fraction financed through the firms' contributions, is now proportional to their labor effort and are not weighted by their respective salaries (i.e., we set

$\alpha_0 = 0$ and $\alpha_1 = 0$). This means that the lower skilled agents will face an incentive to move into formality to take advantage of the higher than normal associated pensions, while high skilled agents will experience the opposite.

This scheme generates similar aggregate effects on capital, consumption, and output as the pure individual capitalization scheme addressed previously, while shifting the distribution of formal labor supplied by households more in favor of the lower skill groups. In this way, the effect this scheme has on formality and informality is substantially lar- ger, favoring the formalization of the less skilled groups. Given the relative sizes of the affected groups and the different incentives they are confronted with, aggregate informal work decreases 2.7%.

It should be emphasized that these results hinge significantly on the degree of internalization of future pensions that the different skill groups face. In the case where agents consider their entire contributions as taxes, both schemes — IDC and C-CDC; and U- CDC for that matter — deliver the same aggregate results. This should not be a surprise since agents change their labor and saving decisions solely as a reaction to the perceived tax and they do not observe any of the incentives introduced by the pension. Moreover, while the change in GDP between steady states is higher under the IDC scheme than under the C-CDC one for the baseline calibration, under the heterogeneous calibration this change is lower.

Let us try to explain why this happens. As illustrated before, there are two major forces at play in this model when a new pension contribution is introduced; first, as the degree of internalization decreases, agents undo a smaller fraction of the forced savings imposed by the new pension policy;[34] second, as the degree of internalization increases agents observe the incentives created by the new policy better, consequently modifying their labor and consumption decisions. The first mechanism tends to dominate in the pension schemes we consider here.

First, let us see why changes in savings and activity are higher under the heterogeneous calibration than under the baseline one. The former calibration differs from the latter one in that the lower skilled groups are less able to internalize their future pensions, whereas the most skilled group keeps its degree of internalization constant. As a consequence, under the heterogeneous calibration, the least skilled groups will undo the new mandatory savings less than under the baseline one, while the most skilled groups will save about the same. Therefore, under both pension schemes, aggregate savings and capital increase. Simultaneously, formal labor increases for the most skilled groups

[34] This could also be easily thought of in terms of financial restrictions; as borrowing constraints strengthen agents find it harder to borrow against their future pensions, undoing to a lesser extent the introduced mandatory savings.

— mainly due to the general equilibrium effect of higher aggregate savings and capital — and strongly decreases for the lower skilled ones, which now perceive a lower net income for working in the formal sector and therefore, decide to relatively intensify their informal labor.

Let us now try to understand why the increase in activity as a consequence of implementing the IDC scheme is larger than when implementing the C-CDC one under the baseline calibration, whereas this reverses under the heterogeneous one. In the C-CDC case, the most skilled agents reduce their voluntary savings less than under the IDC one because their perceived additional pension, given the newly imposed contribution, ends up being lower under this scheme than under the IDC one. In other words, they cannot allow themselves to reduce their private savings as much, since, as a consequence of the redistributive features of the C-CDC system, for each unit contributed they get paid a lower future pension than under the IDC one. The lower skilled groups, on the other hand, receive higher pensions per unit contributed under the C-CDC scheme than under the IDC one, so they tend to undo a higher fraction of the new mandatory savings under the former scheme than under the latter in an attempt to smooth consumption.

TABLE 4

LONG-TERM MACROECONOMIC EFFECTS, CONDITIONAL COLLECTIVE DEFINED CONTRIBUTION SCHEME.

*: EXPRESSED IN PERCENTAGE POINT CHANGES. CONSUMPTION ENCOMPASSES TWO ROWS, THE UPPER ONE SHOWS THE PERCENTAGE CHANGE WHILE ACTIVE, WHEREAS THE LOWER ONE WHEN RETIRED.

Expressed in percentage changes	Baseline calibration						Friction sensibility			Openness robustness
	Aggregate	Skill groups					φ			γ
		5	4	3	2	1	1	0	Heteroge.	0^{++}
Wages	-2.2	-1.1	-2.5	-3.4	-4.3	-6.6	-4.5	0.1	-1.8	-1.1
Formal work	0.8	-0.9	1.3	2.6	4.1	8.0	0.5	0.1	0.9	1.5
Informal work	-2.7	8.3	-1.9	-6.7	-12.3	-2.6	-3.9	-0.1	-2.2	-4.8
Formal net income	2.4	1.3	2.3	2.9	3.6	6.1	3.6	0.1	1.9	3.5
	0.8	0.5	0.7	0.9	1.0	2.0	0.7	0.1	0.6	1.9
Voluntary savings/GGP*	-2.5	-0.8	-0.6	-0.5	-0.5	-0.2	-4.4	-0.8	-2.2	-2.7
Public savings/GDP*	4.3						4.7	3.9	4.3	4.4
Total savings/GDP*	1.8						0.3	3.1	2.0	1.7
Annual interest rate*	-0.1						-0.0	-0.2	-0.1	-0.2
Capital	6.6						1.0	10.9	7.5	9.8
Consumption	6.3	1.2	2.2	2.9	3.6	3.6	2.9	7.9	6.9	7.4
		4.5	16.7	26.7	41.3	34.3				
Formal GDP	3.5						0.7	5.2	4.1	5.4

Now, when moving from the baseline to the heterogeneous calibration, the lowest skilled agents under the C-CDC scheme respond by increasing their savings relatively more than the same skilled agents under the IDC scheme. The reason is that when the degree of internalization decreases, under the C-CDC scheme, agents also stop internalizing the redistributive benefits of the scheme. Therefore, savings under the heterogeneous calibration increase relatively more for the C-CDC scheme than for the IDC one, pushing the activity change under the C-CDC system above the change under the IDC one. Other general equilibrium effects are also at play, such as the change in public savings which depends on the changes in wages and in formal employment.

4.3 Unconditional Collective Defined Contribution

Table 5 presents the results obtained from implementing the U-CDC reform. Under this scheme the two most skilled groups of agents are not entitled to an additional pension, even though firms do pay a payroll contribution on their behalf.[35] The remaining skill groups, in turn, receive an additional pension, financed through the firms' contributions, that is decreasing in the first component of their pension, i.e., the one financed through the employees' contributions. The model predicts a much lower output growth between the initial and final steady states, of only 1%. This is partially explained by the lower capital stock growth, about 4.6% in the long run, and, mainly, by the significantly larger reduction in formal labor, -2.3%. This lower aggregate performance ultimately increases informality in the economy, showing how a redistributive mechanism in a collective defined contribution scheme can be a poor design. In fact, informality under this scheme increases considerably, 4.1% in aggregate terms. This pension plan does, notwithstanding, improve the consumption of the three less qualified skill groups in the economy. Notice that for those skill groups that benefit from this scheme, 1 to 3, there is an implicit tax because for each additional unit they receive from their self-financed pension, the fraction of their pension that is financed through firms' contributions decreases by 1/3 units (similarly to the solidarity pillar currently in place in Chile). This is also responsible for the dynamics that end in a larger informality and in a reduction of formal work.

[35] This assumption follows the redistribution currently used in the pension scheme in place in Chile, where only two thirds of the retirees, the least skilled ones, are entitled to redistributive benefits.

TABLE 5

LONG-TERM MACROECONOMIC EFFECTS, UNCONDITIONAL COLLECTIVE DEFINED CONTRIBUTION SCHEME.

*: EXPRESSED IN PERCENTAGE POINT CHANGES. CONSUMPTION ENCOMPASSES TWO ROWS, THE UPPER ONE SHOWS THE PERCENTAGE CHANGE WHILE ACTIVE, WHEREAS THE LOWER ONE WHEN RETIRED.

Expressed in percentage changes	Baseline calibration						Friction sensibility			Openness robustness
	Aggregate	Skill groups					φ			γ
		5	4	3	2	1	1	0	Heteroge.	0^{++}
Wages	-1.6	-2.0	-2.1	-0.3	-0.3	-0.4	-3.3	0.1	-0.8	-1.1
Formal work	-2.3	-1.6	-1.6	-4.1	-4.1	-4.0	-4.6	0.1	-1.3	-1.5
Informal work	4.1	2.5	1.5	10.5	10.3	0.4	8.3	-0.1	2.3	3.4
Formal net income	-2.4	-2.0	-2.1	-2.9	-2.9	-3.0	-4.7	0.1	-1.4	-1.8
Voluntary savings/GGP*	-2.6	-0.3	-0.1	-0.7	-0.8	-0.8	-4.5	-0.8	-1.8	-2.8
Public savings/GDP*	4.1						4.3	4.0	4.1	4.2
Total savings/GDP*	1.5						-0.2	3.1	2.2	1.4
Annual interest rate*	-0.1						-0.1	-0.2	-0.2	-0.2
Capital	4.6						-1.6	10.9	7.5	6.8
Consumption	3.5	-3.4	-3.3	4.0	8.0	17.9	-1.5	7.9	5.7	4.1
		-6.9	-7.0	34.4	69.7	172.1				
Formal GDP	1.0						-3.2	5.2	2.9	2.5

4.4 Pay-As-You-Go

Finally, Table 6, shows the effects predicted by the model if a PAYG system would be implemented. This scenario is significantly worse than the previous pension reforms in all dimensions considered. In particular, it is the only system that produces a negative impact on capital, consumption, and output; all of them significant. The decrease in savings, caused by the initial transfer to the old generation leads to a contraction of total savings and, consequently, of the capital stock. This lower capital stock level, in turn, reduces the demand for labor of the firms beyond the direct effect on the labor supply implied by the tax on wages. This reduces formal labor around 4.1%, while increasing informality for all skill groups. As a consequence, GDP in the long run decreases about 4.8%. It is worthwhile mentioning that the rule that determines the distribution of funds is proportional to the contributions made by each agent. This reduces the distortions in the labor market, by strongly linking contributions and future benefits. Other alternative pay-as-you-go schemes should have additional negative effects to the ones predicted here.

Clearly, all modelling and calibration exercises are subject to a substantial degree of uncertainty. In particular, it is difficult to calibrate the financial/informational frictions that make agents internalize only partially the future benefits under the different schemes. Notwithstanding, as it can be observed, the ranking of the different alternatives, in terms of their aggregate effects is relatively robust: the individual defined contribution and the conditional collective defined contribution schemes, have the most positive (or least negative) effects in terms of capital, GDP, and labor, while the unconditional collective defined contribution scheme and, in particular, the pay-as-you-go system, have the (less positive) most negative effects on those variables. In addition, only the first two schemes are able to reduce informality.[36]

[36] The collective defined contribution scheme behaves exactly the same as the other first two schemes when the informational and/or financial friction is set to 0 across skill groups, as expected.

TABLE 6

LONG-TERM MACROECONOMIC EFFECTS, UNCONDITIONAL COLLECTIVE DEFINED CONTRIBUTION SCHEME.

*: EXPRESSED IN PERCENTAGE POINT CHANGES. CONSUMPTION ENCOMPASSES TWO ROWS, THE UPPER ONE SHOWS THE PERCENTAGE CHANGE WHILE ACTIVE, WHEREAS THE LOWER ONE WHEN RETIRED.

Expressed in percentage changes	Baseline calibration						Friction sensibility			Openness robustness
	Aggregate	Skill groups					φ			γ
		5	4	3	2	1	1	0	Heteroge.	0^{++}
Wages	-5.4	-5.4	-5.5	-5.5	-5.5	-5.5	-6.2	-4.2	-5.4	-6.3
Formal work	-4.1	-4.1	-4.1	-4.1	-4.1	-4.1	3.3	-4.9	-4.1	4.7
Informal work	6.0	11.8	8.3	8.0	7.9	-0.2	4.6	7.1	6.2	8.3
Formal net income	-5.4	-5.4	-5.5	-5.5	-5.5	-5.5	-6.2	-4.2	-5.3	-6.3
	-2.0	-2.0	-2.1	-2.1	-2.1	-2.1	-0.5	-4.2	-2.3	-3.2
Voluntary savings/GGP*	-0.6	-0.3	-0.1	-0.1	-0.1	-0.0	-0.8	-0.3	-0.6	-0.4
Public savings/GDP*	-0.7						-0.9	-0.5	-0.7	-0.8
Total savings/GDP*	-1.3						-1.7	-0.7	-1.3	-1.2
Annual interest rate*	0.0						0.1	-0.0	0.0	0.1
Capital	-5.5						-6.3	-3.8	-5.4	-7.8
Consumption	-4.0	-5.7	-5.7	-5.7	-5.7	-5.7	-4.7	-2.9	-3.9	5.0
		-1.9	-1.2	-0.6	0.2	-1.7				
Formal GDP	-4.8						-4.8	-4.4	-4.7	-6.2

5. Demographic Transition

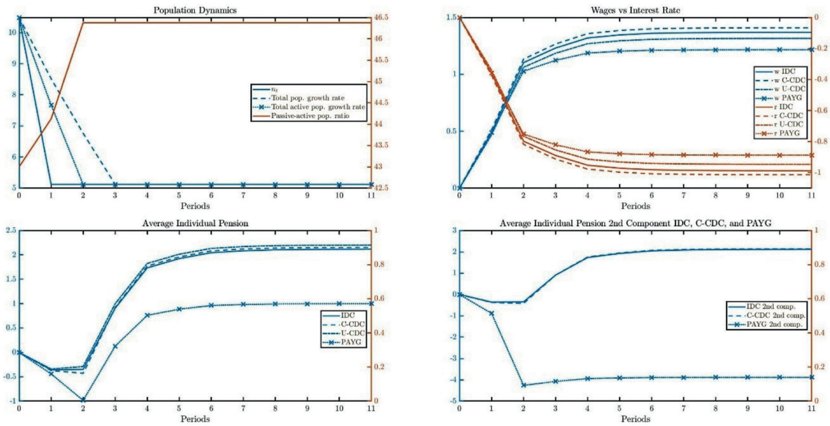
One particularly relevant aspect of pension schemes is their ability to handle population dynamics, such as a decrease in the fertility rate or an increase of life expectancy. In this section we use our model to analyze the first of those situations, simulated by a drop in the population growth rate, and how the different pension schemes can accommodate such a change. We consider a simple steady state transition exercise in which the economy departs form the steady state associated to each pension scheme analyzed, and simulate a drop of n from the calibrated annual 0.5% to 0.25%. In other words, we consider what happens under each of the four alternative pension reforms after they have been fully implemented and the population growth rate drops by half.

The upper-left graph shows the basic population dynamics triggered by the drop in the growth rate n. Remember that each period in the model corresponds to 20 years. In particular, besides the propagation of the shock through the active and total populations, one can observe how as the population growth falls, the amount of passive agents in the economy relative to active workers increases. When the economy stabilizes at its new steady state the ratio of passive individuals relative to the active ones is about 3 percent points higher. Moreover, as population growth slows down, capital becomes relatively more abundant in the economy inducing a decrease in the interest rate. By the same mechanism the relatively more scarcity of workers induce an increase in wages. This increase in wages, in turn, generates a movement of workers from the informal to the formal sector (see upper-left graph in Figure 1). The higher wages together with the increase in formal labor make pension contributions increase. Under the case of the first three schemes, IDC, C-CDC and U-CDC, the drop in n ultimately translates into higher pensions. However, under the PAYG pension alternative, average pensions increase less, as now relatively less workers finance the passive individuals in the economy. It is interesting to note that for all four cases, during the transition, pensions unequivocally decrease, though more strongly under the PAYG scheme. The reason is the decrease in the interest rate and the fact that during the first two periods, the funds used to pay out pensions have been totally or partially in period 2 constituted under the original steady state (when salaries and formal work were lower).

The lower-right graph shows the dynamics of the second component of total pensions, for three pension systems, for the conditional collective defined contribution, for the individual defined contribution, and for the PAYG schemes. We can see how in the case of the PAYG alternative the drop of the second component, the one financed by firms' contributions, is the one pushing total pensions downwards under that scheme. The first component — not shown — behaves in the same way under all four schemes, as is to be expected. Hence a pension system that is fully articulated as a PAYG system would endure more severe problems, in terms of pensions, in the face of a population growth deceleration.

FIGURE 1

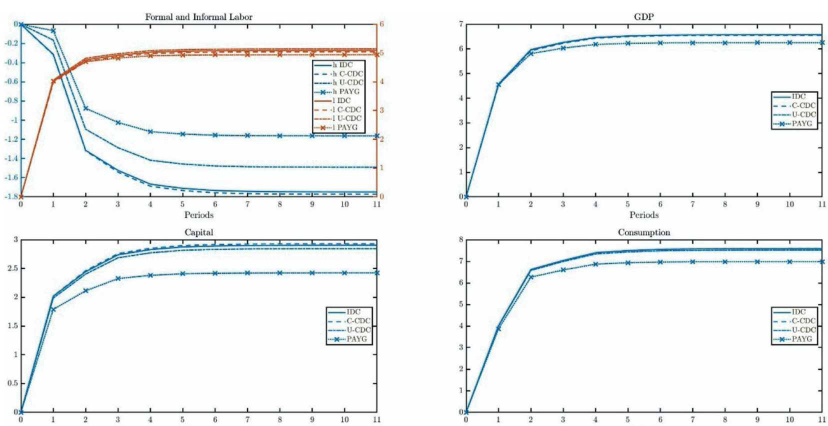
DEMOGRAPHIC TRANSITION



As shown in Figure 2, the slow down in population growth yields larger GDP, consumption and capital stock, for all pension schemes. However, it is worthwhile noticing that the performance of the economy with a PAYG system is clearly dominated by the other three schemes here considered, in particular, by the C-CDC and IDC alternatives.

FIGURE 2

DEMOGRAPHIC TRANSITION



6. Concluding Remarks

In this paper we present a quantitative analysis of the long-term macroeconomic effects of implementing alternative pension system reforms in an economy with a significant informal sector. For this, we construct a three-period OLG model with five skill groups, informational and/or financial frictions and labor informality that we calibrate to the Chilean economy. We consider four different pension schemes — all financed through an identical increase of pension contributions taking the form of a payroll tax — that only differ from each other in the way they treat the additional funds and allocate them among retirees. In particular, we consider two versions of a CDC scheme that differ in whether they make pension benefits depend upon the degree of labor effort during working life or not, and compare their macroeconomic performance to an IDC scheme and a PAYG alternative. Conditioning the receipt of benefits on employment status within a redistributive design is the key aspect that incentivizes a strong formalization of labor supply at low income levels, which are those who make the largest share of informal work, surpassing the effects found under the IDC plan. In particular, the informational and/or financial frictions play the main role in the dynamics of our model as they restrict the degree in which agents internalize how pension contributions translate into future pension payments.

The quantitative results suggest that the C-CDC scheme has similar macroeconomic impacts as an IDC plan under the baseline calibration, including a moderate positive effect on the formal labor market, which together with an increase in capital due to the rise of compulsory savings, generates an expansion of output and consumption. With respect to the effect these schemes have on the informal sector, the C-CDC creates stronger incentives to move away from informality among lower-income workers, and since these are precisely the ones more present in informality, we observe a stronger reduction of aggregate informality under this pension plan. This, despite the opposite effect produced among higher-income workers. The U-CDC alternative, in turn, has a negative effect on the labor market, since by making future benefits independent of contributions, low-income agents no longer have an incentive to move into formality. The additional capital is, therefore, no longer complemented by more work, and total output only increases marginally. This reduces employment and formality. The PAYG system constitutes the most adverse scheme of all the ones considered. The important reduction of the capital stock, of around 5.5%, reduces the demand for labor beyond the negative effect of the imposed contribution on firms. Formal employment falls around 4.1% and informality increases about 6%, while GDP and consumption fall 4.8 and 4% respectively.

Finally, we find that like the IDC plan, the C-CDC scheme's solvency is robust to population ageing, the main shortcoming of unfunded pay-as-you-go (PAYG) systems. Hence, our results suggest that a C-CDC scheme may be an economically sustainable and politically viable alternative for countries with significant labor informality and income inequality.

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Appendix

Model

In what follows we write the stationary model, where variables are expressed in technology adjusted per-capita terms: $c_{i,t}^{y}=C_{i,t}^{y}/A_{t}$, $c_{i,t}^{m}=C_{i,t}^{m}/A_{t-1}$, $c_{i,t}^{o}=C_{i,t}^{o}/A_{t-2}$, $s_{i,t}^{y}=S_{i,t}^{y}/A_{t}$, $s_{i,t}^{m}=S_{i,t}^{m}/A_{t-1}$, $s_{i,t}^{PW,y}=S_{i,t}^{PW,y}/A_{t}$, $s_{i,t}^{PW,m}=S_{i,t}^{PW,m}/A_{t-1}$, $p_{i,t}=P_{i,t}/A_{t-2}$, $p_{i,t}^{F}=P_{i,t}^{F}/A_{t-2}$, $p_{i,t}^{W}=P_{i,t}^{W}/A_{t-2}$, $w_{i,t}^{y}=W_{i,t}^{y}/A_{t}$, $w_{i,t}^{m}=W_{i,t}^{m}/A_{t-1}$, $l_{i,t}=L_{i,t}/N_{i,t}$, $l_{i,t}^{y}=L_{i,t}^{y}/N_{i,t}$, $l_{i,t}^{m}=L_{i,t}^{m}/N_{i,t-1}$, $y_{t}=Y_{t}/\left(N_{t}A_{t}\right)$, $l_{t}=L_{t}/N_{t}$, $w_{t}=W_{t}/A_{t}$, $c_{t}^{y}=C_{t}^{y}/\left(A_{t}N_{t}\right)$, $c_{t}^{m}=C_{t}^{m}/\left(A_{t-1}N_{t-1}\right)$, $c_{t}^{o}=C_{t}^{o}/\left(A_{t-2}N_{t-2}\right)$, $s_{t}=S_{t}/\left(A_{t}N_{t}\right)$, $s_{t}^{y}=S_{t}^{y}/\left(A_{t}N_{t}\right)$, $s_{t}^{m}=S_{t}^{m}/\left(A_{t-1}N_{t-1}\right)$, $s_{t}^{P}=S_{t}^{P}/\left(A_{t}N_{t}\right)$, $s_{t}^{PW,y}=S_{t}^{PW,y}/\left(A_{t}N_{t}\right)$, $s_{t}^{PW,m}=S_{t}^{PW,m}/\left(A_{t-1}N_{t-1}\right)$, $s_{t}^{PF,y}=S_{t}^{PF,y}/\left(A_{t}N_{t}\right)$, $s_{t}^{PF,m}=S_{t}^{PF,m}/\left(A_{t-1}N_{t-1}\right)$, $p_{t}=P_{t}/\left(A_{t-2}N_{t-2}\right)$, $p_{t}^{W}=P_{t}^{W}/\left(A_{t-2}N_{t-2}\right)$, $p_{t}^{F}=P_{t}^{F}/\left(A_{t-2}N_{t-2}\right)$, $p_{t}^{BS}=P_{t}^{BS}/A_{t-2}$, $k_{t}=K_{t}/\left(A_{t-1}N_{t-1}\right)$, $pts_{t}=PTS_{t}/N_{t-2}$, $w_{i,t}^{y}=W_{i,t}^{y}/A_{t}$, $w_{i,t}^{m}=W_{i,t}^{m}/A_{t-1}$ and $wl_{t}^{m}=WL_{t}^{m}/\left(N_{t-1}A_{t-1}\right)$. The stationary recursive competitive equilibrium of the model is then the set of sequences,

$$\left\{c_{1,t}^{y},\ldots,c_{n_l,t}^{y},c_{1,t}^{m},\ldots,c_{n_l,t}^{m},c_{1,t}^{o},\ldots,c_{n_l,t}^{o},s_{1,t}^{y},\ldots,s_{n_l,t}^{y},s_{1,t}^{m},\ldots,s_{n_l,t}^{m},\right.$$

$$s_{1,t}^{PW,y},\ldots,s_{n_l,t}^{PW,y},s_{1,t}^{PW,m},\ldots,s_{n_l,t}^{PW,m},p_{1,t},\ldots,p_{n_l,t},p_{1,t}^{W},\ldots,p_{n_l,t}^{W},p_{1,t}^{F},\ldots,p_{n_l,t}^{F},$$

$$l_{1,t}^{y},\ldots,l_{n_l,t}^{y},l_{1,t}^{m},\ldots,l_{n_l,t}^{m},h_{1,t}^{y},\ldots,h_{n_l,t}^{y},h_{1,t}^{m},\ldots,h_{n_l,t}^{m},w_{1,t}^{y},\ldots,w_{n_l,t}^{y},$$

$$w_{1,t}^{m},\ldots,w_{n_l,t}^{m},l_{1,t},\ldots,l_{n_l,t},y_{t},l_{t},w_{t},r_{t}^{k},r_{t},s_{t},s_{t}^{y},s_{t}^{m},s_{t}^{P},s_{t}^{PW,y},s_{t}^{PW,m},$$

$$\left.s_{t}^{PF,y},s_{t}^{PF,m},p_{t},p_{t}^{W},p_{t}^{F},\left(\mu_{2}+\mu_{3}\right)p_{t}^{BS},k_{t+1},pts_{i,t},pts_{t},\overline{w_{i,t}^{y}},\overline{w_{i,t}^{m}},wl_{t}^{m}\right\}_{t=0}^{\infty}$$

such that for given initial values, the following conditions are satisfied for every t:[37]

(41) $$c_{i,t}^{y}=\left(1-\tau_{s}\right)w_{i,t}^{y}l_{i,t}^{y}+b_{i}\left(\frac{h_{t}^{\xi-1}}{\eta}\right)a_{i}h_{i,t}^{y}-s_{i,t}^{y}-s_{i,t}^{PW,y}$$

(42) $$c_{i,t}^{m}=\left(1-\tau\right)w_{i,t}^{m}l_{i,t}^{m}+\left(1+g\right)b_{i}\left(\frac{h_{t}^{\xi-1}}{\eta}\right)a_{i}h_{i,t}^{m}+r_{t}s_{i,t-1}^{y}-s_{i,t}^{m}-s_{i,t}^{PW,m}$$

(43) $$c_{i,t}^{o}=r_{t}s_{i,t-1}^{m}+p_{i,t}$$

[37] To cast the system into Dynare syntax, predetermined variables, k_{t+1}. and k_{t}, need to be written as k and $k(-1)$, respectively.

(44)
$$c_{i,t}^{y} = \frac{(1-\tau-\tau^{W})\left(w_{i,t}^{y} l_{i,t}^{y} + \frac{w_{i,t+1}^{m} l_{i,t+1}^{m}}{r_{t+1}}\right)}{1+\beta_i^{1/\theta} r_{t+1}^{(1-\theta)/\theta} + \beta_i^{2/\theta}(r_{t+1}r_{t+2})^{(1-\theta)/\theta}} + \frac{b_i\left(\frac{h_t^{\xi-1}}{\eta}\right)a_i h_{i,t}^{y} + \frac{(1+g)b_i\left(\frac{h_{t+1}^{\xi-1}}{\eta}\right)a_i h_{i,t+1}^{m}}{r_{t+1}} + \varphi_i \frac{p_{i,t+2}}{r_{t+1}r_{t+2}}}{1+\beta_i^{1/\theta} r_{t+1}^{(1-\theta)/\theta} + \beta_i^{2/\theta}(r_{t+1}r_{t+2})^{(1-\theta)/\theta}}$$

(45)
$$c_{i,t}^{m} = \frac{r_t s_{i,t-1}^{y} + \left(1-\tau-\tau^{W}\right) w_{i,t}^{m} l_{i,t}^{m} + (1+g) b_i \left(\frac{h_t^{\xi-1}}{\eta}\right) a_i h_{i,t}^{m} + \varphi_i \frac{p_{i,t+1}}{r_{t+1}}}{1+\beta_i^{1/\theta} r_{t+1}^{(1-\theta)/\theta}}$$

(46)
$$c_t^{y} = \sum_{i=1}^{n_l} c_{i,t}^{y} \lambda_i$$

(47)
$$c_t^{m} = \sum_{i=1}^{n_l} c_{i,t}^{m} \lambda_i$$

(48)
$$c_t^{o} = \sum_{i=1}^{n_l} c_{i,t}^{o} \lambda_i$$

(49)
$$s_{i,t}^{PW.y} = \tau^{W} w_{i,t}^{y} l_{i,t}^{y}$$

(50)
$$s_{i,t}^{PW.m} = \tau^{W} w_{i,t}^{m} l_{i,t}^{m}$$

(51)
$$p_{i,t} = p_{i,t}^{W} + p_{i,t}^{F}$$

(52)
$$p_{i,t}^{W} = r_t \left(s_{i,t-1}^{PW,m} + r_{t-1} s_{i,t-2}^{PW,y}\right)$$

(53)
$$p_{i,t}^{F} = \mu_1 r_t \tau^{F}\left(w_{i,t-1}^{m} l_{i,t-1}^{m} + r_{t-1} w_{i,t-2}^{y} l_{i,t-2}^{y}\right) + \mu_2 \frac{pts_{i,t}}{pts_t} p_t^{F} + \mu_3\left[p_t^{BS} - \frac{1}{3} r_t \tau^{W}\left(w_{i,t-1}^{m} l_{i,t-1}^{m} + r_{t-1} w_{i,t-2}^{y} l_{i,t-2}^{y}\right)\right] 1_{i<\bar{i}} + \mu_4 \frac{r_t w_{i,t-1}^{m} l_{i,t-1}^{m}}{wl_{t-1}^{m}} p_t^{F} 1_{i<\bar{i}}$$

(54)
$$p_t^{BS} = \left(r_t\left(s_{t-1}^{PF,m} + r_{t-1} s_{t-2}^{PF,y}\right) + \frac{1}{3}\sum_{i=\bar{i}+1}^{n_l} p_{i,t}^{W} \lambda_i\right) \frac{1}{\sum_{i=\bar{i}+1}^{n_l} \lambda_i}$$
$$pts_{i,t} = r_t\left(a_0 + l_{i,t-1}^{m}\left(\frac{w_{i,t-1}^{m}}{\overline{\overline{w_{t-1}^{m}}}}\right)^{a_1} + r_{t-1}\left[a_0 + l_{i,t-2}^{y}\left(\frac{w_{i,t-2}^{y}}{\overline{\overline{w_{t-2}^{y}}}}\right)^{a_1}\right]\right)$$

$$pts_t = \sum_{i=1}^{n_l} \lambda_i pts_{i,t} \tag{55}$$

$$\chi_i^y \left(l_{i,t}^y + h_{i,t}^y\right)^{\phi-1} = \left(c_{i,t}^y\right)^{-\theta(1-\upsilon)} w_{i,t}^y \left\{1-\tau-\left(1-\varphi_i\right)\tau^W + \varphi_i \left[\mu_1 \tau^F + \mu_2 \frac{\left(w_{i,t}^y\right)^{a_1-1}}{\left(\overline{w_t^y}\right)^{a_1}} \frac{p_{t+2}^F}{pts_{t+2}} - \mu_3 \frac{1}{3} \tau^W 1_{i<\bar{i}}\right]\right\} \tag{56}$$

$$\chi_i^m \left(l_{i,t}^m + h_{i,t}^m\right)^{\phi-1} = \left(c_{i,t}^m\right)^{-\theta(1-\upsilon)} w_{i,t}^m \left\{1-\tau-\left(1-\varphi_i\right)\tau^W + \varphi_i \left[\mu_1 \tau^F + \mu_2 \frac{\left(w_{i,t}^m\right)^{a_1-1}}{\left(\overline{w_t^m}\right)^{a_1}} \frac{p_{t+1}^F}{pts_{t+1}} - \mu_3 \frac{1}{3} \tau^W 1_{i<\bar{i}} + \mu_4 \frac{p_{t+1}^F}{wl_t^m} 1_{i<\bar{i}}\right]\right\} \tag{57}$$

$$h_{i,t}^y = \max\left\{0, \left[\frac{\left(c_{i,t}^y\right)^{-\theta(1-\upsilon)}}{\chi_i^y} \left(\frac{b_i\left(\frac{h_t^{\xi-1}}{\eta}\right)a_i - w_{i,t}^y \left\{1-\tau-\left(1-\varphi_i\right)\tau^W + \varphi_i \left[\begin{array}{c}\mu_1 \tau^F + \mu_2 \frac{\left(w_{i,t}^y\right)^{a_1-1}}{\left(\overline{w_t^y}\right)^{a_1}} \frac{p_{t+2}^F}{pts_{t+2}} \\ -\mu_3 \frac{1}{3} \tau^W 1_{i<\bar{i}}\end{array}\right]\right\}}{\kappa}\right)\right]^{\frac{1}{\phi-1}}\right\} \tag{58}$$

$$h_{i,t}^m = \max\left\{0, \left[\frac{\left(c_{i,t}^m\right)^{-\theta(1-\upsilon)}}{\chi_i^m} \left(\frac{\left(1+g\right)b_i\left(\frac{h_t^{\xi-1}}{\eta}\right)a_i - w_{i,t}^m \left\{1-\tau-\left(1-\varphi_i\right)\tau^W + \varphi_i \left[\begin{array}{c}\mu_1 \tau^F + \mu_2 \frac{\left(w_{i,t}^m\right)^{a_1-1}}{\left(\overline{w_t^m}\right)^{a_1}} \frac{p_{t+1}^F}{pts_{t+1}} \\ -\mu_3 \frac{1}{3} \tau^W 1_{i<\bar{i}} + \mu_4 \frac{p_{t+1}^F}{wl_t^m} 1_{i<\bar{i}}\end{array}\right]\right\}}{\kappa}\right)\right]^{\frac{1}{\phi-1}}\right\} \tag{59}$$

(60) $$w_{i,t}^{y} = a_i w_t \left(\frac{l_t}{\lambda_i l_{i,t}} \right)^{1-\rho}$$

(61) $$w_{i,t}^{m} = \left(1+g\right) a_i w_t \left(\frac{l_t}{\lambda_i l_{i,t}} \right)^{1-\rho}$$

(62) $$l_{i,t} = l_{i,t}^{y} + \frac{l_{i,t}^{m}}{1+n_t}$$

for $i = 1,...,n\_\{l\}$. And, also,

(63) $$\overline{w_t^{y}} = \sum_{i=1}^{n_l} w_{i,t}^{y} \lambda_i$$

(64) $$\overline{w_t^{m}} = \sum_{i=1}^{n_l} w_{i,t}^{m} \lambda_i$$

(65) $$wl_t^{m} = r_{t+1 \sum_{i=\bar{i}+1}^{n_l} w_{i,t}^{m}} l_{i,t}^{m} \lambda_i$$

(66) $$y_t = \left(\frac{k_t}{\left(1+g\right)\left(1+n_t\right)} \right)^{\alpha} l_t^{1-\alpha}$$

(67) $$l_t = \left(\sum_{i=1}^{n_l} a_i \left(\lambda_i l_{i,t} \right)^{\rho} \right)^{1/\rho}$$

(68) $$w_t = \frac{1-\alpha}{1+\tau^{F}} \frac{y_t}{l_t}$$

(69) $$t_t = \tau \sum_{i=1}^{n_l} w_{i,t}^{y} l_{i,t}^{y} + \frac{w_{i,t}^{m} l_{i,t}^{m}}{\left(1+g\right)\left(1+n_t\right)}$$

(70) $$r_t^{k} = \alpha \frac{y_t}{k_t} \left(1+g\right)\left(1+n_t\right)$$

(71) $$r_t = 1 + \left(1-\gamma\right)\left(r_t^{k} - \delta\right) + \gamma r^{*}$$

(72) $$s_t = s_t^{y} + \frac{s_t^{m}}{\left(1+g\right)\left(1+n_t\right)}$$

(73) $$s_t^{y} = \sum_{i=1}^{n_l} s_{i,t}^{y} \lambda_i$$

(74) $$s_t^{m} = \sum_{i=1}^{n_l} s_{i,t}^{m} \lambda_i$$

(75) $$s_t^{P} = \frac{s_t^{PW,m} + r_t s_{t-1}^{PW,y}}{\left(1+g\right)\left(1+n_t\right)} + s_t^{PW,y} + \left(\mu_1 + \mu_2 + \mu_3\right) \left[\frac{s_t^{PF,m} + r_t s_{t-1}^{PF,y}}{\left(1+g\right)\left(1+n_t\right)} + s_t^{PF,y} \right]$$

(76) $$p_t = p_t^W + p_t^F$$

(77) $$p_t^F = \left(\mu_1+\mu_2+\mu_3\right) r_t \left(s_{t-1}^{PF,m} + r_{t-1} s_{t-2}^{PF,y}\right) + \mu_4\left(\left(1+g\right)\left(1+n_t\right) s_t^{PF,m} + \left(1+g\right)^2\left(1+n_t\right)\left(1+n_{t-1}\right) s_t^{PF,y}\right)$$

(78) $$p_t^W = r_t\left(s_{t-1}^{PW,m} + r_{t-1} s_{t-2}^{PW,y}\right)$$

(79) $$s_t^{PW,y} = \sum_{i=1}^{n_l} \tau^W \lambda_i w_{i,t}^y l_{i,t}^y$$

(80) $$s_t^{PW,m} = \sum_{i=1}^{n_l} \tau^W \lambda_i w_{i,t}^m l_{i,t}^m$$

(81) $$s_t^{PF,y} = \sum_{i=1}^{n_l} \tau^F \lambda_i w_{i,t}^y l_{i,t}^y$$

(82) $$s_t^{PF,m} = \sum_{i=1}^{n_l} \tau^F \lambda_i w_{i,t}^m l_{i,t}^m$$

(83) $$k_{t+1} = \left(1-\gamma\right)\left(s_t + s_t^P\right) + \gamma *$$

STEADY STATE

Let variables without time subscript denote steady state values. We solve for the steady state by means of numerical methods, using as starting values for the numerical solver the analytical steady state solution for the special case where $\tau^W = \tau^F = 0$ (note that imposing $\tau^F = 0$ is equivalent to $\mu_1 = \mu_2 = \mu_3 = \mu_4 = 0$, $\chi_i^y = \chi_i^m$ for all i, $\beta_i = \beta_j$ for all i and j, $\theta = \rho = \upsilon = 1$ and $\gamma = \gamma^\star = 0$. From (46) to (48)

$$c_i^o = rs_i^m = r\left(w_i^m l_i^m + \left(1+g\right) b_i \left(\frac{h^{\xi-1}}{\eta}\right) a_i h_i^m + rs_i^y - c_i^m\right) =$$
$$r\left(w_i^m l_i^m + \left(1+g\right) b_i \left(\frac{h^{\xi-1}}{\eta}\right) a_i h_i^m + r\left(w_i^y l_i^y + eb_i\left(\frac{h^{\xi-1}}{\eta}\right) a_i h_i^y - c_i^y\right) - c_i^m\right)$$

and we also have from (49) through (53) and (75) through (82) that

(84) $$s_i^{PW,y} = s_i^{PW,m} = p_i^W = p_i^F = p_i = 0$$

for $i = 1,\ldots,n_l$, and that

(85) $$s^P = s^{PW,y} = s^{PW,m} = s^{PF,y} = s^{PF,m} = p = p^W = p^F = p^{BS} = 0$$

From (41) through (43) and the previous results,

$$c_i^o \overset{(43)}{\triangleq} rs_i^m \overset{(42)}{\triangleq} r\left(w_i^m l_i^m + (1+g) b_i \left(\frac{h^{\xi-1}}{\eta} \right) a_i h_i^m + rs_i^y - c_i^m \right)$$

$$\overset{(41)}{\triangleq} r\left(w_i^m l_i^m + (1+g) b_i \left(\frac{h^{\xi-1}}{\eta} \right) a_i h_i^m + rw_i^y l_i^y + rb_i \left(\frac{h^{\xi-1}}{\eta} \right) a_i h_i^y - rc_i^y - c_i^m \right)$$

$$\Leftrightarrow$$

$$c_i^o + rc_i^m + r^2 c_i^y =$$
$$r\left(w_i^m l_i^m + (1+g) b_i \left(\frac{h^{\xi-1}}{\eta} \right) a_i h_i^m + rw_i^y l_i^y + rb_i \left(\frac{h^{\xi-1}}{\eta} \right) a_i h_i^y \right)$$

We also have that,

(86) $$c_i^m = r\beta_i c_i^y$$

and

$$c_i^o = r\beta_i c_i^m$$

therefore,

$$c_i^o = \beta_i r c_i^m = (\beta_i r)^2 c_i^y$$

Combining both results, we obtain that

(87) $$c_i^y = \frac{w_i^m l_i^m + (1+g) b_i \left(\frac{h^{\xi-1}}{\eta} \right) a_i h_i^m + rw_i^y l_i^y + rb_i \left(\frac{h^{\xi-1}}{\eta} \right) a_i h_i^y}{\left(\beta_i^2 + \beta_i + 1 \right) r}$$

From (60), and (61), and since $\rho = 1$,

$$w_i^y = a_i w$$
$$w_i^m = (1+g) a_i w$$

Thus,

(88) $$w_i^y = \frac{w_i^m}{1+g}$$

From (58) and (59), and as long as $\chi_i^y = \chi_i^m,\ \theta = 1$,

(89)
$$h_i^y = \max\left\{\left[a_i \frac{\left(b_i\left(\frac{h^{\xi-1}}{\eta}\right)-w\right)}{\chi_i^y \kappa}\right]^{\frac{1}{\phi-1}},0\right\}$$

(90)
$$h_i^m = \max\left\{\left[(1+g)a_i \frac{\left(b_i\left(\frac{h^{\xi-1}}{\eta}\right)-w\right)}{\chi_i^m \kappa}\right]^{\frac{1}{\phi-1}},0\right\}$$

if $b_i < 0$ we have that,

$$h_i^y = 0 = h_i^m$$

else,

$$h_i^y = \left[a_i \frac{\left(b_i\left(\frac{h^{\xi-1}}{\eta}\right)-w\right)}{\chi_i^y \kappa}\right]^{\frac{1}{\phi-1}}$$

$$= \left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}\left[(1+g)a_i \frac{\left(b_i\left(\frac{h^{\xi-1}}{\eta}\right)-w\right)}{\chi_i^m \kappa}\right]^{\frac{1}{\phi-1}}$$

$$= \left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} h_i^m$$

which holds also for $b_i \geq 0$. We further choose b_i such that

(91)
$$h_i^y = \frac{l_i^y w}{b_i\left(\frac{h^{\xi-1}}{\eta}\right)}$$

and

$$h_i^m = \frac{l_i^m w}{b_i\left(\frac{h^{\xi-1}}{\eta}\right)} \tag{92}$$

In addition, assuming that such a b_i is constant over i, we have that,

$$c_i^y = \frac{(1+g)l_i^m + rl_i^y}{\left(\beta_i^2+\beta_i+1\right)r} 2a_i w \tag{93}$$

and

$$c_i^m = \beta_i \frac{(1+g)l_i^m + rl_i^y}{\beta_i^2+\beta_i+1} 2a_i w \tag{94}$$

From (56) and (57),

$$\left(l_i^y\right)^{\phi-1} = \frac{a_i w}{\chi_i^y} \frac{1}{1+\frac{w}{b_i\left(\frac{h^{\xi-1}}{\eta}\right)}}$$

$$\chi_i^m \left(l_i^m\right)^{\phi-1} = (1+g)a_i w \frac{1}{1+\frac{w}{b_i\left(\frac{h^{\xi-1}}{\eta}\right)}} \tag{95}$$

$$l_i^y = \frac{1}{1+\frac{w}{b_i\left(\frac{h^{\xi-1}}{\eta}\right)}} \left(\frac{a_i w}{\chi_i^y}\right)^{\frac{1}{\phi-1}}$$

and

$$l_i^m = \frac{1}{1+\frac{w}{b_i\left(\frac{h^{\xi-1}}{\eta}\right)}} \left(\frac{(1+g)a_i w}{\chi_i^m}\right)^{\frac{1}{\phi-1}} \tag{96}$$

Then, if $\phi \neq 1$, we have

$$l_i^y = l_i^m \left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} \tag{97}$$

Therefore, young and middle-aged formal work satisfy the same proportion as young and middle-aged informal work. Then, from (62), (97) and (96),

(98)
$$l_i = \lambda_i l_i^y + \frac{\lambda_i l_i^m}{1+n} = \lambda_i l_i^m \left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} + \frac{\lambda_i l_i^m}{1+n}$$
$$= \lambda_i l_i^m \left(\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} + \frac{1}{1+n}\right) = \lambda_i \left(1 + \frac{(1+g)^{\frac{1}{\phi-1}}}{1+n}\right) \frac{1}{1+\frac{w}{b_i\left(\frac{h^{\xi-1}}{\eta}\right)}} \left(\frac{a_i w}{\chi_i^m}\right)^{\frac{1}{\phi-1}}$$

To normalize l_i to 1 - in this steady state - one needs to set

$$\left(1 + \frac{(1+g)^{\frac{1}{\phi-1}}}{1+n}\right)^{\phi-1} \left(\frac{\lambda_i}{1+\frac{w}{b_i\left(\frac{h^{\xi-1}}{\eta}\right)}}\right)^{\phi-1} a_i w = \left(\chi_i^m\right)$$

$$\chi_i^m = \left(1 + \frac{(1+g)^{\frac{1}{\phi-1}}}{1+n}\right)^{\phi-1} \left(\frac{\lambda_i}{1+\frac{w}{b_i\left(\frac{h^{\xi-1}}{\eta}\right)}}\right)^{\phi-1} a_i w$$

From (67), and since $l_i = 1$,

(99)
$$l = \sum_{i=1}^{n_l} a_i l_i \lambda_i = \sum_{i=1}^{n_l} a_i \lambda_i =$$

Then, using (97) in (93), we can write

$$c_i^y = \frac{(1+g) + r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{\left(\beta_i^2 + \beta_i + 1\right) r} 2 a_i w l_i^m$$

$$l_i^y = l_i^m \left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}$$

(100)
$$c_i^y = \frac{(1+g)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{\left(\beta_i^2+\beta_i+1\right)r} 2a_i w l_i^m$$

From (41), we have that

$$s_i^y = w_i^y l_i^y + b_i\left(\frac{h^{\xi-1}}{\eta}\right) a_i h_i^y - c_i^y$$

(101)
$$= a_i w l_i^m \left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} + a_i w l_i^m \left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} - \frac{(1+g)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{\left(\beta_i^2+\beta_i+1\right)r} 2a_i w l_i^m$$

$$= \left[\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} - \frac{(1+g)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{\left(\beta_i^2+\beta_i+1\right)r}\right] 2a_i w l_i^m$$

From (42), we have that

$$s_i^m = w_i^m l_i^m + (1+g) b_i\left(\frac{h^{\xi-1}}{\eta}\right) a_i h_i^m + r s_i^y - c_i^m$$

$$= (1+g) a_i w l_i^m + (1+g) a_i l_i^m w + r\left[\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} - \frac{(1+g)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{\left(\beta_i^2+\beta_i+1\right)r}\right] 2a_i w l_i^m - c_i^m$$

$$= \left[1+g+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} - \frac{(1+g)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{(\beta_i^2+\beta_i+1)}\right] 2a_i w l_i^m - \beta_i \frac{(1+g)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{(\beta_i^2+\beta_i+1)} 2a_i w l_i^m$$

(102)
$$= 2a_i w l_i^m \left(1+g+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} - (1+\beta_i)\frac{(1+g)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{(\beta_i^2+\beta_i+1)}\right)$$

$$= 2a_i w l_i^m \left(1+g+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}\right)\left(1-\frac{1+\beta_i}{\beta_i^2+\beta_i+1}\right)$$

Starting from (83),

$$k=\left(1-\gamma\right)s$$

$$\overset{(72)}{\cong}\left(1-\gamma\right)s^{y}+\frac{\left(1-\gamma\right)s^{m}}{\left(1+g\right)\left(1+n\right)}$$

$$\overset{(73)(74)}{\cong}\left(1-\gamma\right)\sum_{i=1}^{n_l}\lambda_i\left(s_i^{y}+\frac{s_i^{m}}{\left(1+g\right)\left(1+n\right)}\right)$$

$$\overset{(101)(102)}{\cong}\left(1-\gamma\right)$$

$$\sum_{i=1}^{n_l}\lambda_i\left(\begin{array}{c}\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}-\frac{\left(1+g\right)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{\left(\beta_i^2+\beta_i+1\right)r}\\+\frac{1}{\left(1+g\right)\left(1+n\right)}\left(1+g+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}\right)\left(1-\frac{1+\beta_i}{\beta_i^2+\beta_i+1}\right)\end{array}\right)2a_iwl_i^m$$

$$\overset{\beta_i=\beta_j}{\cong}\left(1-\gamma\right)2w$$

$$\left(\begin{array}{c}\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}-\frac{\left(1+g\right)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{\left(\beta_i^2+\beta_i+1\right)r}\\+\frac{1}{\left(1+g\right)\left(1+n\right)}\left(1+g+re\left(\frac{e}{1+g}\right)^{\frac{1}{\phi-1}}\right)\left(1-\frac{1+\beta_i}{\beta_i^2+\beta_i+1}\right)\end{array}\right)\sum_{i=1}^{n_l}\lambda_ia_il_i^m$$

$$\overset{(98)}{\cong}\frac{\left(1-\gamma\right)2w}{\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}+\frac{1}{1+n}}\left(\begin{array}{c}\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}-\frac{\left(1+g\right)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{\left(\beta_i^2+\beta_i+1\right)r}\\+\frac{1}{\left(1+g\right)\left(1+n\right)}\left(1+g+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}\right)\left(1-\frac{1+\beta_i}{\beta_i^2+\beta_i+1}\right)\end{array}\right)\sum_{i=1}^{n_l}a_il_i$$

$$\overset{(99)}{\cong} \frac{(1-\gamma)2}{\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}+\frac{1}{1+n}} \left(\begin{array}{c} \left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} - \frac{(1+g)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{\left(\beta_i^2+\beta_i+1\right)r} \\ +\frac{1}{(1+g)(1+n)}\left(1+g+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}\right)\left(1-\frac{1+\beta_i}{\beta_i^2+\beta_i+1}\right) \end{array} \right) wl$$

$$\overset{(66)(68)}{\cong} (1-\gamma)2\left(\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}+\frac{1}{1+n}\right)^{-1}$$

$$\left(\begin{array}{c} \left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} - \frac{(1+g)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{\left(\beta_i^2+\beta_i+1\right)r} \\ +\frac{1}{(1+g)(1+n)}\left(1+g+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}\right)\left(1-\frac{1+\beta_i}{\beta_i^2+\beta_i+1}\right) \end{array} \right) \frac{(1-\alpha)}{(1+g)^{\alpha}(1+n)^{\alpha}}\left(\frac{k}{l}\right)^{\alpha} l$$

Then, the capital labor ratio is then a non linear function of r, and the model parameters,

$$\frac{k}{l} = \left\{ \frac{(1-\gamma)(1-\alpha)2}{(1+g)^{\alpha}(1+n)^{\alpha}}\left(\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}+\frac{1}{1+n}\right)^{-1} \left(\begin{array}{c} \left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}} - \frac{(1+g)+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}}{\left(\beta_i^2+\beta_i+1\right)r} \\ +\frac{1}{(1+g)(1+n)}\left(1+g+r\left(\frac{1}{1+g}\right)^{\frac{1}{\phi-1}}\right)\left(1-\frac{1+\beta_i}{\beta_i^2+\beta_i+1}\right) \end{array} \right) \right\} \tag{120}$$

and thus, using (99), we can obtain the steady state value for k ,

(104) $$k=\frac{k}{l}l$$

From (66) and (68), then,

(105) $$w=\left(1-\alpha\right)\left(\frac{k}{\left(1+g\right)\left(1+n\right)l}\right)^{\alpha}$$

Next, we derive the b_i that ensures that (91) and (92) are satisfied and show that this b_i is common for all i. For this, we depart from equations (91) and (92) and use (58), (59), (95), (96) as well as (86), (97) and (100),

$$b_i=\frac{l_i^y w}{h_i^y\left(\frac{h^{\xi-1}}{\eta}\right)}=\frac{w\frac{1}{1+\frac{w}{b_i\left(\frac{h^{\xi-1}}{\eta}\right)}}\left(\frac{a_i w}{\chi_i^y}\right)^{\frac{1}{\phi-1}}}{\left[a_i\frac{\left(b_i\left(\frac{h^{\xi-1}}{\eta}\right)-w\right)}{\chi_i^y\kappa}\right]^{\frac{1}{\phi-1}}\left(\frac{h^{\xi-1}}{\eta}\right)}$$

$$b_i\left(\frac{h^{\xi-1}}{\eta}\right)=\frac{w^{\frac{\phi}{\phi-1}}\frac{b_i\left(\frac{h^{\xi-1}}{\eta}\right)}{b_i\left(\frac{h^{\xi-1}}{\eta}\right)+w}}{\left[\frac{\left(b_i\left(\frac{h^{\xi-1}}{\eta}\right)-w\right)}{\kappa}\right]^{\frac{1}{\phi-1}}}$$

(106) $$\left(b_i\left(\frac{h^{\xi-1}}{\eta}\right)-w\right)\left(b_i\left(\frac{h^{\xi-1}}{\eta}\right)+w\right)^{\phi-1}w^{-\phi}=\kappa$$

for all i. The same result is found if departing from

(107) $$b_i=\frac{l_i^m w}{h_i^m\left(\frac{h^{\xi-1}}{\eta}\right)}$$

for all i. Therefore, there exists a b_i that ensures that (91) and (92) are satisfied. In addition, one can observe, that since $w > 0$ by definition, and $\kappa > 0$, $b_i > w$. The remaining steady state values are then as follows,

from (66),

(108) $$y = \left(\frac{k}{(1+g)(1+n)} \right)^{\alpha} l^{1-\alpha}$$

From (70),

(109) $$r^k = \alpha \frac{y}{k}(1+g)(1+n)$$

From (71),

(110) $$r = 1 + (1-\gamma)\left(r^k - \delta\right) + \gamma r^{\star} = 1 + \alpha \frac{y}{k}(1+g)(1+n) - \delta$$

Using (105) and (110) to express w and r in terms of the capital labor ratio, (103) and (106) constitute a non-linear system of two equations and two unknowns, b_i and $\frac{\kappa}{l}$. Once we solve for this unknowns, all other variables can be determined. From (73)

(111) $$s^y = \sum_{i=1}^{n_l} s_i^y \lambda_i$$

From (74),

(112) $$s^m = \sum_{i=1}^{n_l} s_i^m \lambda_i$$

From (72),

(113) $$s = s^y + \frac{s^m}{(1+g)(1+n)}$$

From (46),

(114) $$c^y = \sum_{i=1}^{n_l} c_i^y \lambda_i$$

From (47),

(115) $$c^m = \sum_{i=1}^{n_l} c_i^m \lambda_i$$

From (48),

(116) $$c^o = \sum_{i=1}^{n_l} c_i^o \lambda_i$$

Runaway Inflation in Chile, 1970-1973 *

Inflación descontrolada en chile, 1970-1973

Sebastian edwards **

Abstract

In this essay, I argue that the explosion of inflation during the Salvador Allende administration in Chile (above 1,500% on a six-month annualized measure) was predictable. The government's use of massive and strict price controls generated acute macroeconomic imbalances. I postulate that the combination of runaway inflation, shortages, and black markets generated major hostility among the middle class and that that unhappiness reduced the support for the Unidad Popular government.

Key words: *Socialism, Salvador Allende, devaluation, hyperinflation, Chile, price controls, Unidad Popular.*

JEL Classification: *B22, E52, E58, F31, F33*

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Resumen

En este ensayo, sostengo que la explosión de la inflación durante la administración de Salvador Allende en Chile (por encima del 1,500% en una medida anualizada de seis meses) era predecible. El uso de controles de precios masivos y estrictos por parte del gobierno generó desequilibrios macroeconómicos agudos. Postulo que la combinación de inflación descontrolada, escasez y mercados negros generó una gran hostilidad entre la clase media y que ese descontento redujo el apoyo al gobierno de la Unidad Popular.

Palabras clave: *Socialismo, Salvador Allende, devaluación, hiperinflación, Chile, controles de precios, Unidad Popular.*

Clasificación JEL: *B22, E52, E58, F31, F33.*

1. Introduction

In this paper I analyze inflation in Chile during the Unidad Popular's government. This is one of the most extreme and traumatic inflationary episodes in Latin America. I argue that the very rapid surge in the price level – an annualized rate of almost 1,600% in mid-1973; see Figure 1 --, contributed to the erosion of popular support for the Allende government and its socialist program, and explains the initial backing– especially among the middle class – for the coup d'état led by General Augusto Pinochet on September 11, 1973. One of the contributions of this paper is that I analyze, deconstruct, and evaluate a little-known document nicknamed "The Puppet' (*El Muñeco*), which contained the short term "recovery program" of the *Unidad Popular*. Originally, only six copies of the document were printed; it was not made public during the government's three years, and only resurfaced two decades after the coup d'état that deposed President Salvador Allende. I show that the program was built on very simple assumptions and did not consider the possibility that an overly expansive fiscal policy financed with money creation could result in runaway inflation, a balance of payments crisis, shortages, and generalized black markets. I argue that the plan was affected by the inability of the government to control the "revolution from below," including the massive seizure of manufacturing firms and farms by far-left activists.

In Section 2 I discuss structuralist views on economic policy and inflation. In Section 3 I summarize the economic platform of the socialist government and analyze its two components: "Recovery" and "revolutionary reforms." An important point is that the two modules were to be implemented simultaneously. In Section 4 I analyze in detail the recovery program. I note that the 1970 document had only one equation. In this Section I "translate" the prose in the document into math used by modern economists. Section 5 deals with 1971, a period when inflation was kept under (relative) control and GDP growth increased significantly to 9%. I argue that these achievements were unsustainable. In Section 6 I discuss the first half of 1972, when inflation increased rapidly. In Section 7 I analyze the explosion of inflation in August 1972 and the government's efforts to make price controls effective. In this Section I document the collapse of real wages during the last six months of the Allende administration. In Section 8 I analyze the role of external factors – and, in particular, of US policy – in the unleashing of the crisis. Finally, in Section 9 I offer some concluding remarks.

2. The Structuralist School And The Unidad Popular Economic Team

President Salvador Allende's economic team was led by former members of the U.N. Economic Commission for Latin America, ECLA. Pedro Vuskovic was appointed Minister of Economics, Max Nolff led the Copper Corporation (Codelco), and Gonzalo Martner took over the Planning Office, which in late 1970 was elevated to ministerial status. The three economists were key figures of the "structuralist school," and had supported Allende in his three previous runs for president (1952, 1964 and 1970). The economic team was rounded out by Américo Zorrilla, a linotype union leader who was a member of the Communist Party.

The "structuralist" school was developed in the mid-1950s by economists Juan Noyola from Mexico, Jorge Ahumada, Osvaldo Sunkel and Aníbal Pinto from Chile, and Celso Furtado from Brazil.[1] Structuralism was, to a large extent, a reaction against the austerity and free market policies of the International Monetary Fund (IMF). For structuralists, orthodox stabilization programs based on fiscal retrenchment and monetary restraint stifled growth and generated suffering among the poor, without impacting the underlying causes of inflation.[2] Structuralists believed that inflation was the result of rigid economic structures, including an inefficient agricultural sector dominated by latifundia, an export sector almost exclusively based on natural resources, a monopolistic industrial sector, and an extremely unequal distribution of income. Structuralists postulated that monetary policy and fiscal imbalances were mere "propagation factors" of inflation. Contrary to orthodox doctrine – and, in particular,

1 At ECLA structuralists worked under famed economist Raul Prebisch.

2 Structuralism was also a reaction against the policies of the Klein-Saks Mission in Chile. See Edwards (2007).

contrary to monetarists such as Milton Friedman --, structuralists posited that public sector deficits financed with money creation were not necessarily inflationary. They also believed that the exchange rate was an ineffective policy tool for addressing external imbalances. In their view, devaluations propagated inflation and made food more expensive for the working class. In his influential book "Instead of Misery" (*En Vez de la Miseria*), Chilean economist Jorge Ahumada, one of the fathers of structuralism, wrote that "deficits – either public or private – don't necessarily result in inflation… [F]iscal deficits in Chile are the result of structural causes…"[3]

In terms of macroeconomic policy, Vuskovic and Martner were followers of Michal Kalecki, the Polish economist who had spent some time in Cambridge (U.K.) in the 1930s and who, according to his admirers, had anticipated many of the theories in John Maynard Keynes's *The General Theory of Employment, Interest, and Money*.

3. Allende's Economic Program: An Overview

The *Unidad Popular's* economic strategy had two interrelated components: a short-term macroeconomic program designed to generate immediate economic recovery and improved income distribution, and an extensive plan for structural (or "revolutionary") reforms to lay the groundwork for transitioning towards socialism. In a document handled to the president elect on October 24, 1970, and presented to the cabinet at its inaugural meeting on November 4, 1970, Pedro Vuskovic wrote: (Vuskovic, 1993, [1970], p. 198; emphasis added).

> "The configuration of the short run economic program… is not strictly based on economic considerations, and should be placed within the context of the Unidad Popular's Basic [Political] Program… There needs to be a coincidence between a political commitment and an economics exigency…. We cannot think of a first stage of purely conventional measures aimed at economic "recovery," and a second stage where the basic [revolutionary] policies would be taken up; on the contrary, from the beginning it is necessary to tackle both aspects *simultaneously*…"

In this Section I provide a brief overview of the Unidad Popular's economic strategy. In Section 5 I discuss in detail the recovery program and I present an evaluation, with special emphasis on inflation.

[3] In the mid-1960s, Argentine economist Julio Olivera formalized the early structuralists' narratives, which seldom included formal equations. Olivera postulated that in most Latin American countries' money was "passive," in the sense that it was printed by central banks to validate inflationary pressures stemming from the country's political and economic structures. See Olivera (1970).

3.1 The Recovery Program

In an article published in September 1970, Pedro Vuskovic wrote that the main goal of the *Unidad Popular's* short-run economic policy was to generate a massive increase in aggregate demand and to create "a drastic change in the concentration of property and income distribution." Inflation, which was running at 35% per year, was to be reduced significantly. Achieving these objectives was considered a key first step in the effort to build a socialist society.[4]

In discussing the short run strategy, minister of finance Américo Zorrilla argued that inflation was the consequence of the country's economic structure, including the monopolistic nature of industry and the dominance of large latifundia in the agricultural sector. He said, "the general orientation of the anti-inflationary fight, is based on immediate change [in the structure] of the Chilean economy." To him inflation had little to do with a large public sector deficit, excessive money creation, accelerating velocity of circulation, a large money multiplier or other variables of concern to orthodox economists.[5] Zorrilla and his colleagues believed that most large firms had a "liquidity cushion," made up of monopolistic profits, which would allow them to absorb a substantial increase in wages while prices were fixed/controlled.

3.2 Structural and "Revolutionary" Reforms

The *Unidad Popular's* structural/revolutionary reforms strategy was based on the nationalization of copper mines and other mineral resources (iron ore, coal, nitrate), the nationalization of the banking sector, large trading companies, insurance companies, and several large manufacturing firms with monopolistic power. In addition, millions of hectares of farmland were to be expropriated and transformed into cooperatives or state-owned farms.

On July 11, 1971, Congress unanimously approved a constitutional amendment that nationalized large copper mines.[6] Compensation to the American companies was calculated as book value minus "excessive profits" accrued since 1955. The Office of the President determined that excessive profits corresponded to income above 12 percent of book value. According to government estimates, Chile would not have to pay any compensation; in fact, the mining companies owed Chile approximately US$400 million. The decision not to compensate the American firms generated a major rift between the Chilean government and the United States that lasted until the end of the Allende administration. In part, this dispute was behind the Nixon administration's

[4] Vuskovic (1970, 58-59).
[5] Zorrilla (1971), p. 31-32.
[6] Chile already owned 51 percent of some mining companies. Fortín (1975).

decision to pressure the multilateral institutions -- the World Bank, the Interamerican Development Bank, and the International Monetary Fund. – to cut off assistance to Chile.[7] Within the Unidad Popular's government there were disagreements on whether some compensation should be paid. Max Nolff, who favored paying even a small amount, resigned his position as head of Codelco over this matter. Orlando Letelier, then the Chilean ambassador to the US, who was assassinated by agents of the military Junta in 1976, also favored the payment of compensation. President Allende and the leaders of his political party believed that the formula in the amendment was the best way forward. (Fortín, 1975).

Banks were nationalized through massive tender offers, where the state holding company, *Corfo*, paid a large premium for shares. Purchases of banks' shares were financed by loans from the Central Bank to the government, or money printing. Expropriated farmland was paid for with long-term government bonds issued in nominal local currency.

The original Unidad Popular's economic plan called for the nationalization of 91 large companies with "monopolistic power." These companies were to have 100% state property and would form the Area of Social Production (*Area de Propiedad Social*). In another group of firms the state would own a majority stake (51% and up). These firms would make up the Area of Mixed Property (*Area de Propiedad Mixta*). The rest of the manufacturing firms – most of them small and medium enterprises – were supposed to remain in private hands and formed the so-called Area of Private Property (*Area de Propiedad Privada*). As noted below, however, many small and mid-size firms were taken over by the government.

The legal bases for the nationalization of manufacturing firms emanated from an executive order dating from the Great Depression. According to the 1932 executive order (Number 520), if certain goods became in short supply due to a factory stoppage, the government could "requisition" the company for an undetermined period. Frequently, unions seized the facilities and stopped work to artificially create shortages. Owners were compensated using Central Bank credits. A second mechanism for taking control of manufacturing firms was related to labor conflicts. The Ministry of Labor could decide that a labor dispute was generating shortages and take over the firm in question through a procedure known as "intervention." Government appointed functionaries would then run the firm for an undetermined time.

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7 Book value was estimated at US$414 million, and "excessive profits" added up to US$774 million. Fortín (1975).

4. The Short-run Program In Detail

Immediately after the presidential election, Pedro Vuskovic and his team began to work on a short-term "economic recovery" program for 1971. Its goal was to generate an aggregate demand jolt and a substantial increase in economic activity, employment, and wages, and at the same time unleash a major redistributive process. The plan was rooted in a very simple premise: Chile's industry was dominated by monopolistic firms that kept output below optimal and charged excessive prices. Thus, it was argued, there was ample unutilized capacity that could be used to expand production and employment. The increase in demand was to be initially generated through expansive fiscal policy financed by the central bank. Price controls would ensure that the increase in demand would not put undue pressure on inflation, which in 1970 had been 35%. In addition to price controls the program called for negotiations between the government and the private sector to keep prices in check or to lower some of them.

If the short term program worked as planned, real incomes would increase dramatically while inflation would be cut (approximately) in half. This would generate a major increase in wages, which were adjusted by past inflation, and a leap in political support for the government. In the Leninist language of those times, this would greatly improve the "correlation of forces." This, in turn, would allow the *Unidad Popular* to move forward in the implementation of the revolutionary/structural reforms presented in its program.[8]

4.1 "The Puppet"

The short-term recovery program was summarized in a document titled "Basic guidelines of the short-term economic program, 1970" (*"Orientaciones basicas del programa economico de corto plazo, 1970"*), which its authors nicknamed "The Puppet" (*El Muñeco*).

The document was co-written by Pedro Vuskovic, Gonzalo Martner, Alberto Martínez, and Sergio Ramos. Originally, only six copies were printed, and it was circulated in great secrecy. For many years, the document has remained underground and even today it is difficult to find it.[9] On November 4, 1970, the plan was presented to the cabinet during its first meeting. After a short discussion it was approved, and Pedro Vuskovic and his team were given a free hand to implement it.

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8 A major political goal was to enact a new constitution that would replace the historical bicameral congress with an Assembly of the People and a Chamber of Workers and would introduce major changes to the judiciary.

9 The complete text of The Puppet can be found in Vuskovic (1993 [1970]), p. 168-197.

Although the program was not laid out in a formal fashion – there was only one equation in the document –, its core and logic may be summarized using simple mathematics. In providing this summary I have tried to be as faithful as possible to the original text. Indeed, I consider what follows to be an exercise in "translation," an effort to rewrite the program presented in words into the language of modern economics.

Before proceeding it is important to clarify that the model presented here is not supposed to be "solved" in a traditional way. That was not the authors' intention – remember that there is only one equation in the document --, and, thus, "solving" the model is not the purpose of this section. Equations (1) through (13) provide a summary and "translation" of the main aspects of the plan. The subindex -1 means that that variable is lagged one period (one year).

(1) $$Y = C + I + G + X - M$$

(2) $$C = C^W + C^K$$

(3) $$I = I^C + I^R$$

(4) $$G = \sigma G_{-1}$$

(5) $$W = \left(1 + \varepsilon \pi_{-1}\right) W_{-1}$$

(6) $$\pi = \theta \pi_{-1}$$

(7) $$\pi = \alpha_0 + \alpha_1 \widehat{W} + \alpha_2 \hat{r} - \alpha_3 \hat{\rho}$$

(8) $$C^W = \left(1 + (\widehat{W} - \pi)\right) C^W_{-1}$$

(9) $$\delta = \gamma \delta_{-1}$$

(10) $$D \leq \bar{D}$$

(11) $$\mu = \left(\beta D + z\right) \leq \bar{\mu}$$

(12) $$X = X^C + X^R$$

(13) $$M = \vartheta M_{-1}$$

Equation (1) is the basic macroeconomic equilibrium condition, where standard notation has been used and all variables are in real terms. Equation (2) captures the spirit of Polish economist Michal Kalecki and decomposes consumption (C) into consumption by workers $\left(C^W\right)$ and consumption by capitalists $\left(C^K\right)$. An important goal of short-run policies was to increase C^W at a much faster pace than C^K. This, in fact, was the most salient redistributive feature of the program. Equation (3) decomposes investment into two parts: investment in construction, housing, and infrastructure, largely undertaken by the government $\left(I^C\right)$, and investment in the rest of the economy (I^R). The authors of the plan recognized that given the "revolutionary" nature of the government, it was likely that during 1971 private investment I^R would decline. Equation (4) relates current government expenditure to its level the previous year $(\sigma \geq 1)$ Equation (5) establishes that nominal wages in the current period (1971) will be adjusted by a multiple $\varepsilon \geq 1$ of past inflation. Equation (6) is the inflation target; $\theta < 1$, indicating that the government's goal was to achieve a reduction in inflation. Notice that in this model inflation is a goal, and thus an exogenous variable.

Equation (7) is an explicit expression for the cost components of inflation and is the only equation that appears as such in The Puppet. It says that inflation (or more precisely its costs' elements) is a linear function of nominal wage increases $\hat{W}$, increases in non-workers' income $\hat{r}$, and productivity improvements $\hat{\rho}$, with a minus sign. I analyze equation (7) in some detail below. Interestingly, this equation was taken from a study by Jorge Cauas (1970), the economist who four years later would become finance minister during the Pinochet regime and would implement a "shock treatment" stabilization program to tackle the inflationary spiral unleashed during the Unidad Popular. (See Edwards, 2023, for details). Equation (8) states that the growth in real workers' consumption is determined by the rate of growth of real wages in the current period $\widehat{(W-\pi)}$.

Equations (9)-(13) are loose expressions that summarize constraints and considerations presented in an ad-hoc fashion in the paper. Although the authors attach (some) importance to them, they do not explain formally how they interact with the first part of the model.

Equation (9) is for the rate of devaluation, δ. Although the authors considered two options for 1971 – a crawling peg or a fixed rate --, the government decided that the best choice was to peg the exchange rate and set $\gamma = 0$. It was thought that by doing so, inflation would be lower (notice, however, that δ does not enter equation (7)). Equation (10) notes that there is an upper limit to the fiscal deficit $\overline{D}$. How that limit is connected to the rest of the model, or to money creation, is not singled out or discussed in any detail. Towards the end of The Puppet, it is noted that for 1971 the deficit should not exceed 5.3% of

GDP. The actual deficit, however, exceeded the target significantly. (Edwards 2024). There is no discussion, however, on the connection between the deficit and the public sector debt. (More generally, in the document there is no connection between stocks and flows).

Equation (11) is for money creation. It states that a fraction $\beta \leq 1$ of the fiscal deficit will be financed by the central bank; z represents other sources of money printing. According to this expression money creation should not surpass an upper limit, $\bar{\mu}$. As in the case of the fiscal deficit, there is no formal discussion on how monetary policy is connected to the rest of the model, nor is there an indication that monetary expansion could become "passive," in the sense of Olivera's (1970) structuralist models of inflation.[10] Nothing is said about the demand for money or velocity of circulation.

Equations (12) and (13) provide a minimal framework for the external sector. According to equation (12) it is useful to decompose exports into copper and rest. Finally, equation (13) states that there is persistence through time in imports. Notice that no connection is posited between exports and imports and the (real) exchange rate. This is in line with the structuralist credo.

4.2 Putting The Program Together

Based on this framework, the short-run program was put together by Vuskovic et.al. through the following steps:

- Historical data and estimates of capacity "underutilization" were used to forecast the evolution of GDP in each productive sector; see Table 1, which has been taken directly from The Puppet. These calculations of aggregate supply came from outside the model. As may be seen in Table 1 the recovery plan called for a major increase in output in the mining and construction sectors. Mining expansion would be a consequence of the nationalization of large mines, an event scheduled for the first half of 1971. The leap in construction would be a response to a major program in public works and housing. The plan also called for a substantial increase in industrial (manufacturing) output of 12%. At the heart of this enhanced performance was the nationalization of monopolies and the response of the private sector to higher aggregate demand; no magnitudes of elasticities, however, were provided. As Table 1 shows, the plan contemplated an overall growth in GDP of 10%, significantly higher than during the previous three decades. Between 1945 and 1970 Chile's GDP grew at an average rate of 4.1%, below Latin America's average of 5.6%. (Edwards 2023).

[10] In discussing monetary policy, The Puppet makes a distinction between money in the hands of the private sector (*dinero privado*) and in hands of the public sector (*dinero público*).

However, the 10% growth forecast was consistent with the analysis made by the same team six years earlier, during Salvador Allende's 1964 presidential campaign.

- The two components of investment in fixed capital – equation (3) – were forecasted from outside the model. While investment in housing and infrastructure, driven by the public sector, would grow by 24% in 1971, investment by the private sector in machinery and equipment would retract by 10%. No discussion was provided on whether this contraction in private investment would create bottlenecks and compromise growth in 1972 and the years to follow. Almost two decades later, Gonzalo Martner, Salvador Allende's minister of planning, pointed out that one of the key factors behind the slowdown of the economy in 1972 were, indeed, bottlenecks. (Martner, 1988).
- Based on the previous estimates, the components of aggregate demand were projected – see Table 2. Aggregate consumption for 1971 was expected to increase by 10% in real terms. Exports were assumed to grow at 25%, the same rate of mining output (see Table 1). Imports were forecasted to expand at the same pace as exports. In these projections, Allende's economic team did not anticipate a large external imbalance. As it turned out, this was a miscalculation.
- A fundamental question was how the 10% real increase in aggregate consumption would be distributed between workers and non-workers. The answer depended on the behavior of wages, inflation, and the evolution of non-workers' income. The latter was treated as one of the adjustment variables that made the program close in a consistent way. (See the discussion below, however.)
- In this program, inflation was exogenously given as a policy goal. According to The Puppet: "[T]he inflation problem is not a purely financial issue, but rather it is considered as a problem related to the intensity of the redistributive process." The inflation target was set at 15% for 1971. Since, according to equation (5), nominal wages are adjusted by more than lagged inflation ($\varepsilon \geq 1$), the program implied an increase in real wages of approximately 20%, twice as fast as GDP. This was the major redistributive driver in the short run strategy.
- As noted, equation (7) is the only mathematical expression in the report. In the development of the model, it is used to calculate the rate of growth of non-workers income that is consistent with the inflation target of 15% and with an increase in nominal salaries of approximately 40% (35% of past inflation plus 5% additional adjustments in family income supplement; see the discussion in Section 6, below). The following specific parameterization of (7) is provided in the document:

$\pi = 0.565 + 0.433\hat{W} + 0.613\hat{r} - 1.613\hat{\rho}$.

Consequently, if $\hat{r}$, and $\hat{\rho} = 3.0\%$ (the very optimistic assumption on productivity growth in The Puppet), no-workers income $\hat{r}$ would merely increase, in nominal terms, by 3.2%. It is interesting to notice that the parameters in the equation are identical to the ones used by Cauas (1970).

- If the inflation goal of 15% is attained, equation (8) indicates that workers' real consumption will grow at approximately 25%. Given that $\left(C^W / C \right) = 0.66$, this meant that under the base-case scenario non-workers real consumption would have to decline by 15%, to close the model in a consistent way. (See below for a discussion). However, Pedro Vuskovic and his colleagues understood that such an abrupt decline in capitalists' consumption could generate major political resistance. Thus, an option was to provide some tax relief, so that non-workers' consumption would not suffer so severely. (This option is discussed very briefly in the document; no details are given, however).
- Regarding the fiscal deficit and its financing by the central bank, The Puppet made a cryptic commentary: "Given the magnitude of the deficit [6,000 million escudos, or 5.3% of GDP] it should be appreciated that the increase in Central Bank's credit to the public sector should be compatible with an inflation [target] of 15%."
- The Puppet then provided some "rough estimates" for the monetary program. It observed that an expansion of money of at most 3,270 million escudos was compatible with the inflation target of 15%. It was then noted, in a premonitory fashion, that that amount was "notoriously lower" than the projected fiscal deficit of 6,000 million escudos.

> "The balance (2,730 million escudos) would constitute a pressure factor that could bring inflation significantly higher than 15%. In addition to the fiscal measures that could be enacted, this balance would have to be covered by using accumulated international reserves…"

The document emphasized that aggregate supply had to respond adequately to the demand stimulus. For this to happen, the authors pointed out that it was crucial for the government to take control quickly of large monopolistic firms and the banking sector. Special emphasis was given to the nationalization of firms that produced goods consumed by the popular classes. Nationalized banks would direct credit to nationalized firms and to medium and small companies. The composition of imports was also a consideration in the short-term strategy; licenses for luxury goods would not be approved easily, or not at all.

4.3 A Critical Evaluation

From today's perspective, the short run program presented above has some serious limitations. The different parts are connected to each other weakly, or not at all, and key variables such as interest rates, parallel market exchange rates, and velocity of circulation are not considered. There is no specific role for expectations. A particularly significant limitation was not to include devaluations and money growth in the inflation equation (7). It is possible to argue that this was consistent with the structuralist views of the time, according to which monetary factors were mere "propagators" of inflation. However, that role is not incorporated in a formal way. For instance, there is no role for a sophisticated dynamic of propagation. Another limitation is not specifying the evolution of international reserves or considering how their possible decline and depletion – as it abruptly happened in late 1971 – could generate bottlenecks, negatively affect the supply response to the stimulus, impact on expectations, and generate a major exchange rate crisis.

The model could have been improved by extensions that, at the time, were already used by macroeconomists, both in Chile and internationally.[11] Here are (just) a few examples of additions and improvements that could have alerted the authorities to the dangers behind the strategy, dangers that materialized in the second half of 1971, and that by 1973 had fueled hyperinflation. (I should emphasize that this is not an exhaustive list of amendments; it's a partial catalog that illustrates how fragile the model was):

a) $$S_i = \left(1 + c_i v_i\right) S_{i,-1}\,;\; v_i \neq v_j$$

b) $$I^R = \left(1 + \phi\right) I^R_{-1}$$

c) $$\pi = \left(1+\lambda\right)\left(\alpha_0 + \alpha_1 \hat{W} + \alpha_2 \hat{r} - \alpha_3 \hat{\rho} + \alpha_4 \left(\delta + \pi^*\right)\right) + \gamma_1 \left(1-v\right) + \gamma_2\, ESM$$

d) $$v = g\left(ESM, \ldots\right)$$

e) $$ESM = h\left(\widehat{M},\; BMP \ldots\right)$$

f) $$\Delta R = R_{-1} - CAD\,;$$

Equation (a) relates output evolution in sector i to its sector-specific unutilized capacity, v_i. The coefficient c_i embodies that sector's supply elas-

[11] One could, of course, be even more critical and point out that from the perspective of 2023 there were several omissions. But such an analysis would be ahistorical and not very useful.

ticity. Equation (b) is for the dynamics of "rest of investment," where ϕ is a paramenter that depends on expectations about future economic and political conditions. A rapid and unwieldly nationalization process would result in a lower (and, perhaps, smaller than one) ϕ. Equation (c) is for inflation, and it is a simple, and yet important revision to the model. This equation is a reduced form that combines cost and demand factors. On the cost side it adds inflation pressures from devaluation and imported inflation $\left(\delta + \pi^*\right)$, and explicitly considered a mark-up factor $\left(1+\lambda\right)$, which will depend on elasticities of demand as well as on supply constraints. On the demand side it adds a capacity utilization component (higher utilization increases inflationary pressures resulting from a jolt in aggregate demand), and a term that considers the excess supply of money $(\gamma_2 ESM)$. ESM is, of course affected, by changes in the velocity of circulation -- what some economists call the Cagan-effect, after Phil Cagan's work on hyperinflation --, and the black-market premium (BMP). In a dynamic setting this equation (e) may be considered as capturing long run inflation. Equation (f) is the law of motion of international reserves, where CAD is the current account deficit.

As noted, the extensions in (a)-(f) are quite simple, and by 1970-71 they had been considered, either implicitly or explicitly, by several economists who had studied inflation in Chile, including Hirschman (1963), Harberger (1963), García (1964), and Corbo (1971). As I argue below, an important limitation of The Puppet was ignoring the dynamics of salary increases and parallel exchange rates. Once these two forces are considered, it is apparent that there was a real danger that inflation could become explosive, as it did since mid-1972.

The Puppet is almost silent regarding tax revenue or the need for a major tax reform. In mid-November 1970, Minister Zorrilla dealt with the issue when he submitted the "Public Sector Budget for 1971," to Congress. He noted that relying on indirect taxes had negative distributive effects, and pointed out that a great effort would be made to reduce tax evasion and avoidance. But there is no detailed discussion on a major reform aimed at increasing tax revenues.[12]

It is important to recognize that the program, as presented in The Puppet and summarized above, doesn't look, on its own, like a particularly revolutionary text or as a strategy to transform Chile into Cuba or an Eastern European country in the then Soviet sphere. It rather looks like a run-of-the mill recovery-cum-stabilization program put together by a group of ECLA functionaries steeped in structuralist principles. It is a simplistic plan, but if the policies were kept within the parameters considered in the document, it would not result in a combination of major output contraction and rapidly accelerated inflation.

[12] A possible explanation for this is in two parts: First, the UP economists knew that, given the composition of Congress it would be virtually impossible to have a fiscal reform approved. Second, for them a large fiscal deficit was not a cause for alarm.

However, for several reasons explained in the Sections that follow, policies were not kept within the boundaries of The Puppet, and the result was hyperinflation-cum-shortages and black markets. In many ways this was a repeat of the French *assignats* case from the late 18th century. (Hawtry, 1938).

Although the program didn't say anything specific about dynamics, the mechanisms delineated in the report were consistent with a very simple autoregressive process of order one, where lagged inflation impacted current inflation through the backward-looking indexation system.

$$\pi_t = \alpha + \beta \pi_{t-1} + \varepsilon_t$$

However, there were reasons to believe that that would not be the dynamic structure going forward. More specifically, it was likely that, given the nature of the new government, economic agents would expect a change of regime, in the sense of Tom Sargent. This would result in changes in the parameters of the different equations that capture economic behavior and agents' reactions to policies. For example, one would have expected (or, at least, entertain) that there would be a fast decline in the demand for domestic money (Escudos) and a rapid increase in velocity of circulation. Along these lines, it is possible that until 1970 an acceleration variable $\Delta\pi_{t-1}$ had a zero coefficient in the dynamics of inflation equation, but a non-zero one after 1970. The importance of this remark has to do with the possibility that at some point – first quarter of 1972, for example --, the process governing inflation experienced a structural break and became explosive. In that case a more complex dynamic structure would operate. For instance:

$$\pi_t = \alpha + \beta \pi_{t-1} + \gamma \Delta\pi_{t-1} + \varepsilon_t$$

It is important to keep in mind that, as noted earlier, the recovery program was only one component of the *Unidad Popular's* economic strategy. As discussed below, the second component – nationalization, expropriation, heightened regulation, price controls, deep agrarian reform –contributed significantly to the creation of major macroeconomic imbalances, runaway inflation, shortages, black markets, and a prolonged crisis.

5. Controlled Inflation In 1971

On November 27, 1970, before Salvador Allende completed his first month in office, minister of finance Américo Zorrilla submitted to congress the "State of Public Finances." In addition to unveiling the budget for 1971, the minister explained that the government's anti-inflationary program was rooted in price and exchange rate controls (emphasis added):

> "We have initiated the *strictest policy of price controls*, which will be maintained in the future in an effort to centralize control over major producers and wholesale distributors, and drastically sanction those who violate legal norms [regarding price caps]. Any unauthorized price increase will be immediately annulled…"

Concerning the exchange rate policy, Minister Zorrilla stated:

> "One of the main elements of firms' costs is foreign exchange. Thus, we will not continue with the periodic [mini] devaluations policy, since they would generate, as in the past, autonomous inflationary pressures and [higher] inflationary expectations."

5.1 Wage Adjustments and Income Redistribution

In his speech, minister Zorrilla announced that at the center of the government's redistributive program was a generous wage adjustment policy. The minimum wage was increased from 12 to 20 escudos – that is an increase of 67%. Workers at the lower end of the income scale – those earning less than one *sueldo vital* – would receive a wage increase equal to 105% of past inflation. Those earning between one and two *sueldos vitales* got 103% of past inflation, while those earning more than two *sueldos vitales* were to obtain an adjustment equal to past inflation. Since inflation was expected to decline from 35% to 15%, workers at every level of the income scale would obtain substantial real wage increases. In addition, the government mandated an upward adjustment of family and other allowances -- lunch, public transportation and other.[13] These wage adjustments were mandated by Law 17,416 and represented a floor for wage increases for the public and private sectors. The minister emphasized that private companies and their unions could negotiate higher wage adjustments.

The wage adjustment policy resulted in an immediate and very substantial jump in real incomes across the board, and an important increase in labor income's share in national accounts; I discuss the evolution of real wages in Section 7 and in Figure 3. Politically, the rapid improvement in wages was translated in a major rise in voters' support for the *Unidad Popular* in the municipal elections of April 1971, when Allende's coalition garnered 50.2% of the votes,

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13 The *sueldo vital* was a metric used to benchmark pay to public-sector white-collar workers. In 1970, the *sueldo vital* was 71% higher than the minimum wage. In 1970 family allowances for blue-collar workers were 39% of the family allowances for white-collar workers. The government's goal was to slowly make both equal. That goal was not achieved during the UP administration.

a significant improvement from the 36.5% obtained in the presidential contest only six months earlier.

During most of 1971, the macroeconomic strategy appeared to work. As noted, real wages increased significantly, real gross domestic product (GDP) growth shot up to almost 9%, and inflation was contained at 22 percent (as observed, it had been 35% in 1970). However, imbalances were rapidly mounting. Investment in equipment and machinery by the private sector declined drastically, and agricultural output stagnated. In addition, a substantial trade deficit developed. Also, the United States and the international financial organizations that it controlled – the World Bank and the IMF – cut loans to Chile, making things even more difficult.

5.2 The Nationalization of Manufacturas Yarur

During the second half of 1971 there was a fast acceleration of firms' nationalization. The procedure used for (most) nationalizations had three components: (a) A labor conflict between the union and the company was started. (b) When (and if) the labor conflict was not solved, workers seized the company and took control of the facilities. And (c), given that a seized company was unable to produce any goods, the government had a legal excuse, based on Executive Order 520 discussed previously, to requisition it. As Peter Winn (2020) has pointed out, one of the most important early nationalizations based on this process took place in April 1971, when the Yarur textile company was taken over by its workers, who demanded immediate requisition.[14] President Allende was, initially, reluctant to move forward with nationalization. Jorge Yarur, the patriarch of the Yarur family, had been his friend, and he had promised the family that his government would treat them well. However, the union mobilized more than one thousand workers, staged massive rallies, and its demands were supported by minister Pedro Vuskovic and undersecretary Óscar Guillermo Garretón. At the end, Allende relented, and in May 1971 Yarur was requisitioned by the government. One week later, the workers' representatives were added to the management council. This was a first that would soon be emulated in other nationalized firms.

What makes the Yarur episode particularly important is that it created a "domino effect." As soon as the government gave in to workers' pressures, unions in other factories demanded that the government requisition their firms. In most cases the authorities acquiesced, and a new company was added to the state-owned enterprises area. Out of the 137 manufacturing firms nationalized by late 1971, only 49 were in the original "list of 91." (Martínez, 1978, p.

[14] This was not the first company nationalized, but it was the largest one and the one that became the clearest symbol of "revolution from below."

268). This rapid expansion of the scope of the nationalization process had two important consequences:

- Most nationalized firms faced serious management problems. In most cases technical personnel (engineers, accountants, managers) were either fired or resigned. Government appointed managers (*"interventores"*) were usually very young individuals without practical experience. Many were last year university students, who played the double role of managers and political commissars. Because of the lack of experienced executives and technicians, productivity declined abruptly. Also, inventories dwindled, spare parts were unavailable (forex required to import them was scarce, due to the macroeconomic policies and the cutoff of foreign loans by the US), and the number of workers hired increased significantly. This combination of factors contributed to the dislocations in production processes, shortages and eventually to the generalization of black markets.
- Most nationalized companies had significant losses due to a combination of higher costs (mostly related to higher wages), low productivity, and work stoppages. These losses were financed by the central bank through money printing and contributed to the acceleration of inflation.

In the national budget, money printing and central bank loans to the government were obliquely called "Revenues from Capital." The 1971 budget, presented to Congress in late November 1970, contemplated that 17% of all government expenditures would be financed with money creation. A year later the actual deficit financed by "monetary flooding" amounted to almost 50% of expenditures. In 1971 the supply of money increased by 136%, significantly faster than the government's original plan for an expansion of 47%.[15]

On November 16, 1971, with inflation still under control – it was 19%, in 6-months annualized terms – minister Américo Zorrilla delivered his second "State of the Public Finances" report. The first part of the speech focused on economic performance during 1971. The minister noted that in some sectors there were signs of supply shortages: (Zorrilla 1971, p. 12. Emphasis added):

> "Despite all the efforts deployed, the increase in purchasing power for the majority of the population beyond the limits set by the economic policy of the Popular Government, combined with accidental factors such as the earthquake and weather events, as well as deficiencies in the state apparatus itself, resulted in varying degrees of *insufficiency in the supply of some everyday consumer products*. Some of these supply problems are purely circumstantial, and their solution will be addressed in the short term. Others, such as the beef issue, require a longer-term effort, and initial measures have already been taken. It should not be forgotten that

[15] Inostroza (1971). See, also, Edwards (2024).

> developed countries have a lower consumption of beef compared to other protein sources, proportionally, than what characterizes the Chilean diet."

In late 1971, Fernando Flores, who would eventually become minister of finance and very close to President Allende, convinced British management scholar Stafford Beer to develop a computer-based program to detect bottlenecks and supply constraints, and to help determine the right prices for consumer goods. During his first trip to Santiago in November 1971-- a trip that coincided with Fidel Castro's long visit to Chile --, Beer assembled a team of (mostly) engineers that for the next 22 months would work incessantly in the development of the *Cybersyn* project, a program that with the passage of time has become mythical. (Medina 2001; Edwards 2023).

By the end of 1971, government officials declared that the first year of the *Unidad Popular* had been a great success. These evaluations relied as much on politics as on economic results. Gonzalo Martner, the Minister of National Planning said:[16]

> "1971 will be inscribed in the history of Chile as the year of its second independence and of the beginning of the revolutionary process conducted within the framework of what has been called 'the Chilean Way.' The goal is to implement a popular revolution that is nationalistic, democratic, pluralistic..."

6. Price Controls, Repressed Inflation, And Shortages in 1971-1972

The combination of severe price controls, increasingly large fiscal deficits financed by money creation, work stoppages and "requisitions," and foreign exchange shortages, exacerbated macroeconomic imbalances. On January 20, 1972, the Communist Party newspaper *El Siglo* informed that the office of price controls DIRINCO was making a major effort to have cigarettes supplied through official channels at controlled prices. On February 21, 1972, the conservative newspaper *El Mercurio* noted that several industries were facing problems because foreign exchange rationing made the importation of spare parts difficult and, in some cases, almost impossible. A day later (February 22, 2022) pro-Unidad Popular paper Clarín noted that the government was redoubling the efforts to have all companies in the "list of 91" requisitioned, intervened, or nationalized in short order. According to the story, that step would help reduce the "shortages problem."

[16] Panorama Económico (1972, p. 17).

6.1 The Arrayán Conclave

On February 7, 1972, and because of growing economic imbalances, President Allende called for a meeting of the heads of the political parties in the *Unidad Popular* coalition to discuss economic policy and political strategies. The gathering became known as the "*Arrayán Conclave*", after the Santiago neighborhood where it took place. The issues discussed included: drafting a new constitution that would replace the two-chambers system with an Assembly of the People, the nationalization of manufacturing companies, shortages, the pace of agrarian reform, the takeover of firms by workers, farms invasions by peasants, and inflation. During the conclave disagreements between the Socialist and Communist parties became palpably clear. The former wanted to speed up the process and move decisively towards socialism, while the latter sought to slow it down and consolidate the progress made util then. No major agreements were reached, no significant changes to economic policy were made, and Pedro Vuskovic continued at the helm of the economic team. At the end of the Conclave, the parties in the coalition issued a communiqué that identified three major economic challenges for 1972:

- There was a need for more robust central planning and greater consistency and coordination of actions across industries and sectors. Some believed that the incipient project *Cybersyn* would help achieve this goal.
- Workers had to take an active role in the running of nationalized firms and farms. The experience of the Yarur textile firm had to become generalized to most industrial companies.
- Small and medium-sized companies had to be supported by the government. Although the document stopped short of saying it clearly, it was intimated that workers should not take over these smaller entities, since that would alienate the middle class and reduce the support for the government.

The Socialist Party issued its own communiqué where it argued that it was "not the time to slow down and consolidate what had been obtained in the process." On the contrary, for Socialists the correct strategy called for leading the masses towards the complete "seizure of power" and the replacement of capitalist and bourgeoise institutions (including the judiciary) with new revolutionary and socialist ones. (Farias, 2000, p. 1994).

6.2 Neighborhood Price Controls Committees (JAPs)

On April 5, 1972, the government issued an Executive Order creating "neighborhood committees" to help with price controls and food distribution. Members of the committees were supposed to denounce shopkeepers that charged prices above official prices or sold them in the black market. These committees were called *Juntas de Abastecimiento* y *Control de Precios* (JAP), and their members were allowed to purchase a basket of basic goods at official prices. From the beginning the JAPs were extremely controversial. Even before the Executive Order was approved by the National Comptroller's Office, newspaper *El Mercurio* referred to them as a "instruments of [citizens'] control by the Communist Party." In contrast, *El Siglo* said that the JAP's role was to "protect the interests of workers and their families, and of small shopkeepers, through the use of official supply channels, the denunciation of hoarding, and the enforcement of price controls." The fact that deliveries of the "basic basket" and other necessities were written down in cards that looked like "rationing cards" used in Cuba and the Eastern bloc republics added to the controversy.[17]

During early 1972 inflation accelerated rapidly. In January, the 6-month annualized inflation metric climbed to almost 30%, and in February it increased further to 43%. This was more than double its December 1971 reading (21%) and much higher than at the end of Eduardo Frei's administration. In January, minimum wages were raised by 50%, a figure that was more than twice accumulated inflation in the previous year. This was consistent with the *Unidad Popular's* program and had a ratchet effect over the complete structure of wages in the private and public sectors. Higher wages, coupled with controlled prices, meant higher costs, and increased losses for nationalized firms. To survive, they required additional credit, which was promptly provided by the central bank. A "*prices-wages-money creation*" vicious circle developed. A decline in the demand for money (or increase in the velocity of circulation) added to the inflationary pressures. The government tried to combat inflation by using even more severe price controls.

6.3 Multiple Exchange Rates

In November 1970, minister of finance Américo Zorrilla announced that the government would put an end to six years of mini devaluations. The value of the U.S. dollar would be fixed at 12.21 escudos.[18] Because of the acceleration of inflation and the increase in imports, this was a short-lived policy. On December 13, 1971, the escudo was devalued. A new official parity of 15.80 escudos per USD was established and a multiple exchange rate system was adopted and four "import lists" were created. On August 7, 1972, the escudo was devalued again, and four additional import lists were established.[19]

During the next 12 months the currency was devalued several times and a spiral of devaluation and inflation ensued. In September 1973, Chile had ten

[17] El Mercurio, March 6, 1972. El Siglo, April 6, 1972.

[18] See Zorrilla (1971).

[19] Multiple exchange rates were not new in Chile. They had been used between 1952 and 1955 as a way of dealing with a balance of payment crisis.

different official exchange rates. This created serious economic distortions and encouraged corruption, as importers and exporters tried to have their goods reclassified into the most convenient list. In early September 1973, the black-market rate stood at 3,150 escudos per dollar, implying a premium of 142% with respect to the highest official rate of 1,300 escudos per dollar. Because of foreign exchange shortages the importation of spare parts became increasingly difficult, further hurting the production process.

7. Stagnation And Runaway Inflation In 1972 And 1973

By mid-1972 the nationalization process had spun out of control, with many small and medium sized firms being seized by workers who demanded their immediate requisition and expropriation. Instead of producing large surpluses, as expected by government economists, the new state-owned firms incurred very substantial losses. A succession of labor strikes in the nationalized copper mines further hampered the investment cycle. Wage increases to compensate for inflation were financed with even more money creation. And so, a whirlpool of money printing, inflation, currency devaluation, higher velocity of circulation, and wage adjustments took over. Congress, dominated by opposition forces refused to raise taxes, making the government account imbalances more pronounced.

As inflation accelerated, the real value of tax collection declined; this is the so-called "Tanzi effect," which operates in countries with extremely high inflation. Housewives spent hours standing in line in front of shops and supermarkets, in the hope of buying sugar, tea, coffee, chicken, detergent, toilet paper, and other necessities. Political tension increased and the government blamed the opposition, shop owners, capitalists, the U.S., and speculators for the deterioration of economic conditions.

7.1 The "Millas Plan" and The October 1972 National Strike

In June 1972, a new administration conclave was held. This time in the Lo Curro neighborhood. Immediately after the meeting Pedro Vuskovic was replaced in the Ministry of Economics by Harvard educated Carlos Matus. Communist lawyer Orlando Millas took over as Minister of Finance and became the de facto head of the economic team.[20] With the support of his party, Millas

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20 The decision to replace Vuskovic as minister of economics took place after the "*Lo Curro Conclave*", a meeting of the president and the heads of the UP political parties. The conclave was held at the home of Vicente Sota, in the Lo Curro neighborhood of Santiago.

tried to engineer a vast stabilization program. On August 18, 1972, hundreds of prices controlled by the government were adjusted up, and the government declared that state-owned and nationalized firms would redouble the effort to increase output. The goal was to put an end to shortages and black markets, and to reduce inflation. By coordinating the needs of firms with the availability of inputs and fuel, the *Cybersyn* project developed by Stafford Beer and Fernando Flores would help achieve this goal. These policies, it was thought, would result in increased support for the government in the upcoming crucial March 1973 congressional elections.

The data in Figure 1, vividly capture the rapid acceleration of inflation in 1972. According to this gauge -- annualized six-month rate of change in the official price level --, annualized inflation doubled from 30% in January 1972 to 60% in April. It doubled again to 120% in August, immediately after the Millas adjustment plan. Because of the jump in inflation and in accordance with the *Unidad Popular's* program, in October the government decreed a doubling of wages, further fueling the vicious inflationary circle.

Instead of calming things down, the Millas adjustment program destabilized the government further. Labor unrest increased, land invasions in the rural sector intensified, the seizure of manufacturing companies went on, and monetary largesse deepened. In addition, the interruption of credits and loans by the United States and international financial institutions (IMF, World Bank) further strangled the economy.

Things took a turn for the worse in early October, 1972, when several business and professional associations (truck owners, shopkeepers, medical doctors) staged a national strike aimed at paralyzing the country and destabilizing the government. This event became known as the "Truckers' Strike" (*Huelga de los Camioneros*). Street fights between government supporters and opposition demonstrators became commonplace. One of the most serious consequences of the strike was the severe rationing of fuel. Without it, it was not possible to distribute food and other basic goods to shops, supermarkets, or JAPs. Women staged massive demonstrations to protest supply problems; as they marched down Santiago's main boulevard, they banged empty pots and shouted anti *Unidad Popular* slogans. The government fought the strike using a combination of legal tools and police tactics. Workers in the "industrial belts" were asked to work overtime, and the data gathered for the *Cybersyn* project were used to battle supply disruptions. Government functionaries supported by the police forced-open shops and warehouses with hoarded goods and requisitioned them. Owners and managers were swiftly arrested. The crisis only abated when, on November 2, 1972, President Allende appointed the commanders in chief of the army, navy, and air force to the cabinet. According to a report prepared by the US Senate after the coup d'état, the strike was partially financed by the CIA.[21]

7.2 Two Views On The Economy

As inflation accelerated, the disagreements between the two camps within the government intensified. A question that divided the waters was the impact of money printing on inflation. On one side of the ledger there were technocrats and members of the Communist Party who believed that excessive money printing contributed to the jump in demand and was harmful; on the other side were members of the Socialist Party who believed that worrying about monetary issues was a "social democratic" deviation.[22] Both groups, however, thought that wages and salaries had to be raised periodically in response to accumulated inflation.

The Communist Party perspective on inflation, money and wages is clearly captured by an exchange between El Siglo's reporter Eduardo Labarca and the head of the Communist Party, Senator Luis Corvalán. (Labarca, 1972, p. 36-37. Emphasis added.):

> <u>*Corvalán*</u>: "[In August 1972 we] concluded that we really needed an adjustment of prices and remunerations… We gave [workers] two bonuses in September, and in October there was a [100%] wage adjustment. *We will now make a new effort to slow down inflation*."
>
> <u>*Labarca*</u>: "Do you really think that you will succeed, with all the shortages that have resulted because of the excess *liquidity in hands of the public,* which fuels speculation and inflation?"
>
> <u>*Corvalán*</u>: "We believe that an anti-inflationary policy is our obligation. We are taking several measures…Measures to reduce money supply, measures to restrict the economic level of our adversaries, measures aimed at allowing workers to voluntarily save part of their income… *All these measures are directed towards reducing as much as possible the inflationary pressures derived from the great mass of circulating money* …"
>
> <u>*Labarca*</u>: "Workers understand that the instantaneous wage adjustment decreed by the government meant a doubling of the wages and salaries. For the first time in Chile there is an inflation that doesn't generate [workers'] suffering and anguish."

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[21] See Edwards (2010) and Select Committee to Study Governmental Operations with Respect to Intelligence Activities (1975).

[22] The central bank staff sided with the more prudent view. A report published in early 1973 noted that when "the quantity of money increases faster than output and imports… there will be an increase in prices." (Banco Central de Chile, Boletin Mensual, May 1973, p. 466). Even in this group there was the belief that wages needed to be adjusted according to past inflation.

<u>*Corvalán*</u>: "I think that it is fundamental that all workers fully understand that the doubling of wages means that we must take very seriously all the anti-inflationary measures that I just mentioned."

However, many – in fact, possibly a majority – of *Unidad Popular* economists insisted that money creation was not the main driver of inflation. According to them, the root causes were political and had to do with opposition-led (and U.S. financed) boycotts and speculation.[23]

As the congressional elections of March 1973 got closer, the government decided to redouble price controls to slow down inflation (see Figure 1 for February-April 1973). Since neither the deficit nor money creation subsided, delaying price adjustments made shortages more acute and fed the black market, despite the government's efforts to increase the number and preponderance of the consumers' committees, JAPs. After the elections, where the government got 44% of the votes, inflation again picked up; in September 1973 (the month of the coup) it stood at an annualized rate of 1,570%.

The data in Figure 1 refer to official inflation and are based on controlled prices. However, since many goods could not be bought at government-determined prices, this index underestimates true inflation. The World Bank computed an "adjusted" price index that used data collected by the Universidad de Chile and captured prices at which goods could be purchased. This was a hybrid index that included some controlled and some free prices. (World bank, 1980, p. 543). According to this measurement, effective prices increased at a much faster pace that the official numbers; "true inflation" peaked in September of 1973 at a six-months annualized rate of 1,830%, three hundred percentage points higher than the government gauge (See Figure 2 for the two measures of inflation).

7.3 The Collapse Of Real Wages And The Growing Malaise Among The Middle Class

One of the costliest consequences of accelerating inflation and breakdown of supply chains and output was the decline of real wages. By September 1973 real wages and salaries were, on average, 35% lower than at their peak in 1971, and had declined by 14% relative to the pre-Allende period (Dornbusch and Edwards, 1991).

In Figure 3 I present data on the evolution of real *minimum wages*, using four alternative price deflators: (1) official CPI, (2) adjusted World Bank/Universidad de Chile CPI; (3) World Bank CPI (an alternative adjusted measure); (4) and food component of the official CPI. These indexes have an average

[23] Sergio Bitar, who was a Minister during the Allende government provides a summary of these debates. Bitar (2020).

of 100 in 1970. Although the precise evolution of real wages depends on the deflator used, the behavior is similar, and follows a saw-tooth pattern. The data show rapid improvement in the real minimum wage during the early months of the Unidad Popular, followed by an even faster collapse during the second half of 1973. When the official CPI is used there are four high points or peaks during the *Unidad Popular* period: January 1971=150, January 1972 = 181; October 1972 (immediately after the Millas Plan) = 172; and March 1973 (just before the congressional election) = 198. According to this official measure, the lowest point in real *minimum wages* was reached in September 1973, the month of the coup d'état, with an index value of 83. This was 17% below the average for 1970 (100) and less than half the UP's peak in March 1973.

It is possible to undertake a similar exercise using data on average wages (white collar workers) and salaries (blue collar workers), also deflated by different price indexes. In contrast with the figures on the *minimum wage*, these data are only available quarterly. Depending on the deflator the peak in average real wages was reached either the third quarter of 1971 or the first quarter of 1972, with an improvement between 26% and 35%, relative to 1970. The trough was observed either in July or October of 1973. Depending on the deflator, the real wages and salaries index was, at its lowest, between 59 and 30 (with 1970=100).

8. The Role of External Factors In the Economic Crisis

An important question is to what extent external factors – and, in particular, US actions, including the cutoff of loans, or the so-called "invisible blockade" – contributed to the crisis and the explosion of inflation. In this Section I deal with the issue by discussing the Nixon administration reaction to Salvador Allende's election. On September 5, 1973, one day after the presidential the election, Edward Korry, the US ambassador to Chile, sent a cable to the US Department of State, commenting on the results:

> "Chile voted calmly to have a Marxist-Leninist state, the first nation in the world to make that choice freely and knowingly… There is no reason to believe that the Chilean armed forces will unleash a civil war… It is a sad fact that Chile has taken the path to Communism with little more than a third (36pct) of the nation approving this choice, but it is an immutable fact. It will have the most profound effect on Latin America and beyond."

On September 15, President Richard Nixon met in the White House with Central Intelligence Agency (CIA) director Richard Helms, National Security Adviser Henry Kissinger, and Attorney General John Mitchell to discuss the events in Chile. It was decided to launch a plan—eventually code-named Operation FUBELT—coordinated by Thomas Karamessines, the CIA's deputy director for plans, to impede Allende's accession to power. As noted, Helms took notes at the meeting and wrote that one of the goals of the strategy was to "make the [Chilean] economy scream."

In the weeks that followed the CIA considered two tracks to stop Allende from being inaugurated. "Track I" was based on what was known as the "Frei gambit," a maneuver where Congress would elect Jorge Alessandri, who came second in the election, as president. Alessandri would immediately resign the post and a new election would be called. Outgoing Christian Democratic president Eduardo Frei, who was barred from immediate reelection, would now be allowed to run, and would defeat Allende. However, Eduardo Frei refused to be part of this scheme, and in early October 1970, the Agency tried a new stratagem. "Track II" consisted of generating enough political and economic chaos to convince the military to stage a coup. The CIA provided arms—submachine guns and pistols—to a group of civilians that, on October 22, tried to kidnap General René Schneider, the commander in chief of the Chilean Army. The attempt failed, and the general was seriously wounded as he tried to repeal the kidnappers. General Schneider died three days later, becoming an instant hero of the Left. (Davis, 1985).

When the US Senate "Church Committee" investigated CIA activities in Chile, after Nixon's resignation, it found that the agency had been involved in early attempts to keep Allende from becoming president – the Track I and II efforts mentioned above. However, after reviewing thousands of confidential documents and cables, it was determined that despite providing about 8 million dollars to the opposition, there was no evidence supporting the view that the CIA was directly behind Pinochet's coup. (US Senate, 1975).

In August 2023, when the 50th anniversary of the coup d'état approached, the Biden administration declassified two pages from President Nixon's daily briefing books from September 1973. On September 8, Nixon was told that there was a strong possibility of a coup attempt led by Chilean navy officers, and that Allende believed that "the armed forces will ask for his resignation if he doesn't change his economic and political policies." Concerned about an "armed confrontation," the CIA believed that Allende thought that "his supporters do not have enough weapons to prevail in such an event." On the day of the coup – Tuesday, September 11, 1973 -- Nixon's daily briefing addressed the Chilean situation once again. The report, written the night before, said that "[a]lthough military officers are increasingly determined… they may still lack an effectively coordinated plan that would capitalize on the widespread civilian opposition." The authors of the brief were wrong. When the report hit Nixon's desk, Allende was already under siege in La Moneda presidential palace. (State Department, 2023).

Although it is still not clear what was the full extent of the CIA's support for Pinochet and his co-conspirators, there is increased agreement that the failure of Allende's economic policies, including the eruption of very high inflation, contributed to widespread disaffection with the socialist experiment. The "blockade," of course contributed to the economic crisis. It may not have been its root cause, but it made it worse. Possibly, the best summary on the role of foreign forces in the collapse of the Chilean economy was given by Clodomiro Almeyda, Allende 's minister of foreign affairs and one of the country's leading Marxist intellectuals. In 1977 he wrote: (Almeyda, 1977, p. 37; emphasis added).

> "There are those who believe that external factors were ultimately responsible for the frustration of the Chilean revolutionary experience. There is particular emphasis on the significance of the American financial blockade, the economic and technical assistance provided by the CIA to the adversaries of Unidad Popular, and the American influence and infiltration within the Chilean Armed Forces. These factors tilted the balance of power in favor of the counter-revolutionary coup. In the Chilean case, as in most cases, external actions aimed at promoting subversion worked upon pre-existing internal destabilizing factors, deepening and extending their negative effects, thus favoring the success of the coup d'état. Thus, the American financial blockade and the obstacles to Chilean American trade worsened the balance of payments crisis and accentuated certain supply problems, but *it cannot be said that they caused or originated them*."

9. Concluding Remarks

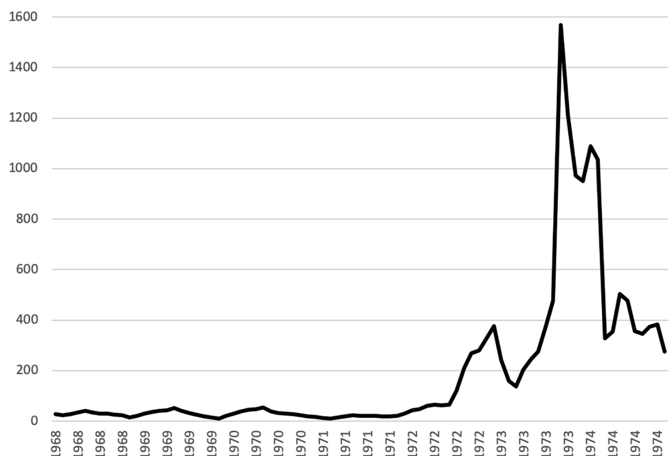
On June 29, 1973, the Armored Regiment No. 2 led an attempted coup. It failed because it had no support from the very senior echelons. On September 11, 1973, General Augusto Pinochet led a coup d'état that deposed President Salvador Allende. *The New York Times* carried the news on its front page on September 12:

> "The coup followed weeks of nationwide strikes and economic chaos, with growing groups of workers and professionals joining in demands that Dr. Allende halt his attempts to bring socialism to Chile and resign…A statement that the President had committed suicide was issued after the attack…"

The original economic and political strategies *Unidad Popular's* were based on the creation of a virtuous circle. Nationalized industrial firms would increase output at a rapid clip, generating a large surplus that would help finance investment in other sectors, including housing for the poor. The newly nationalized copper mines would provide significant funds to finance social programs. In addition, agrarian reform would result in a rapid expansion of food production. Price and exchange controls would keep inflation under wraps, and higher wages would improve the incomes of the poor in a sustainable fashion. Ample international reserves would finance imports of food and necessities. Economic success, in turn, would generate greater support for the government – the Left talked about improving the "correlation of forces" --, allowing it to move forward with its revolutionary program and a swift transition towards Socialism. However, nothing of that sort happened. The imagined virtuous circle was wrecked by very large fiscal deficits, huge money printing, by runaway inflation and black markets, by shortages and political violence, by declining real wages, and by political malaise.

FIGURE 1

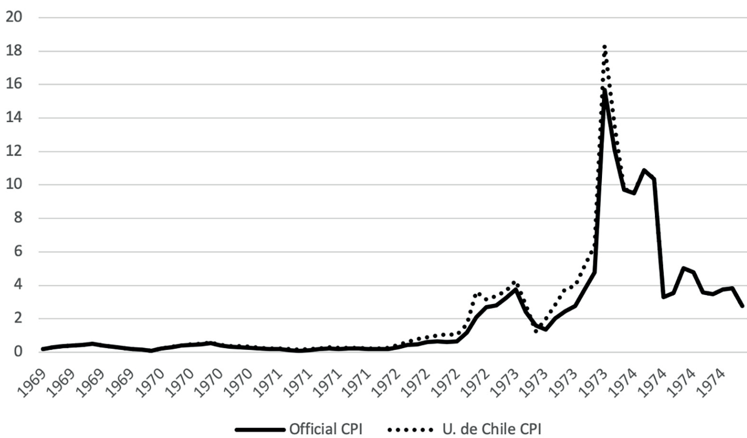
ANNUALIZED SIX MONTH INFLATION (%), 1968-1974



Source: Banco Central de Chile.

FIGURE 2

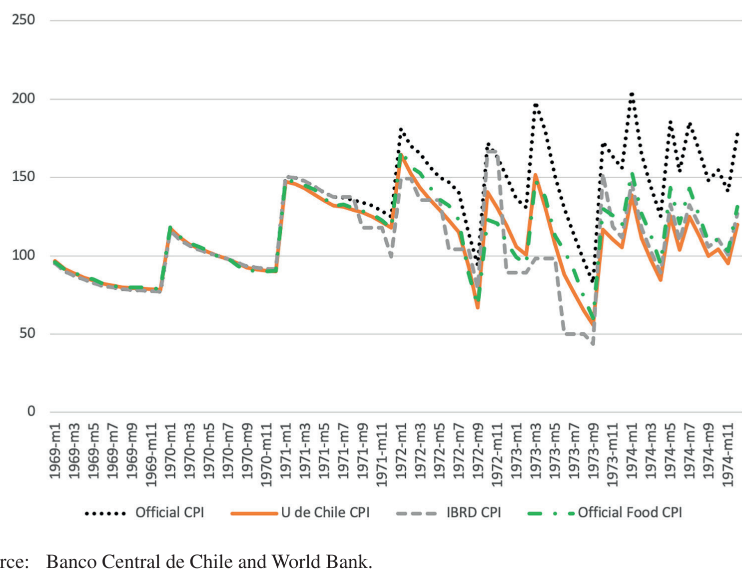
TWO MEASURES OF INFLATION (X100), 1969-1974



Source: World Bank, 1980.

FIGURE 3

REAL MINIMUM WAGES INDEXES (1970=100)



Source: Banco Central de Chile and World Bank.

TABLE 1
GDP PROJECTIONS IN THE PUPPET
(MILLIONS OF 1970 ESCUDO)

	1970	**1971**	**% change 1971/1970**
Agriculture	6,443	6,900	7
Fishing	256	250	-
Mining	10,327	13,000	25
Manufacturing	25,150	28,000	12
Construction	3,530	4,400	25
Electricity, gas and water	1,653	1,750	6
Services	42,193	44,200	5
Total	59,612	98,500	10

Source: Vuskovic et. al. (1970).

TABLE 2
PROJECTION OF AGGREGATE DEMAND IN THE PUPPET
(MILLIONS OF 1970 ESCUDO)

	1970	**1971**	**1971-1970 (%)**
Consumption expenditure of households	62,215	68,200	10
Consumption expenditure of government	11,960	13,000	8
Gross fixed capital formation	12,944	14,300	12
Existences	1,237	1,308	-
Exports	13,819	17,200	25
Imports	12,566	15,500	25
Total	89,612	98,500	10

Source: Vuskovic et. al. (1970).

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Institutional Vulnerability, Breakdown of Trust: A Model Of Social Unrest In Chile*

Vulnerabilidad institucional, ruptura de la confianza: un modelo del malestar social en Chile

Andrés velasco **
Robert funk ***

Abstract

This paper revisits the standard explanations of the violent Chilean protests of late 2019, and in particular their exclusive focus on the role of inequality, which in fact had been falling prior to the emergence of unrest. Instead, we suggest that blame may lie in a crisis of trust in institutions, political and otherwise. We employ a formal model of how trust in government institutions can arise —and also disappear— overnight. In that model, the level of trust is tied (but not uniquely tied) to the level of civic capital in a society. If civic capital is above a certain threshold, then trust can only be high and increasing, but if civic capital is below that threshold, then the outcome is indeterminate, meaning the level of trust is vulnerable to self-fulfilling bouts of optimism or pessimism. The threshold for civic capital can be shifted by exogenous shocks to parameter values, including the quality of institutions, with the consequence that small shocks can have small and lasting effects if they take the system from one region to another. We document how these dynamics resemble the facts from Chile, where a small drop in reported institutional quality was associated with a large drop in measured trust around the time of the protests. In turn, the protests involved patterns of behavior (like the destruction of urban infrastructure, the evasion of user fees in buses and trains, and the non-repayment of student loans) which further deteriorated the capacity of the state to provide certain quality public services, and aggravated the decline in institutional trust.

Key words: *Dynamic Games, Crisis Management, Public Services, Trust, Political Economy.*

JEL Classification: *C73, H11, H41, P16*

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Resumen

Este artículo revisa las explicaciones más comunes que se han entregado sobre las violentas protestas en Chile de fines de 2019 y, en particular, su enfoque exclusivo en el rol de la desigualdad, que de hecho venía disminuyendo antes de la irrupción de los disturbios. En cambio, sugerimos que la culpa recae en una crisis de confianza en las instituciones, políticas y de otro tipo. Empleamos un modelo formal sobre cómo la confianza en las instituciones gubernamentales puede surgir —y también desaparecer— de la noche a la mañana. En ese modelo, el nivel de confianza depende (pero no es únicamente dependiente) del nivel de capital cívico en una sociedad. Si el capital cívico se mantiene por encima de un cierto umbral, entonces la confianza solo puede ser alta y creciente, pero si el capital cívico se encuentra por debajo de ese umbral, entonces el resultado es indeterminado, y como consecuencia el nivel de confianza es vulnerable a episodios de optimismo o pesimismo autocumplido. El umbral del capital cívico puede desplazarse mediante perturbaciones exógenas a los valores de los parámetros, incluyendo la calidad de las instituciones, con la consecuencia de que pequeñas perturbaciones pueden tener efectos pequeños y duraderos si trasladan el sistema de una región a otra. Documentamos cómo estas dinámicas se asemejan a los hechos en Chile, donde una pequeña caída en la calidad institucional reportada se asoció con una gran caída en la confianza al momento de las protestas. A su vez, las protestas involucraron patrones de comportamiento (como la destrucción de infraestructura urbana, la evasión de tarifas en autobuses y trenes, y la negación a pagar préstamos estudiantiles) que deterioraron aún más la capacidad del Estado para proporcionar ciertos servicios públicos de calidad y agravaron la caída en la confianza institucional.

Palabras clave: *Juegos Dinámicos, Gestión de crisis, Servicios públicos, Confianza, Economía Política.*

Clasificación JEL: *C73, H11, H41, P16.*

1. The Puzzle

Why did millions of angry Chileans take to the streets in protest in late 2019? Why did many of them stop paying bus and subway fares and road tolls? And why did a country like Chile –arguably the most prosperous and law-abiding country in Latin America– explode in a rampage of street violence, vandalism and looting?

Chile tried to find a way out of its political crisis by drafting a new constitution. But a first draft text, which leaned to the far left, was rejected by voters in

September 2022, and a second one, which leaned to the right, was also rejected in a referendum in December 2023. So it seems that Chilean voters themselves are far from holding a single interpretation of the multiple tensions and conflicts revealed back in 2019.

As Pons et al (2020) highlight, the Chilean protests of 2019 appear to have been part of a global movement of rage that resulted in social unrest from Israel to Hong Kong, and from Iran to Bolivia. In Chile, the immediate trigger was a 3% increase in subway fares, which caused most observers to lay the blame more generally on rising prices and inequality.[1] As in other cases around the world, a sense of unfairness was likely at the root of the protests. But with its narrow focus on inequality and the cost of living, the standard account was overly simplistic.

Take price increases. Yes, Chile had a history of inflation. And, yes, because it is more prosperous, Santiago tends to be more expensive than most Latin American cities. Yet Chilean inflation in the 12 months to September 2019 was barely 2.1%, and the Central Bank had been cutting interest rates because inflation was below target.

Or take income inequality. For an upper-middle-income country, Chile is very unequal, with a high Gini coefficient of 46.6 in 2017 (100 represents absolute inequality). Yet according to the World Bank, the Gini coefficient had fallen from an eye-popping 57.2 when Chile returned to democracy in 1990.[2] The notion that *rising* income inequality was behind citizen discontent does not fit reality.[3]

Another explanation that has been offered is that years of economic stagnation clashed with public expectations of ever-increasing incomes and social mobility. In addition to the meagre growth rates of the 2010s, Donoso (2020), for example, adds the issue of deteriorating labor conditions and increased immigration during the period, creating a crisis of expectations.

While it seems natural to link economic grievances, including inequality and sluggish growth, to the occurrence of protests, it is far from clear that they are either a necessary or a sufficient explanation. In their ambitious cross-country analysis if the determinants of protests, Cantoni et al (2023) conclude that "while a society's economic performance has limited association with the occurrence of protests at the country level, a range of attitudes, preferences, per-

1 This New York Times piece, "Chile Learns the Price of Economic Inequality", is representative of this type of analysis (https://www.nytimes.com/2019/10/22/opinion/chile-protests.html, accessed 9 March, 2020).

2 See the data in https://datos.bancomundial.org/indicador/SI.POV.GINI?locations=CL

3 Proponents of this view would have to explain why intolerance for income inequality rose in the recent past, so that even a reduced level of inequality became unacceptable and triggered protests and looting. The classic paper by Hirschman and Rothschild (1973) provides a few clues along these lines.

sonality traits, and social factors are strongly associated with individual protest participation."

To understand the causes of a social phenomenon, one must ask: Why here? Why now? If citizen discontent spiked in Chile, some other causal factor must also have spiked so as to explain the change (or, alternatively, the sensitivity to the relevant causal factor must itself have spiked suddenly, which seems unlikely). What changed dramatically in Chile over the year or so prior to October 2019 that might explain massive citizen anger? Here is a possible answer: Chileans lost trust in the institutions of their country.

Development is always a race between frustration and trust. In a not-quite developed nation with much inequality and large pockets of poverty, many people lead harsh lives. Their income and consumption fall far short of their needs; they have difficulty paying their bills at the end of each month; they worry about losing their job or getting sick; they receive mediocre public services. All of this causes anxiety, frustration and, yes, anger.

But people control their anger as long as they believe that things will get better for them and their children. And crucially, that institutions —the executive, parliament, judges, prosecutors, the police, the military, labor unions, big business— are working to make that improved future possible (or at least are not working to impede it). Over time, trust rises and social or civic capital is accumulated (Persson and Tabellini, 2009; Aghion, Algan, Cahuc and Shleifer, 2010; Guiso, Sapienza and Zingales, 2011).

But if trust suddenly collapses, and people come to believe that institutions are not working —or, worse, that they are working to further the interests of people in power, not of ordinary citizens— then frustration and anger can boil over and quite possibly turn violent. That may be what happened in Chile.

Chile, like most Latin American countries, never achieved the levels of institutional or interpersonal trust seen in the United States. This should not be surprising. When de Tocqueville travelled to the United States, he was struck by what he found. American exceptionalism extended to the trust citizens accorded one another. In France, by contrast, rather than turn to each other for help, citizens looked to the state (de Tocqueville (1856)). Latin America is more like France than the United States in this respect. In the region, according to Latinobarómetro, interpersonal trust has been very low and on a downward trend for the last fifteen years. So has trust in most institutions: government, parliament, political parties and the judiciary, among many others.[4]

It might seem odd that trust in political institutions declined after many countries in Latin America became democracies. But politicians are not trusted in advanced democratic countries, either. Ronald Inglehart has argued that modernity and postmodernity contribute to a decrease in trust in institutions.

[4] Latinobarometro.org.

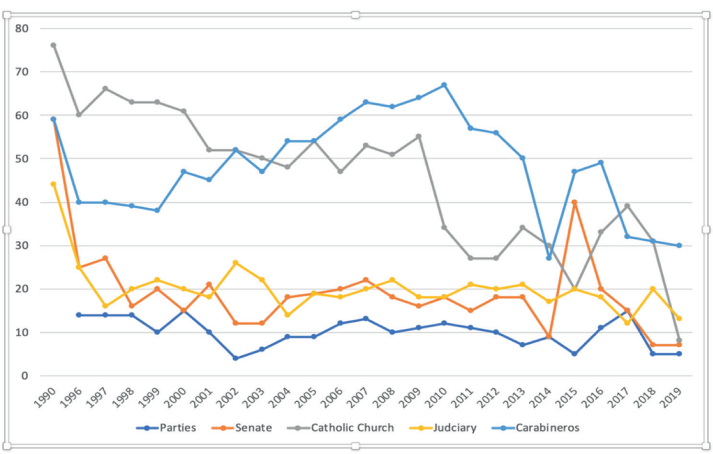
Alternatively, in Robert Putnam's account, modern life reduces face-to-face interactions and, as a result, interpersonal trust (Putnam, 2000). While traditional societies have a strong sense of authority resulting from paternalism or religious authority, modern societies, as they become more democratic lose respect for authority, and also trust in the institutions that in one way or another channel that authority (Inglehart, 1999).

Many organizations gather data on trust in Chile and Latin America, —including Latinobarómetro and Chile's Centro de Estudios Públicos (CEP)— but the CERC-Mori poll has the longest series on the subject, having asked the same set of questions regularly since 1990. Figure 1 shows CERC-Mori data for Chile on trust in five institutions: political parties, the Senate, the Catholic Church, the Judiciary and Carabineros (the national police force). Plotted is the share of people answering "very much" and "to some extent" to the question "Do you trust the following institution?"

For some institutions, like political parties, trust has been consistently low since the 1990s. For others, like the Catholic Church and Carabineros, sizeable drops are plausibly associated with specific scandals: a slew of cases of sexual abuse in the Church, starting around 2010, and financial fraud in Carabineros, revealed in 2016. But a generalized decline seems to have begun around 2009-10, and it accelerated prior to 2019.

FIGURE 1

DO YOU TRUST THE FOLLOWING INSTITUTION?
(PERCENTAGE ANSWERING "VERY MUCH" AND "TO SOME EXTENT")



Source: CERC-Mori

The CERC-Mori report issued in May 2019, just 5 months before the outbreak of violence, was alarming in both tone and content: "Trust collapses between 2018 and 2019, reaching the darkest moment since we began measuring trust in 1990." The report goes on to point out that in the previous year trust in Carabineros fell from 49% to 32% and trust in the judiciary dropped from 31% to 13%. The two institutions displaying the lowest levels of trust were the Catholic Church (from 31% to 8%) and political parties (from 15% to just 5%). The least trusted categories of people, the report concludes, were politicians with 6%, and bishops and priests, with just 5%.

The *Centro de Estudios Públicos* (CEP) polls show a similar shift regarding how much Chileans trust institutions in their country. A comparison between 2013 and 2019 one reveals a generalized collapse. Trust in the national government (the same President, Sebastián Piñera, was in office at both times) fell from 25.8 to 4.7 percent. Institutions that already endured low levels of trust

(Congress, political parties, private business firms) reached unbelievably low figures: by late 2019 fewer than 3 percent of citizens reported trusting Congress or political parties.

TABLE 1

DO YOU TRUST THE FOLLOWING INSTITUTION

(PERCENTAGE ANSWERING "VERY MUCH" AND "TO SOME EXTENT")

	July / August 2013	***November 2018***	***December 2019***
National government	*3.8 + 22.0 = 25.8*	*NA*	*0.7 + 4.0 = 4.7*
Congress	*1.5 + 10.1 = 11.6*	*0.9 + 3.6 = 4.5*	*0.5 + 2.2 = 2.7*
Political parties	*1.6 + 6.4 = 8.0*	*NA*	*0.3 + 1.8 = 2.1*
Municipal governments	*3.3 + 14.0 = 17.3*	*NA*	*1.7 + 14.9 = 16.6*
Courts of justice	*1.8 + 9.5 = 11.3*	*1.2 + 5.7 = 6.9*	*0.8 + 7.5 = 8.3*
Armed forces	*9.8 + 40.4 = 50.2*	*NA*	*7.5 + 16.6 = 24.1*
Carabineros	*10.9 + 37.5 = 48.4*	*NA*	*3.9 + 12.7 = 16.6*
Ministerio Público	*3.5 + 25.1 = 28.6*	*NA*	*0.9 + 5.3 = 6.2*
Private businesses	*3.5 + 14.0 = 17.5*	*2.3 + 9.5 = 11.7*	*2.2 + 6.0 = 8.2*
Labor unions	*3.3 + 17.1 = 20.4*	*NA*	*3.2 + 14.4 = 14.6*
Catholic church	*13.8 + 19.7 = 33.5*	*4.5 + 8.7 = 13.2*	*4.7 + 9.3 = 14.0*
Newspapers	*2.8 + 26.3 = 29.1*	*NA*	*1.5 + 9.8 = 11.3*
TV channels	*2.8 + 25.2 = 28.0*	*NA*	*0.7 + 7.4 = 8.1*
Radio stations	*7.3 + 39.5 = 46.8*	*NA*	*4.5 + 24.4 = 28.9*

Source: www.cepchile.cl

The courts of justice and the public prosecutor´s office, two institutions responsible for law enforcement, also suffered a sharp drop: by 2019 neither commanded the trust of even one citizen in ten. And that is not the end of the story. Institutions that were once widely trusted —the Catholic Church, radio stations, Carabineros (the national police), the military— also fell sharply in public esteem, losing the confidence of more than half the people who once trusted them. What Chile experienced, then, was a meltdown of institutional trust.

The Centro de Estudios Públicos also asks whether the country is, in the opinion of respondents, moving forward, stagnating or going backwards. Between 2013 and late 2019, the survey shows, Chileans took a gigantic leap toward pessimism. Table 3 shows that the share of people who felt the country was "moving forward" went from 41.6 to just 6.3 percent, and those fearing the country was "going backwards" grew four-fold, from 8.2 to 32.3 percent of the total. This drastic change in the national mood surely influenced people´s assessments of the quality of the country´s institutions —and could possibly been affected by it, in a two-way feedback loop.

TABLE 2

DO YOU THINK THAT AT THE PRESENT MOMENT THE COUNTRY IS…
(PERCENTAGE CHOOSING EACH ALTERNATIVE)

	July / August 2013	***December 2019***
Moving forward	*41.6*	*6.3*
Stagnating	*48.6*	*60.5*
Going backwards	*8.2*	*32.3*

Source: www.cepchile.cl

A character in a Hemingway novel says that he went bankrupt in two ways: first gradually and then suddenly.[5] The same seems to have been true for Chile´s trust crisis. Most indicators of trust had been declining slowly but in the CERC-Mori data the sharp collapse happened in 2018 and 2019. The consumer confidence compiled by GFK Adimark had no clear trend in 2010-17, but went from the low 50s (it runs from 0 to 100) to the high 20s in late

5 The line is from the character Mike Campbell in *The Sun Also Rises* (2022).

2019.[6] Other indicators fell even more abruptly. The monthly index of business confidence, had been in the high 40s and low 50s (it also runs from 0 to 100) for years until it suddenly dropped to the low 30s in late 2019.[7]

Do these subjective assessments of the quality of Chilean institutions coincide with more objective assessments? Not quite. The World Bank compiles six indices of the quality of governance. They are based on household surveys but also on the assessments of experts, NGOs, businesses, multilateral organizations and other public sector bodies. As such, the indices offer a different evaluation of the quality of institutions in Chile than the opinion polls cited above.[8]

Table 3 contains the World Bank indices for Chile in 2013 and 2018. Chile´s performance is strong: in both years and in 5 out of the 6 indicators, Chile is in the top 20 percent of countries in the world. And in Political Stability, the one indicator in which Chile is not in the top 20 percent, there is an improvement starting in 2013 that places Chile in the top 40 percent of countries by 2018.

TABLE 3
WORLD BANK GOVERNANCE INDICATORS FOR CHILE
(BASED ON SURVEYS / EXPERT OPINION)

	2013		***2018***	
	Governance Index (-2.5 to 2.5)	*Percentile Rank (1 to 100)*	*Governance Index (-2.5 to 2.5)*	*Percentile Rank (1 to 100)*
Voice & accountability	*1.11*	*84.5*	*1.05*	*82.27*
Political stability	*0.36*	*59.72*	*0.43*	*61.43*
Government effectiveness	*1.26*	*86.73*	*1.08*	*81.73*
Regulatory quality	*1.49*	*91.94*	*1.34*	*89.94*
Rule of law	*1.37*	*87.79*	*1.12*	*83.65*
Control of corruption	*1.54*	*90.52*	*1.01*	*81.73*

Source: www. https://info.worldbank.org/governance/wgi/Home/Report

6 Index available in https://www.gfk.com/es/home
7 See https://www.icare.cl/assets/uploads/2020/01/imce_dic2019.pdf
8 For details on the methodology behind the surveys, see Kaufmann, Kraay and Mastruzzi (2010).

Yes, five of the indices for Chile show a decline between 2013 and 2018, but that drop is small. The average for all six indices was 1.19 (in a range that goes from -2.5 to +2.5) in 2018, and 1.01 in 2013 —a drop of 15%. The decline is much smaller than that in the CEP survey, where the average drop in the share of people reporting high trust is 56%.[9]

So, the World Bank indices suggest that Chile has reasonably high-quality institutions, even after the drop in quality for the last five or six years. And there was no sharp decrease in institutional quality or in the quality of the services they provide that could obviously explain citizen discontent. Yet, in 2019 Chileans believed that their country´s institutional framework was in terrible shape, and their assessment was getting dramatically more pessimistic. Ideally, an account of what happened in Chile should explain how this divergence was possible.

Last but not least, an account of social unrest in Chile must also include a role for foreign factors, and perhaps also for contagion from abroad. Whenever something as dramatic as the protests and the rioting of 2019 takes place, the natural tendency is analysts is to look for domestic triggers. But the fact is that in the same period people took to the streets in Chile, there was similar social unrest in countries from Brazil, Bolivia, Colombia and Chile to Iran, Egypt, Lebanon, India and Hong-Kong. Advanced countries were also affected, including France (the so-called *gilets jaunes* movement) and the United States (the *Black Lives Matter* protests after the death of George Floyd). Arezki et al (2020) report a sharp increase in protests world-wide in 2017-2020, compared to the prior period starting in 2000. They also report finding “strong evidence for contagious protests with a catalyzing role of social media”. One way to think about contagion relies on multiple equilibria, with information from abroad shifting the prevailing equilibrium at home. The model we develop below allows for that kind of contagion.

One caveat is important. We try to explain in this paper why Chile had a sudden crisis of citizen discontent. This discontent was manifested through protests that often turned violent, but also in several other ways. Users stopped paying bus and subway fares and tolls in roads subject to concessions to private operators; there was a sharp increase in non-payment of guaranteed student loans, which quite plausibly was politically-motivated, given that university fees and the cost of student loans had been the major focus of an earlier round of protests in 2011; the approval ratings of President Sebastián Piñera and his conservative coalition tanked; and in May 2021, Chileans elected a constitu-

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9 In the World Bank data there is one category, Control of Corruption, which is a bit of an outlier, with a 34% drop in the index. But that drop is still smaller than 11 of the 14 drops in trust reported in the CEP survey.

tional convention where the far left held a large majority.[10] The model here can shed light on why the increase in discontent was so sudden and deep. It has little to say on why that discontent may have then manifested itself through violent or peaceful protest, civil disobedience and non-payment of financial obligations, shifts in poll results and electoral preferences –or all at the same time.

This paper is related to several strands of the academic literature. There is, first, a growing empirical literature documenting the recent wave of worldwide unrest, which includes papers by Arezki et al (2020), Abi-Nassif et all (2020), Barrett et al (2020) and Cantoni et al (2023). Bursztyn et al. (2021) study which factors have a causal effect on participation in the Hong Kong protests and find individual incentives directly increase protest turnout and attendance has a persistent effect on future protest engagement. Chenoweth et al (2022) examine who protested, what they protested against, and why, during the summer of 2020 in the United States. They present evidence that protesters were a diverse sample of the population and that the decision to protest was responsive to individual circumstances and incentives. They also find, contrary to conventional wisdom, that attending a Black Lives Matter protest was associated with a higher likelihood of attending a protest calling for fewer public health restrictions.

An interesting theoretical literature has been developing on an issue we do not address directly: why and how acute citizen discontent expresses itself via protests. That literature includes Bueno de Mesquita (2013), Battaglini (2017), Pasarelli and Tabellini (2017), Barbera and Jackson (2020), and Bueno de Mesquita and Shadmehr (2022).

There is of course a long literature on trust, its causes and its consequences, dating back to de Tocqueville (1856) and Max Weber (1964). Recent and important contributions include Fukuyama (1996) and Levi, Sacks, and Tyler (2009). The idea of a 2-way feedback loop between government effectiveness and trust in government is present, under different guises, in Levi (2019) and Aghion, Algan, Cahuc and Shleifer (2010). Keefer and Scartascini (2022) argue low trust is behind all kinds of social and economic ills in Latin America. It may also be a cause of the rise of right-wing populism in Europe, as reported by Algan (2017).

Ostrom and Ahn (2009) also stress the link between social capital and collective action problems. Benabou and Tirole (2006a) call the kind of behavior

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10 Some of these changes were only transitory. The radical constitution drafted by that convention was rejected by a large margin in a September 2022 referendum. A second convention elected in 2023 is now dominated by the far right. In December 2022 Chileans elected Gabriel Boric, a far-left former student leader, as president. His honeymoon was brief and the drop in his approval rating precipitous. At the time of revision of this paper, in late 2023, fewer than one-third of Chileans approve of the job he is doing in office.

that helps solve collective action problems “pro-social”; Besley (2020) calls it “civic” behavior. Campante et al (2021) analyze the role of media in the accumulation and destruction of social capital. This is all part of a larger literature on the transmission and persistence of values, launched by Cavalli-Sforza and Feldman (1981), Bisin and Verdier (2001) and Boyd and Richerson (2005).

Last, our paper is related to the literature on multiple equilibria and the question of what pins down outcomes. The trap of the weak state, according to Fergusson et al (2022), involves a potentially self-reinforcing loop: citizens are unwilling to pay taxes to finance an effective state, and the state can therefore only engage in clientelism, defined as “the exchange of votes for particularistic benefits like money, jobs, and other private rewards”. Krugman (1991) was the first to ask formally when it is that initial conditions (say, the stock of civic capital) determine outcomes, versus situations where expectations can be self-fulfilling and history (initial conditions) becomes irrelevant. We develop a similar approach here.

2. A Basic Model

Start from two simple ideas. The first is quite obvious: the trust people place in an institution depends on many factors, but a key factor is how effective that institution is. The British love the National Health Service because it delivers (waiting times notwithstanding) high-quality health care. Americans have rejected attempts to privatize the popular Social Security system for analogous reasons. The average Chilean used to trust Carabineros because it delivered a reasonably safe country (certainly when compared to neighbors in Latin America).

The second idea is less obvious: the effectiveness of a public institution depends crucially on how much citizens trust it. A national development bank can fund its operations via low-cost deposits only if savers are confident their money is safe when deposited there. Doctors at a public hospital can cure disease only if a patients trusts them and follows their instructions. Once users start jumping over turnstiles and refusing to pay their fee, as in the Santiago metro in the Spring of 2019, no one can be surprised if the quality of service deteriorates. Or, to return to the Carabineros: when they were widely respected, a verbal warning from a cop was all that it took for a protestor to stick to the unwritten rules of peaceful protest; by 2019, when Carabineros were widely viewed as brutish, ineffective and corrupt, no display of water cannons sufficed to keep protestors from breaking store windows and setting buses on fire.

This second idea comes with a twist: strategic complementarities are at work. If I trust the bank and no one else does, my money is not safe. If I trust public health authorities and follow rules on social distancing but no one else does, then I am still susceptible to contagion during a pandemic. In short: the trust I place in an institution matters, but other citizens´ trust matters just as much.

To fix ideas, consider a concrete model, borrowed and simplified from Funk and Velasco (2023). There are two types of people: citizens and political elites. Politicians run the institutions whose job it is to provide public services such as education or healthcare. Citizens play a double role: they benefit from the public good but also contribute to financing it. The most natural interpretation is that citizens make tax payments and government then uses the revenue to fund the public good. The payments could also be interpreted as user fees —as in a subway or in a toll road— with the resulting resources then used to maintain the system.

Alternatively, the contribution by citizens could be non-pecuniary: for instance, behaving in a public school classroom so that fellow students can learn, or obeying the instructions of health authorities and respecting social distancing so that others will not catch a virus. In what follows we use the language of taxes and revenue, but keep in mind the alternative interpretation.

The continuum of citizens has size (measure) one. Everyone faces a choice: pay taxes and contribute to the public good, or evade taxes and fail to contribute. Let k_t be the fraction of people who contribute, which is a good proxy for the civic capital of society (to be defined in mor detail below). Suppose also that those who do not contribute enjoy only a share β , $\beta \in (0,1)$, of the benefits of the public good.[11] So β is a "free riding" parameter: the higher β , the easier it is to free ride, since one can get more of the benefits of the public good without helping pay for it.

Exogenous individual output is normalized to one. The constant tax rate on output is τ , $\tau \in (0,1)$, so total tax revenue is τk_t . Those resources are used by politicians to produce a public good that yields $(1+\alpha)\tau k_t$ in utility. One can interpret α in three alternative ways:

- A *policy-competence* parameter, indicating the ability of politicians in the government to turn private resources into a high-quality public good or high-quality public services.
- A *probity* parameter, indicating what share of tax revenues politicians use for public-good provision as opposed to stealing or redistributing to their cronies.

[11] Some of these changes were only transitory. The radical constitution drafted by that convention was rejected by a large margin in a September 2022 referendum. A second convention elected in 2023 is now dominated by the far right. In December 2022 Chileans elected Gabriel Boric, a far-left former student leader, as president. His honeymoon was brief and the drop in his approval rating precipitous. At the time of revision of this paper, in late 2023, fewer than one-third of Chileans approve of the job he is doing in office.

- A *suitability* parameter, indicating how well suited the public good is to people´s desires. Politicians who understand the preferences of the population will provide a suitable kind of public good or service, while an out-of-touch governmental elite will do the opposite

So competent, honest and "in-touch" politicians yield government institutions that have a high and positive α, while those who do not yield institutions with a low α.

The welfare level of an individual who contributes is

$$w_t^c = (1-\tau) + (1+\alpha)\tau k_t,$$

while the welfare level of someone who does not contribute is

$$w_t^n = 1 + (1+\alpha)\beta\tau k_t$$

For both contributors and non-contributors, welfare is increasing in k_t: the larger is civic capital, the higher the level of provision of the public good. But welfare rises more quickly as a function of k_t for contributors, since they can enjoy the full benefits of the public good. Notice that $w_t^n(k_t = 0) > w_t^c(k_t = 0)$ always, which is intuitive: if no one else is contributing, it pays not to contribute. Note also that $w_t^c(k_t = 1) > w_t^n(k_t = 1)$ if and only if $(1+\alpha)(1-\beta) \equiv \pi > 1$. Tr contribution to be a best response when everyone else is contributing, α must be sufficiently high and β sufficiently low. Intuitively, the quality of government in delivering public services must be high enough, while the incentives for "free riding" must be low enough. From now, assume this condition holds.

There is one k_t, labeled $\bar{k}$, that makes welfare from contributing and non-contributing equal:

$$\bar{k} = (1+\alpha)^{-1}(1-\beta)^{-1} \equiv \pi^{-1}$$

Note that $\bar{k}$ is decreasing in α and increasing in β, which is intuitive. Note also that $\bar{k} < 1$ requires $\pi > 1$, which we have assumed.

FIGURE 2
STATIC PAYOFFS

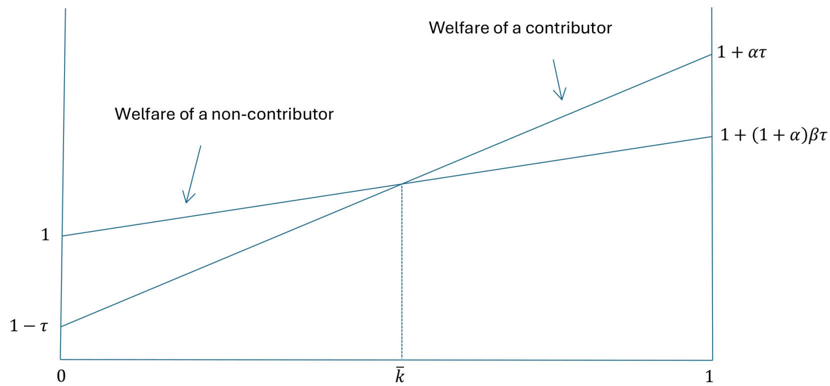


Figure 2 shows both welfare functions, which cross at $\bar{k}$. There are three candidates for equilibria: $k=0$, $k=\bar{k}$ and $k=1$. Multiple equilibria occur because of strategic complementarities across citizens: it is more attractive to contribute when many others are also contributing, and as the stock of civic capital rises, the return associated with contributing rises more quickly than that associated with not contributing. Which of these tree candidates turns out to be a stable steady state equilibrium will depend on the associated dynamics, which we specify in the next section.

What are welfare implications? When $k=0$ individual welfare is 1, while if $k=1$ individual welfare is $1+\alpha\tau$. So having everyone be civic-minded and contribute is better than having no one contribute as long as $\alpha>0$, which is intuitive. If politicians in government are minimally competent, honest and "in-touch," having as much civic capital as possible is preferable. Yet, as we explore next, society can be trapped in an equilibrium in which no civic capital vanishes and eventually no one contributes, in what constitutes a glaring failure of social organization.

3. Trust And Expectations

Trust is by definition a forward-looking variable. If I trust someone, it is because I expect that both today and in the future that person will "do the right thing". If people are free to choose at every instant whether to contribute and behave in a civic manner, then all that ought to matter to them is the share of fellow citizens who are civic-minded today. If the payoff from a course of action turns out to be low, then tomorrow one can always change.

But choosing to be a contributor or a non-contributor, and to be civic-minded or not, has important implications for people´s identity, self-esteem and social recognition so it is reasonable to assume such patterns of behavior, and the self-perception that goes with them, change within a lifetime, but changes come only occasionally and then only after lengthy intervals.

In Funk and Velasco (2023) we formalize this intuition in the following way: people can only choose whether or not to be to be civic-minded when they receive a signal, which arrives with probability θ. So, by the law of large numbers, at any time only a fraction θ of the population can choose to change behavior, while a fraction $1-\theta$ cannot. The lower is θ, the "stickier" are choices. An interpretation is that once a choice is made, the person internalizes a set of values (civic-minded or not) and continues to hold those values for a period of expected length θ^{-1}.

So far we have no variables that can serve as proxies for forward-looking trust. So, think of being a contributor as an asset. If everyone were free to change pattern of behavior at any given time, then such an asset would not exist. But if the expected value of contributing is higher than not contributing, then being a contributor today, and expecting to remain a contributor for a period for a period of time, has value, which is reflected in the price of this asset, denoted by q_t.

By arbitrage it must be the case that

$$\frac{\dot{q}_t}{q_t}+\frac{w_t^c-w_t^n}{q_t}=\theta$$

The LHS is the total return on this asset, given by the capital gain (the first term) and the difference in welfare levels between contributing and not (second term), both expressed as a proportion of q_t. On the RHS is the probability that at the next "instant" a person will be able to change from contributor to non-contributor, which plays the role of a discount rate.

Notice q_t is a forward-looking variable, since the arbitrage equation takes into account not only the contemporary level of q_t but also its expected change (technical details on the definition of q_t are in the appendix). We can think of this variable as a proxy for the trust placed on the institutions that produce public services which, in turn, depends on the degree of confidence that in the future others will act in a civic-minded way. Perhaps something akin to q_t is what public opinion polls were capturing in 2019 Chile, when they suddenly showed a collapse in trust.

Plugging in the welfare levels w_t^c and w_t^n and rearranging, the arbitrage equation becomes

$$\dot{q}_t=\theta q_t-\tau\left(\pi k_t-1\right)$$

Funk and Velasco (2023) show that civic capital evolves according to

$$\dot{k}_t = \theta\left(\frac{p_t}{\theta} - k_t\right)$$

where p_t / θ is the fraction of those allowed to make a choice who decide to be civic-minded. If it is larger than k_t, the fraction of the population that already is civic-minded then, quite intuitively, k_t should be rising. Notice that p_t has an upper limit of θ, the share of the population that receives the signal and gets to choose.

Now, given the definition of q_t, people agents who get to choose will prefer to become civic-minded and contribute if and only if q_t is non-negative. So,

$$p_t = \begin{cases} \theta & if \;\; q_t \geq 0 \\ 0 & if \;\; q_t < 0 \end{cases}$$

In words, whenever it is advantageous to become civic-minded, all θ people who can, make that choice; while when it is not, no one does. Therefore, the evolution of civic capital follows:

$$\dot{k}_t = \begin{cases} \theta\left(1 - k_t\right) > 0 & if \;\; q_t \geq 0 \\ -\theta k_t < 0 & if \;\; q_t < 0 \end{cases}$$

We have a system of two differential equations in q_t and k_t, with q_t a "jumpy" variable (it can react instantaneously to changes in expectations) and k_t "sticky" (that is, it evolves gradually).

If $\pi \leq 1$, the benefit of being non civic-minded is always higher than that of being civic-minded, so the model has a single long-run equilibrium at $k = 0$. We have assumed away that uninteresting possibility. There are two other, and more interesting, cases: low-quality institutions, requiring $1 < \pi \leq 2$, and high-quality institutions, requiring $\pi > 2$.

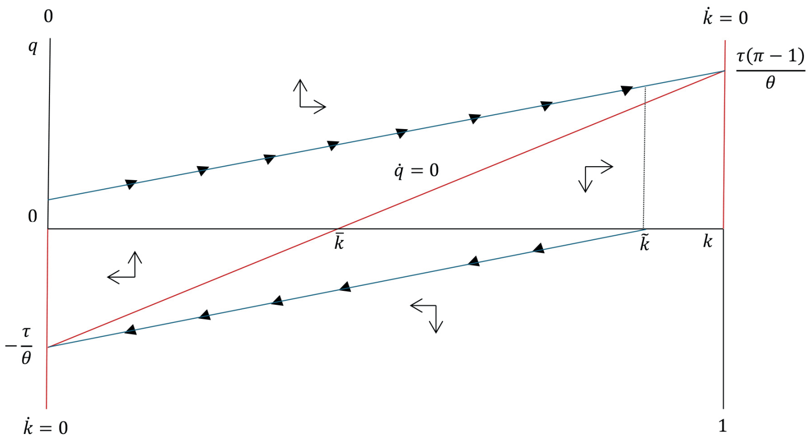
Here we only consider the case of high-quality institutions, which would seem to be the one relevant for Chile given our earlier discussion. That case is simple enough to be analyzed by means of diagrams (Figure 3 and the others that follow), with no further algebra required.

Because institutional quality is high, there is always a range of initial conditions starting at $\tilde{k}$ and reaching all the way to $k = 1$ where saddle-paths do not overlap.[12] If civic capital starts out in that range, the only feasible level of trust is high (on the saddle path leading to the steady state with $k = 1$) and progress is inescapable: civic capital will accumulate gradually until it everyone is civic-minded and contributes to the financing of public services. In the language of Paul Krugman's (1991) pioneering paper on history versus expectations, for countries starting out between $\tilde{k}$ and 1, only "history" (initial condition) matters.

[12] The appendix shows that $\tilde{k} = 2\bar{k} = 2\pi^{-1} < 1$.

But to the left of $\tilde{k}$, and all the way to 0, there is a range of indeterminacy. Saddle-paths leading to steady states with $k=0$ and $k=1$ overlap, so pessimistic expectations and low trust can cause civic capital to decline until there is no one left to contribute, while optimism and high trust can cause civic capital to follow a sustained upward trajectory. Because government institutions are strong, even nations starting out with near-zero levels of civic capital can sustain high trust and a gradual increase in pro-social behavior. In the range between 0 and $\tilde{k}$, and again using Krugman´s terminology, expectations are all-important and history is irrelevant.

FIGURE 3
HIGH-QUALITY INSTITUTIONS



Notice that under this pattern of dynamic behavior, $\bar{k}$ is not a tipping point. That is, civic capital can start above $\bar{k}$ and still decline, or start to below $\bar{k}$ and rise persistently. This is because people are forward-looking: they consider the stream of payoffs associated with choosing to be or not to be a civic-minded contributor. And it makes sense for them to look forward, because after choosing they will be "trapped" in that pattern of behavior for a period of expected length θ^{-1}.

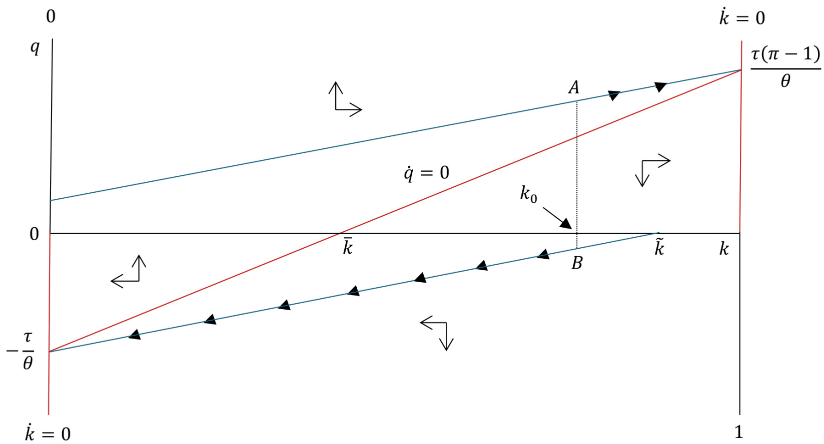
4. Putting The Model To Work

We are now ready to apply this model to the situation of Chile. There are two kinds of shocks that could have occurred, leading to a situation reminiscent of what Chile experienced starting in 2019. The first is a self-fulfilling confidence shock. We saw above there is plenty of evidence, both formal (from polls and surveys) and also anecdotal, which suggests that around that time Chileans become a great deal more pessimistic and less trusting. And, crucially, the drop in reported trust and confidence levels was quite sudden.

Suppose that initially civic capital is at point $k_0 < \tilde{k}$, high enough to make strong trust possible, but not so high that strong trust is the only feasible outcome. Suppose in addition that initially expectations are optimistic, so that society is on the upper saddle path leading to the steady state with $k = 1$. From that initial point, labeled A, a sudden confidence and trust crisis causes a vertical drop to point B. Nothing has happened —except in the minds of people— but civic capital, which had been rising, suddenly begins to fall. And that in turn causes trust to drop even further, as the system moves down to the southwest along the saddle path leading to $k = 0$. Crucially, with reduced funding the quality of those services also drops along the transition, confirming people´s pessimistic expectations and rendering initial expectations self-fulfilling.

Such a shock and its consequences have plenty of similarities with what transpired in Chile in 2009. The change was sudden and its consequences profound. There was a collapse in measured trust and confidence, without an obvious exogenous shock, internal or external, that could have caused it. An open question is whether the switch in expectations was the result of contagion from abroad, with citizens becoming pessimistic and taking to the streets to protest in response to similar developments in other nations, both close by and far away.

FIGURE 4
SHOCK TO EXPECTATIONS

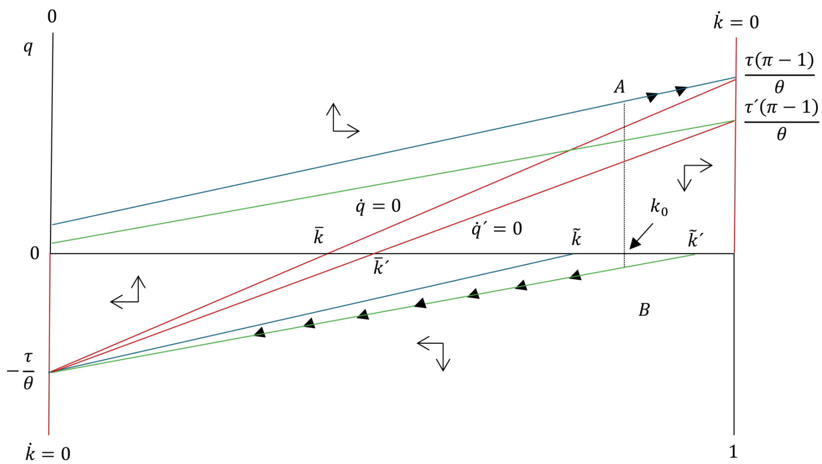


A self-fulfilling expectational shift is not the only perturbation that can occur. Suppose instead that π drops permanently to π', so that the quality of institutions goes down forever. Recall that this shock can be interpreted as a drop in the policy competence of elites, their probity, or the suitability of the public services they provide. It could also imply a change in the free-riding parameter, with free riding now easier or less costly. In any case, π matters for the slope of the $\dot{q}_t = 0$ line and the associated saddle paths. New and old schedules are shown in Figure 5 (original saddle-paths in blue and post-shock saddle paths in green).

The long-term consequences of this shock depend on initial conditions. If initial civic capital was to the right of $\tilde{k}'$, then nothing dramatic happens. Society was initially enjoying high trust and accumulating civic capital, and after the shock it would continue on such a path. Trust would drop a bit on impact (the new saddle path leading to the steady state with $k = 1$ is now lower) and the eventual resting point would involve lower welfare than before the shock, but society would still converge to a steady state in which everyone is civic-minded and contributes.

If the initial condition was to the left of $\tilde{k}'$, on the other hand, new (and dangerous) possibilities arise. Imagine society starts from a point like k_0, where $\tilde{k} < k_0 < \tilde{k}'$. Before the shock, that level of civic capital was only congruent with high trust and growing civic-mindedness, so the country had to find itself at point A. But because k_0 is smaller than $\tilde{k}'$, the new threshold below which multiple equilibria are possible, point B, with low trust and declining civic capital, is now also feasible. If the exogenous shock puts society in a position where self-fulfilling confidence crises can occur, and one does take place (taking the system from A to B), then the country in question shifts to a trajectory of low-trust and declining civic-mindedness.

FIGURE 5
HIGH-QUALITY INSTITUTIONS



We could put the model to work in analyzing other kinds of shocks (temporary instead of permanent, for instance) but we leave that task to readers. Instead, we summarize the uses a model of this kind have in thinking about events like those of Chile (and other countries) in 2019. The first is that trust and civic-mindedness are fragile. The trust we place in other people, the trust we place in government institutions, and the ability of those institutions to deliver, are all interrelated, and can fluctuate as a result of exogenous shocks and self-fulfilling confidence crisis.

The second lesson is that reversals in trust can be sudden and unexpected. This would seem to fit the narrative of the Chilean crisis, where few people, if any, "saw it coming". It also fits the sudden deterioration of trust as reported in surveys and polls.

Third, contagion from abroad can happen —and seems to have happened, given that so many different countries around the world suffered from unrest at about the same time. Whenever multiple equilibria are possible, events outside our borders can help trigger a shift from the "good" to the "bad" equilibrium, with consequences for trust and civic-mindedness.

Fourth, if they trigger a change in expectations, small changes —in the quality of institutions, for instance— can have a large and lasting impact on both institutional trust and long-term individual welfare. But notice: the large adverse effect will only occur societies in that are not too developed to begin with —that is to say, where the initial stock of civic capital is not too high.

Fifth, there can be a large divergence between the reported "objective" quality of government institutions and the trust people place on those institutions —and that gap can rise sharply overnight, as it seems to have occurred in Chile in 2019. That is because trust is forward-looking and it depends not just on the quality of public services today, but on their anticipated quality in the future as well. And when that quality is expected to deteriorate, trust drops. And, course, that trust crisis can be self-fulfilling if initial civic capital is not sufficiently high.

5. Conclusions

In the early 2010s the world witnessed a series of protest movements, associated with the after-effects of the Financial Crisis and the Arab Spring. There was another wave of street unrest late in the same decade, of which the Chilean protests of 2019-2020 were an extreme example: angry citizens did not just join protest marches, but some also torched supermarkets, firebombed subway stations, and vandalized uncounted small businesses. Chile, often celebrated for having the best institutions in Latin America, experienced a breakdown in the rule of law. But unlike the Occupy Wall Street protests in the United States, Chile's unrest did not follow a spike in economic hardship; and unlike the Arab Spring, it was not associated to a call for a transition to democracy. Instead, Chile's protests followed a generalized breakdown in institutional trust.

The quality of institutions and the trust that citizens deposit in them are two sides of the same coin. Quality of course promotes trust, but a citizenry that trusts and respects a country´s institutions in turn allows them to function better. There can be a virtuous cycle along which quality inspires trust which in turn improves the performance of institutions. But the opposite can also happen: shocks can trigger a vicious circle in which collapsing trust and deteriorating public good provision reinforce each other. It does not take much to push a successful society off the "narrow corridor" that leads to development and into an abyss of distrust, distemper, bad politics, bad policies —and even violence. That is what seems to have happened to Chile.

Several kinds of shocks can push a country off the narrow corridor of institutional progress. We saw that "small" declines in exogenous institutional quality and in the ability to free ride can do the trick. Some of this seems to have happened to Chile. Its institutions were strong compared to those of most other emerging nations (and some developed nations too), but not strong enough to shield society and politics from a sudden meltdown in national self-esteem.

What is to be done? If you believe the story in this paper, then you must conclude there is no quick technocratic fix that can get the country back on its feet. There are, as observers from Tocqueville to Putnam to Fukuyama point out, deep-rooted social foundations underlying trust, which include family life and associativity, and these have been evolving together with Chile's economic progress. Beyond playing institutional catch-up, the name of the game is social coordination. But coordination across millions of people who feel they are living through several intertwined crises —economic, political, social and, until recently, epidemiological— is notoriously difficult.

Coordination needs to happen along two dimensions. Citizens must come to believe again that it is their duty to pay taxes or subway fares even if many others are not doing so. The marauding gangs of toughs who harassed those who chose to pay at several Santiago metro stations, for example, show that task will not be easy to accomplish. At the same time, the leaders of the country's institutions —politicians, bureaucrats, judges, prosecutors, business and union leaders, reporters and journalists, even priests— must listen more carefully, get the message and improve their performance.

It took Chile the better part of two centuries to build trusted institutions of which citizens could be proud. All that vanished in a matter of months. How long will the rebuilding take?

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Long-Run Labour Income Distribution Dynamics: The Case of Chile 1990-2017*

La dinámica de largo plazo de la distribución de ingresos laborales: el caso de Chile 1990-2017

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Abstract

We analyse the long-run evolution of the labour income distribution for Chile. To this end, we use thirteen waves of the CASEN household socioeconomic survey from 1990 to 2017. During this period hourly earnings inequality measured by the Gini coefficient fell from 0.47 to 0.40. We use a RIF regression approach similar to Ferreira et al. (2021) for Brazil to decompose changes in average earnings and earnings inequality. We do not find observable variables that explain –either through an endowment effect or through a structural price change– a significant part of the decrease in hourly earnings inequality.

Key words: *Income Distribution, Inequality Dynamics, RIF Decomposition, Chile.*

JEL Classification: *D30, D31, D39, J31.*

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Resumen

Este trabajo analiza la evolución de largo plazo de la distribución de ingresos laborales para Chile. Con este fin, se usan trece olas de la encuesta de hogares CASEN desde 1990 a 2017. Durante este período, la desigualdad en los ingresos por hora, medida por el coeficiente Gini, cayó desde 0.47 a 0.40. Usamos regresiones RIF, similar a Ferreira et al. (2021) para Brasil, para descomponer cambios en los ingresos promedio y la desigualdad de ingresos. No encontramos variables observables que expliquen –ya sea a través de un efecto dotación o cambio estructural de precios– una parte significativa de la disminución en la desigualdad de los ingresos por hora.

Palabras clave: *Distribución de Ingresos, Dinámica de Desigualdad, Descomposición RIF, Chile.*

Clasificación JEL: *D30, D31, D39, J31.*

1. Introduction

In this paper we analyse the long-run evolution of the distribution of labour incomes for Chile. To this end, we use thirteen waves of the CASEN household socioeconomic survey from 1990 to 2017, a 28-year time span.

Chile is an interesting case to analyse since it is often touted as a regional economic success story. Real per capita GDP grew from 9,702 (PPP, constant 2017 international $) in 1990 to 24,547 in 2017.[1] Absolute poverty rates decreased from 38.6% in 1990 to 8.5% in 2017 and extreme poverty rates from 13% to 1.5% during the same period (MSDF and UNDP (2020)).[2] According to the same source, multidimensional poverty (household with unsatisfied needs in at least three dimensions or more) fell from 34.7% to 7.4% between 1990 and 2017.

Despite these impressive figures, income inequality has remained stubbornly high. According to OECD data, Chile's Gini coefficient of household disposable income was 0.46 in 2017, the highest among all 37 OECD coun-

1 World Development Indicators database, World Bank, https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?locations=CL. Last accessed on August 7, 2023.

2 The absolute poverty rate is the percentage of households whose disposable income is below the poverty line, while extreme poverty is the percentage of households whose income is below the price of a basic basket of foodstuff. Different official poverty lines have been defined through time resulting in slightly different poverty dynamics during this period. However, they all point in the same direction: a significant fall in poverty rates measured by income. See MSDF and UNDP (2020) for more details.

tries, and only slightly lower than the maximum value of 0.48 (2009) recorded for Chile in this dataset.[3]

That Chile has an unequal income distribution is well known and researched.[4] In part, this is due to a tax system with low progressivity with almost half of revenues coming from VAT taxation, together with government transfers that have been unable to reduce the post tax-transfers Gini coefficient by more than a few basis points.[5]

The distribution of labour earnings in Chile has been studied by Behrman (2011) who simulates the potential impact of different human capital policies on earning inequality. Sapelli (2011) analyses income distribution by age cohort between 1957 and 2004 and shows that there is an inverted U shape of income inequality by cohort through time. He decomposes these changes and suggests that the fall in income inequality for younger cohorts seems to be related to a flattening of the age-income profile and thus a reduction in the returns to experience. Sapelli (2016) argues that owing to the educational attainment of recent generations, income inequality by cohort should continue to decrease in the future. UNDP (2017) (Chapter 7) also analyses the distribution of earnings inequality. It notes that inequality was quite stable until it began to fall between 2003 and 2015. It attributes half of this fall to the higher supply of more educated workers; that is, a fall in the educational wage premium.[6] Contreras and Gallegos (2011) decompose earnings inequality for a set of Latin American countries (including Chile) and find that changes in educational attainment is the most important factor explaining the evolution of wage inequality between 1990 and 2000.

In this paper, we contribute to the literature by revisiting the long-term dynamics of the distribution of hourly labour incomes. Our data covers the 1990 to 2017 period, a more recent time frame than previous studies (e.g. Sapelli (2011)) and longer than most other studies.[7] We show that common time effects by educational group are important factors in the evolution of earnings by cohort. Once these common time effects are controlled for, younger cohorts with low levels of education have a similar wage-age profile as their older peers. However, younger cohorts of both female and male workers with medi-

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3 OECD (2020), Income inequality (indicator). https://doi.org/10.1787/459aa7f1-en. Last accessed on December 28, 2020.

4 An encompassing and up-to-date analysis is the book UNDP (2017). For a historical analysis going back to the mid nineteenth century see Rodríguez (2017) and Eyzaguirre (2019). For the top income dynamics from 1964-2017 see Flores et al. (2019).

5 According to the same OECD data cited above, Chile's market Gini coefficient (market incomes before taxes and transfers) in 2017 was 0.495, so the tax and benefit system reduced inequality (measured by the Gini coefficient) by only 3.5 points that year.

6 UNDP (2017) also analyses wage inequality according to employer and finds that a significant proportion of wage inequality is explained by firm attributes.

7 UNDP (2017) is the exception. In some of their analysis they use the same data from 1990 to 2015.

um levels of education seem to earn less at the same age as older cohorts once these common time effects are controlled for. This is even more marked for workers with a high level of education. The educational wage premium has declined once educational group time effects are considered. That common time effects are important and modify the interpretation of wage-age profiles and income distribution dynamics has been found for the United States by Heathcote et al. (2005) and more recently by Blundell et al. (2023). In this paper we discuss the possible impacts that common educational group time effects may have on the labour income distribution dynamics in Chile.

In addition, we decompose the changes in earnings between 1990 and 2017 using a recentered influence function (RIF) approach (Firpo et al. (2009)) to delve deeper into the potential structural factors that may have influenced the evolution of labour income inequality during this period. This is similar in spirit to Sapelli (2011, 2016) who decomposes the variance in (log) income to explain the evolution of earnings inequality in Chile. Although complementary to our approach, there are several limitations to the variance decomposition that justify exploring a different methodology (see Section 4.1 of Fortin et al. (2011)). First, only a limited set of covariates can be used since the quadratic form in the compositional effect variables will generate interaction terms that are difficult to interpret. In Sapelli (2011, 2016) only education (and the evolution of the returns to education) are analysed. In contrast, in this paper we use a large set of potential explanatory variables. Second, under the reasonable assumption of heteroskedasticity of the error term in the Mincer equation, the conditional moment for the variance of unobservables must also be specified and estimated. Finally, our approach can be used to decompose other inequality measures, such as the Gini, Theil index and interquantile ratios.

During the period of our data there was a marked increase in the educational attainment of the workforce. The percentage of workers with at least 12 years of schooling (approximately a high-school degree) increased from 41.2% in 1990 to 70.2% in 2017. Also, the percentage of workers with 17 years of schooling or more (approximately a higher education degree) increased from 6.6% to 13.5%. On the other hand, the minimum wage during this period increased 159% in real terms, more than the 113% increase in mean labour income from the main occupation of workers. Another structural change was the female participation rate that grew from 33.6% in 1990 to 52.9% in 2017. Our aim is to discern what these and other exogenous or policy changes may have had on the distribution of (hourly) labour incomes.

In spirit and methodology, our approach follows closely the analysis undertaken for Brazil by Ferreira et al. (2021). They find that between 1995 and 2012 labour income inequality declined in Brazil. Rising educational levels does not seem to explain this evolution. The composition effect of a higher skilled labour force moving workers into the more convex part of the skill-wage premium curve more than compensated for the equalizing effect of higher educational endowments. Minimum wage policies may have contributed to the decline in inequality in Brazil, but only in the second half of the period (2003-2012). In the first half, it may have increased inequality by increasing informal activities and thus increasing the wage difference between informal workers earning below the minimum wage and formal workers earning a higher minimum wage. The main explanations for the decline in labour income inequality put forward by Ferreira et al. (2021) are a reduction in the returns to potential experience and the closing of the wage gap by gender, race, location and formal work status.

We undertake a similar approach, using a simple decomposition to explore possible explanations for the changes in average earnings in Chile between 1990 and 2017. We find that while the increase in educational attainment explains part of the increase in average earnings it was countered by a fall in the returns to education with a small overall effect. Other observable characteristics, such as gender, economic sector, potential experience, rural or urban workers and several institutional variables of the labour market (formal contract, firm size and minimum wage) explain but a small proportion in the increase in average labour incomes during the period. Most of the change is explained by returns to unobservable skills.

As for earnings inequality measured by the Gini coefficient, most of the observed characteristics are estimated to have been inequality increasing or neutral, with the possible exception of minimum wage policies, worker formalization and some regional convergence. We do not find observable variables that help to explain –either through an endowment effect or through a structural price change– a significant part of the decrease in the Gini coefficient of hourly earnings.

However, we do find that certain observable variables explain the reduction in the p90/p10 and p95/p5 interquantile ratios of the wage distribution. Changes in the return to potential experience, equalizing regional earnings differences and possibly the increase in the minimum wage, reduced this indicator and more than compensated the impact of rising educational attainment. However, for the wage at the 10th and 20th quantile in the earnings distribution, the results are similar to those for the Gini coefficient.

These results, together with our initial finding that educational group time effects are important explanatory variables for income dynamics, may suggest that the unexplained fall in labour income inequality may be related to these time effects. However, we present evidence to indicate that this does not seem to be the case. Therefore, it is still an open question as to what factors explain most of the decrease in earnings inequality.

The paper is organized as follows. Section 2 presents the data used in this study. In Section 3 we present a variety of summary statistics of the evolution of labour income distributions and other socioeconomic data. We also describe life cycle average income by cohort and show that stripping out common time effects drastically changes these wage profiles compared to the raw data.

Once the main patterns of the data have been described, Section 4 presents the RIF methodology, a decomposition technique in the spirit of the Oaxaca-Blinder approach but generalized to assess the impact of changes in variables over different distributional statistics. Then Section 5 presents the results of the decompositions. Lastly, the paper concludes in Section 6 summarizing the results and discussing the policy implications.

2. Data

The data used in this paper come from the *Encuesta de Caracterización Socioeconómica Nacional* (CASEN).[8] The CASEN is a nationally and regional representative household survey, covering both urban and rural areas of Chile. The survey was fielded every two years from 1990 to 2000, every three years from 2000 to 2009, and every two years again from 2009 to 2017, which amount to a total of thirteen waves of the CASEN household socioeconomic survey for the 1990–2017 period.[9]

Before 2013 –that is, in the period 1990-2011– the income information in the survey was corrected by the Economic Commission for Latin America and the Caribbean (ECLAC) for non- response and adjustments to national account aggregates. Starting with the 2013 CASEN, this approach (also called the 'historical methodology') was no longer applied. Therefore, to have comparable data for the whole period, our database was constructed using the supplementary CASEN databases available from the MSDF for the period 1990-2011 that record income variables without the adjustments applied by ECLAC.

Our working sample comprises all workers between the ages of 18 and 65 who reported strictly positive hourly labour earnings from their main occupation during the reference year of the survey. Information on total monthly earnings from all jobs is also provided in the surveys. All labour income measures are expressed in real terms using the *Unidad de Fomento* (UF) deflator with base-year 2017. Our primary focus is on the hourly labour earnings measure (henceforth, HLE), which is constructed by dividing the main occupation labour earnings by the weekly hours worked. Further, HLEs are trimmed at the 1st and 99th percentiles by year. Altogether, the full dataset is a pseudo-panel that contains information on 883,399 workers (about 68,000 workers per CASEN wave, on average).

Our analysis includes continuous variables such as the earnings measures

8 National Socioeconomic Characterization Survey. This survey is administered by the Ministerio de Desarrollo Social y Familia (MDSF), that is, the Ministry of Social Development and Family.

9 The specific years in which each survey was conducted are 1990, 1992, 1994, 1996, 1998, 2000, 2003, 2006, 2009, 2011, 2013, 2015, and 2017.

just described, schooling, and potential experience in the labour market.[10] Schooling and potential experience are measured in years. The remaining variables are categorical. Demographic characteristics of workers are recorded by a gender dummy and a dummy that differentiates between urban and rural workers. Workers are also classified into 9 different economic sectors. A variable indicating the worker's firm size is also included.[11] We also explore the influence of labour unions by including an indicator variable if the worker is a member of a labour union or not.

We differentiate between three types of workers. First, workers are classified whether they are self-employed or employees according to their answer to a specific question regarding their labour market status. Workers are further divided into formal employees if they reported having a labour contract, if they contributed to the pension system or if they emitted bills or invoices. Those without a contract, who did not contribute to the pension system or did not emit bills or invoices are considered informal workers.[12] Finally, we have also included an indicator variable for workers whose HLE in their main occupation was below the national minimum wage in a given year.

3. Descriptive Statistics, Inequality, And Education

Table 1 presents descriptive statistics for four years of our data (1990, 2000, 2011, and 2017). Average household size of workers decreased from 4.7 in 1990 to 3.7 in 2017. Also, the population has been aging with the average age of workers rising from 36.2 years to 41.1 years in the sample period. The proportion of women in the sample increased from 32.6 % to 43.9 %. Hours worked, on the other hand, has fallen from close to 49.9 hours per week in 1990 to 43.0 hours per week in 2017.[13] The proportion of rural workers fell from 15.1 % to 10.8 % during the period. The number of years of schooling and potential experience increased during the 28-year period. The proportion of formal workers rose from 61.5 % in 1990 to 72.0 % in 2017 while informality fell from 38.5 % to 28.0 % (self-employed workers are added to informal workers). There was a significant increase in real labour incomes during the sample period as well as in the (gross) minimum wage.[14]

10 Potential experience is computed from age and schooling variables as: *exp = age-educ-6 if educ* > 9 and *exp = age-15 if educ* < 9.

11 Firms are classified into 5 groups according to the number of workers: 1, 2-9, 10-49, 50-199 or 200 and more.

12 Many self-employed workers may also be informal, and they are often grouped along with informal workers to estimate the level of informality in the labour market.

13 The legal working week was decreased from 48 to 45 hours per week in 2001.

14 Using the minimum wage net of social security contributions does not change the empirical results of this paper. But, for reasons that will become apparent below, we used the gross minimum wage in what follows.

TABLE 1

DESCRIPTIVE STATISTICS FOR 1990, 2000, 2011 AND 2017

	1990		2000		2011		2017	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Persons per Household	4.96	2.01	4.42	1.89	4.1	1.8	3.73	1.7
Age	36.2	11.7	38.3	11.3	40.1	12.3	41.1	12.6
Women (%)	32.6	46.9	37	48.3	40.3	49.1	43.9	49.6
Hours worked	49.9	15.6	47	15.7	43.3	13.4	43	13.7
Rural (%)	15.1	35.8	10.2	30.3	11	31.3	10.8	31.1
Education (years)	9.86	4.3	11	4	11.5	3.7	12.3	3.67
Potential experience (years)	19	12.3	20.4	11.9	22	13.2	22.3	13.6
Self employed (%)	0	0	21.8	41.3	8.58	28	8.79	28.3
Formal (%)	61.5	48.7	65.1	47.7	71..9	45	72	44.9
Informal (%)	38.5	48.7	13.1	33.8	19.6	39.7	19.2	39.4
Labour income (CLP$/month)	208,167	230,414	366,505	405,139	395,259	418,508	489,170	460,169
Hourly income (CLP$/hour)	1,133	1,247	1,094	2,267	2,423	2,523	2,998	2,789
Total income (CLP$/month)	221,769	264,077	402,309	500,753	436,126	478,226	546,432	573,043
Household income (CLP$/month)	602,487	697,429	979,788	1,115,177	1,107,300	1,084,351	1,320,237	1,498,773
Household per capita income (CLP$/month/person)	147,761	200,717	261,224	339,385	313,549	357,978	415,155	509,579
Minimum wage (CLP$/month)	102,018	0	170,223	0	206,943	0	264,000	0
Below hourly minimum wage (%)	34.4	47.5	30.3	45.9	22.7	41.9	19.9	39.9
N	32,325		71,011		71,113		82,385	

Note: Hourly Labour Earnings (HLEs) trimmed at the 1st and 99th percentiles by year. Labour income and hours worked refer to the main occupation while total income is the sum of all labour earnings. All monetary figures expressed in 2017 Chilean Pesos (CLP$). Sample weights used to calculate descriptive statistics.

Panel A in Figure 1 presents the evolution of monthly average and median income from the main occupation and household per capita income (from all sources of income of household members). There was a steady rise in labour incomes during the 90's but then stagnated during most of the following decade. This was probably a consequence of the international financial crisis that affected Latin America starting in 1998 and earnings only started to rise again after 2010. However, average household per capital disposable income rose continually during this period. Changing demographics, higher government monetary transfers or higher labour market participation rates for women in the household could explain the difference between average household incomes and the evolution of individual earnings.

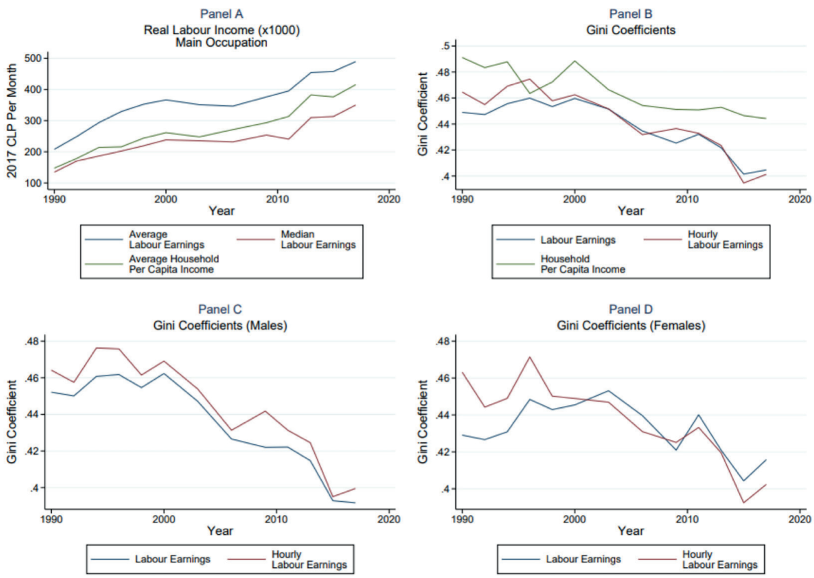
Panel B in Figure 1 presents the evolution of the Gini coefficient using total individual labour income from the main occupation, HLE from the main occupation and total household per capita income. This figure suggests an optimistic view of income inequality dynamics. All indices fell during the period indicating a steady decrease in labour income inequality.

The fall in inequality measured using HLE is significant, from 0.47 to 0.40, close to 15%. Also, after 1998, HLE and total labour earnings from the main occupation have a similar level and evolution, suggesting that in the aggregate the distribution of hours worked did not change significantly.

However, if we analyse the earnings distribution separately by gender, we find there are differences between the distribution of total labour earnings and HLE for females. It can be seen from Panel C of Figure 1 that for males, both Gini coefficients have the same level and evolution, and similar to the aggregate measures shown earlier. Nevertheless, Panel D of Figure 1 for females shows a somewhat different picture. Although the fall in the inequality of hourly earnings is comparable to that for males, the fall in inequality of total labour earnings is lower, indicating that the distribution of hours worked among women changed during the period.

FIGURE 1

LABOUR AND HOUSEHOLD REAL MONTHLY INCOMES AND GINI COEFFICIENTS



Note: All measures are calculated over the estimating sample (formal, informal, and self-employed of ages 18-65). Hourly labour earnings trimmed at the 1st and 99th percentiles by year. Labour earnings refer to monthly earnings reported in the main occupation. Hourly earnings is this last figure divide by monthly hours worked. Households per capita income includes all incomes perceived by household members

Figure 2 shows the evolution of other inequality measures. Panel A show the same tendency as noted above. All indices declined substantially after a peak in the mid 90's. Panel B and C show the same information separately for males and females, respectively.

Panels D and E show the evolution of ratios taken at other points of the income distribution. The p95/p90 and p99/p95 ratios exhibit a slight downward tendency during the period. How- ever, inequality seems to have stagnated at the bottom end of the distribution with the p10/p5 and p5/p1 ratios decreasing and then increasing towards the end of the period. Despite this last tendency, these ratios were lower in 2017 than in 1990.

FIGURE 2

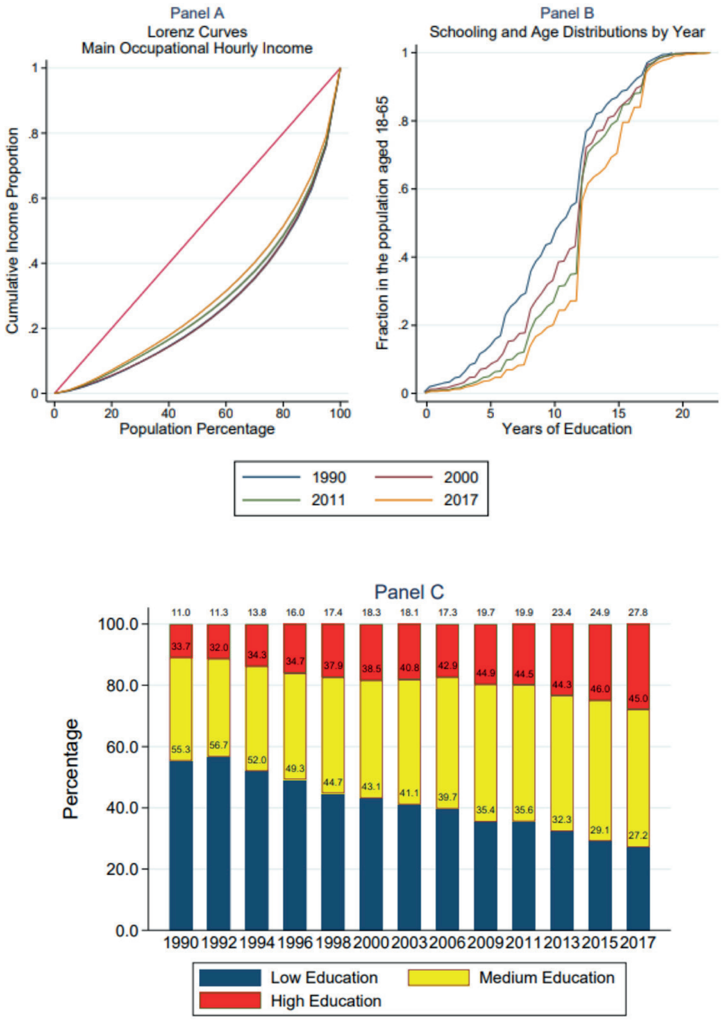
OTHER INEQUALITIES MEASURES (HOURLY EARNINGS)

Note: All measures are calculated over the estimating sample (formal, informal, and self-employed of ages 18-65). Hourly labour earnings trimmed at the 1st and 99th percentiles by year. Labour earnings refer to monthly earnings reported in the main occupation.

In sum, the earnings distribution seems to have improved in Chile over the 1990-2017 period. However, this improvement seems to be coming more from the centre of the distribution rather than the tails, as we have just discussed. Graphing the Lorenz curves for selected years (Figure 3, Panel A) shows that the curves for 1990 and 2000 are indistinguishable, however, by 2017 there is a noticeable improvement, particularly in the middle of the curve.

FIGURE 3

LORENZ CURVE (MAIN OCCUPATIONAL HOURLY INCOME), SCHOOLING AND AGE DISTRIBUTIONS BY YEAR AND EDUCATIONAL ATTAINMENT BY YEAR



Note: All measures are calculated over the estimating sample (formal, informal, and self-employed of ages 18-65). Hourly labour earnings trimmed at the 1st and 99th percentiles by year. Labour earnings refer to monthly earnings reported in the main occupation. The distributions of years of education are calculated for all the individuals over the estimating sample (formal, informal and self-employed of ages 18-65). The empirical cumulative distribution function of schooling is approximated by an adaptative kernel density estimate to produce a kernel smoothed cumulative distribution function. Low education are workers without a high school degree, medium education are workers with a high school degree and high education are workers with more than high school degree. For every year, observations with negative Hourly Labour Earnings (HLE) and the 99th and 1st percentiles of HLE are trimmed.

The results discussed so far raise several questions. First, some commentators have expressed concerns that income distribution measures in Chile may be biased due to the increasing difficulty of measuring incomes of top earners using the CASEN survey. In Appendix A we explore this hypothesis and conclude that there is no evidence that this is the case.[15]

Another interesting question is how inequality has been affected by the significant increase in the educational attainment of the labour force. Panel B of Figure 3 shows the distribution of schooling for four years of our sample. There was a significant rise in the years of education in the population. While in 1990 nearly 60% of workers had 12 years or less of schooling, by 2017 this proportion had fallen to approximately 30%.

Using the OECD classification of educational attainment, we see that the proportion of workers without a high-school degree (low education) fell from 55.4% in 1990 to 27.2% in 2017 (Figure 3, Panel C). On the other hand, the group with medium educational attainment in- creased from 33.7% to 45% while those with high educational attainment increased from 10.9% to 27.8% between 1990 and 2017.

Whether this sharp increase in the supply of skilled labour affected the educational wage premium is a hypothesis we explore empirically further below.[16] In this section we present the HLE of each educational group by birth cohort in panels A, B and C of Figure 4 for women and panels D, E and F for men.[17]

There is a clear cohort effect for low and medium education female and male workers. Hourly earnings increase with age and for younger cohorts. The age-wage profile is also steeper for younger cohorts. For high education female workers there is also a cohort effect up to the 1980-1985 cohort, but less clear for later cohorts. In the case of high education males, the age-wage profiles are quite similar across cohorts.

These age-wage profiles may be affected by common time effects. This period was characterized by rapid economic growth in earnings. Therefore, in the spirit of Blundell et al. (2023) we explore how the cohort age-wage profiles shown in Figure 4 change if we eliminate educational group specific

15 UNDP (2017) also argues that there is no evidence that under-reporting of top incomes may be generating a dynamic bias in inequality measures. Given the number of means-tested welfare benefits in Chile, there is also the issue of whether low incomes are over reported as low-income individuals are not willing to report their true (higher) earnings in a survey if they think it may affect their eligibility for future benefits. We do not explore this possibility here.

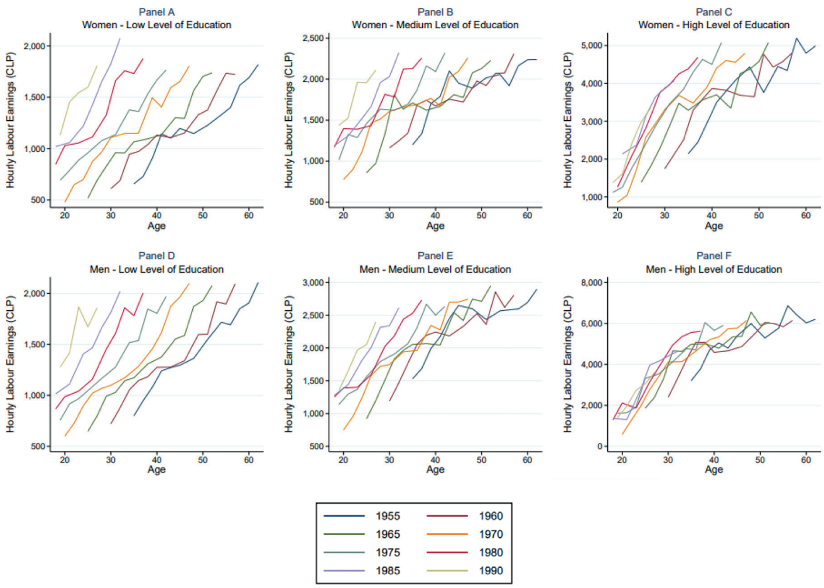
16 This was found to be the case in Brazil by Ferreira et al. (2021) where the increase in educational attainment was neutralized by a decrease in the wage premium.

17 Cohorts are defined by 5-year birth periods starting with the year of the name of the cohort. Cohort 1955, for example, includes all individuals born between 1955 and 1959.

time effects.[18] To this end, for each educational group we ran a regression of individual hourly earnings on cohort specific age effects and common yearly time dummies.[19]

FIGURE 4

AVERAGE HOURLY EARNINGS AGE PROFILES BY COHORT AND WORKERS' EDUCATIONAL LEVEL



Note: All measures are calculated over the estimating sample (formal, informal, and self-employed of ages 18-65). Hourly labour earnings trimmed at the 1st and 99th percentiles by year. Cohorts are defined by year groups starting with the year of the name of each cohort.

Figure 5 graphs the cohort specific wage-age profiles for each gender and educational group without the educational group common time effects.[20] These profiles now have the expected concave shape. Comparing with Figure 4 it can see that educational group common time effects have an important impact on these profiles. For low education workers the raw data shows younger cohorts have higher hourly earnings at the same age as older cohorts. However, this seems to be due to the favourable economic conditions faced by these workers early in their working careers. Striping out the common time effects for low educated workers shows that the earning profiles do not change much across cohorts for women. For men, younger cohorts of low education workers earn roughly the same as older cohorts at the same age. For medium and high educated workers, younger cohorts earn less at the same age than older cohorts.

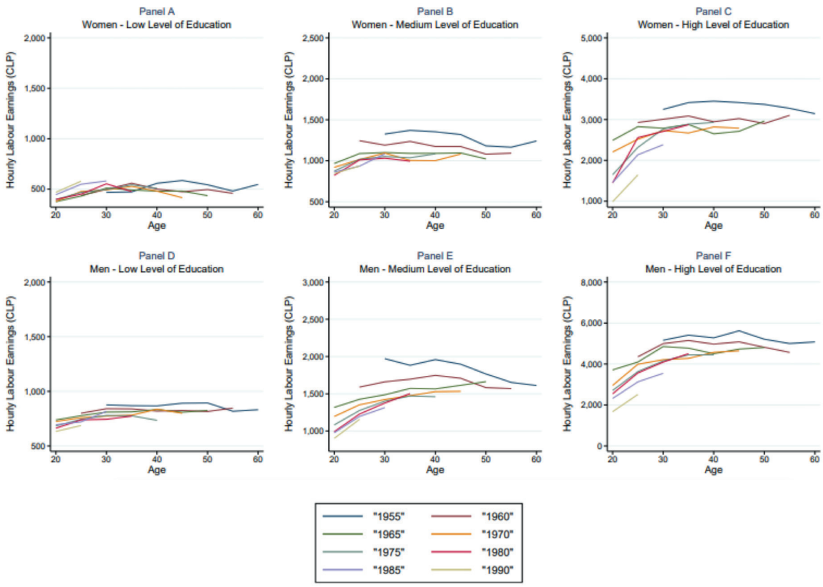
18 However, unlike Blundell et al. (2023) we do not control for sample selectivity in the observed distribution of wages.

19 Regression results are available upon request.

20 The scale in these figures is the same as their counterpart in Figure 4.

FIGURE 5

AVERAGE HOURLY EARNINGS AGE PROFILES WITHOUT EDUCATIONAL GROUP TIME EFFECTS



Note: All measures are calculated over the estimating sample (formal, informal, and self-employed of ages 18-65). Hourly labour earnings trimmed at the 1st and 99th percentiles by year. Cohorts are defined by 5 year groups starting with the year of each cohort.

The above comparison suggests that the educational wage premium has fallen through time but owing to favourable economic conditions (common time effects) younger cohorts earn more than their older peers at the same age and educational attainment.

In sum, earnings distribution has improved in Chile between 1990 and 2017. This seems to have come about through less inequality in the middle of the income distribution rather than the tails. It is also associated with an increase in workers with medium and high educational attainment. Hourly earnings for low and medium educational workers are on average higher for younger cohorts. This last effect seems to be related to common time effects within each educational group. For workers with high education, younger cohorts earn about the same as older cohorts at the same age. However, if common time effects are excluded, younger cohorts would earn less than what their older peers earned at the same age.

We now turn to the empirical analysis to ascertain to what extent the reduction in earnings inequality in Chile is related to observable characteristics, either through endowment or price effects.

4. Methodology

Standard regression models focus on measuring the marginal effect of covariates on the conditional expectation of the variable of interest. Therefore, these methods are not useful when the interest lies in the effects of covariates over other aspects of the distribution of the dependent variable, such as its quantiles or higher-order moments.

Recentered influence function (RIF) regressions offer an alternative to estimate marginal effects of covariates over more complex statistics of the distribution of the variable of inter- est. In what follows, we briefly explain the RIF regression and decomposition methods used in this paper.

4.1 RIF Regressions

Let $F_Y(y)$ be the cumulative distribution function (CDF) of a real-valued random variable Y (labour income in our case) which means that $F_Y(y) = \Pr(Y \leq y)$. Henceforth, we omit the argument y in $F_Y(y)$ for the sake of notational simplicity. Furthermore, let $v(F_Y)$ be a functional (or distributional statistic) of the labour income distribution (e.g. mean income, Gini coefficient or Theil index).[21]

Now, if we want to assess the effect on the value of the functional $v(F_Y)$ of an infinitesimal perturbation at the point y, one way to do this is to use the influence function (IF) which is defined as:[22]

(1) $$IF\left\{y, v\left(F_Y\right)\right\} = \lim_{t \to 0} \frac{v\left(\left(1-t\right)F_Y + t\delta_y - v\left(F_Y\right)\right)}{t}$$

where $0 \leq t \leq 1$ and δ_y is a distribution that puts mass only at the value y.

Nevertheless, for an attractive statistical reason stated below in equation (4), Firpo et al. (2009) propose instead the so-called 'recentered influence function' (RIF):

(2) $$RIF\left\{y, v\left(F_Y\right)\right\} = v\left(F_Y\right) + IF\left\{y, v\left(F_Y\right)\right\}$$

Following closely Rios-Avila (2020), the foremost statistical properties of the IF and RIF functions are:

---

21 Roughly speaking, functionals are functions where the inputs are themselves functions. The terms functional and distributional statistic are interchangeable throughout this work.

22 More precisely, the influence function corresponds to the one-sided Gâteaux derivative of $v(.)$ at F_Y, in the direction of δ_y. Meanwhile, the Gâteaux derivative is a generalization of the concept of directional derivative, but for functionals instead of functions.

$$\int IF\left\{y, v\left(F_Y\right)\right\} dF_Y = 0 \tag{3}$$

$$\int RIF\left\{y, v\left(F_Y\right)\right\} dF_Y = v\left(F_Y\right) \tag{4}$$

Thus, equation (3) states that the expected value of IF is 0. Consequently, equation (4) implies that the expected value of RIF is equal to the functional itself, and is the main reason why Firpo et al. (2009) propose using RIF regressions instead of IF regressions.[23]

However, when our approach is a conditional analysis of $v(F_Y)$, and we are interested in exploring the effect of a vector of covariates X on Y, we must be capable of generalizing equation (4).

More formally, let X be a random vector with CDF $F_X(x)$, then when applying the law of iterated expectations to equation (4) to incorporate the effect of covariates, we have that:

$$v\left(F_Y\right) = \int RIF\left\{y, v\left(F_Y\right)\right\} dF_Y = \int E[RIF\left\{y, v\left(F_Y\right)\right\} | X = x] dF_X \tag{5}$$

In practice, given an observation yi of the sample data ($y_1, y_2, \ldots, y_N$), the empirical and linear counterpart of the previous equation is a linear regression of the form:

$$RIF\left\{y_i, v\left(F_Y\right)\right\} = X_i^{'}\beta + \varepsilon_i \tag{6}$$

where ϵ_i is an error term with $E(\epsilon_i) = 0$.

The final step is to calculate the correct marginal effects of the model. Firpo et al. (2009) show that the unconditional partial effect on $v(F_Y)$ induced by a small translation of the distribution of X is given by:

$$\alpha\left(v\right) = \int \frac{dE[RIF\left\{y, v\left(F_Y\right)\right\} | X = x]}{dx} dF_X \tag{7}$$

where $\alpha(v)$ is the vector of partial effects of 'small location shifts' in the distribution of X, that is, the effect on $v(F_Y)$ of moving each coordinate of X separately as a location shift assuming that the conditional distribution of Y given X remains constant.

The preceding equation has significant implications as it allows for the determination of the partial effects resulting from a slight shift in the CDF of X in three steps: (1) Regress the RIF of the distributional statistic of interest, on the

[23] Note that estimating the variance of the IF is equivalent to estimating the variance of the RIF, since adding the mean to the IF is just a constant shift in values.

vector of covariates X (RIF regression); (2) compute the marginal effects; and (3) integrate over the values of X. In essence, the partial effect of a covariate on an unconditional quantile of Y can be expressed as a weighted average (over the distribution of X) of the conditional partial effects.[24]

4.2 RIF Decomposition

As RIF regressions are a generalization of the standard regression methods, RIF decompositions are a generalized framework of the standard Oaxaca-Blinder approach for decomposing changes in average earnings (Blinder (1973); Oaxaca (1973)). In fact, a RIF decomposition applied to the mean (i.e. average earnings) yields exactly the Oaxaca-Blinder decomposition. Nevertheless, RIF regressions allow extending this decomposition to any statistic of the earnings distribution v(FY), not just the mean.

Henceforward, we suppress the argument F_Y in $v(F_Y)$. Given two groups (or time periods) indexed by $t = 1, 2$; the overall change in the distributional statistic v (i.e. $\Delta v = v_2 - v_1$) for a counterfactual $v_c = v\left(F_Y^c\right) = v\left(\int F_{Y|X,t=1} dF_{X,t=2}\right)$ can be disaggregated into two components as:

(8) $$\Delta v = v_2 - v_1 = \underbrace{v_2 - v_c}_{\Delta v_S} + \underbrace{v_c - v_1}_{\Delta v_X}$$

where the first term v_S is the structural or price effect that measures how changes over $v(F_Y)$ can be explained by changes in returns or premiums, while the second term v_X is the composition or endowment effect that explains changes in $v(F_Y)$ attributable to changes in covariate composition. Notice that when the counterfactual chosen is $v_c = \overline{X_2'}\hat{\beta}_1$, (8) leads to the standard Oaxaca-Blinder decomposition when the baseline wage structure is given by $\hat{\beta}_1$.

However, the previous RIF decomposition strategy may yield an incorrectly identified counterfactual statistic v_C because the distribution of outcomes and covariates of the counterfactual scenario are not directly observed. Considering this limitation, we use a semiparametric reweighting approximation proposed by Rios-Avila (2020) to identify the counterfactual distribution based on the observed data.

After reweighting factors are estimated using a probit or logit model;[25] $v_c = \overline{X'}_c \hat{\beta}_c$ is estimated by weighted least squares and the new reweighted RIF decomposition components are given by:

[24] When the RIF regression is linear with respect to the X variables, the estimated β coefficients can be interpreted in a manner similar to traditional linear regression models. The only difference is that these coefficients must be interpreted as the marginal effect of a slight change in the mean value of X ($E[X]$) on the distributive statistic.

[25] We direct readers to Rios-Avila (2020) for a comprehensive overview of this method.

(9) $$\Delta v = \underbrace{\overline{X}_2'\left(\hat{\beta}_2 - \hat{\beta}_c\right)}_{\Delta v_S^p} + \underbrace{\left(\overline{X}_2' - \overline{X}_c'\right)\hat{\beta}_c}_{\Delta v_S^e} + \underbrace{\left(\overline{X}_c' - \overline{X}_1'\right)\hat{\beta}_1}_{\Delta v_X^p} + \underbrace{\overline{X}_c'\left(\hat{\beta}_c - \hat{\beta}_1\right)}_{\Delta v_X^e}$$

The first term is a pure price or structural effect. The second term, Δv_S^e, is a reweighting error that should go to zero in large samples and can be used as a specification test for the reweighting strategy. If large and significant, this term will be indicating that the counterfactual is not well identified. The third term is a pure endowment or compositional effect while the last term, Δv_X^e, is a specification test for the RIF model. A large and significant value for this error may be indicating that the model is not well specified, and the RIF regression is not providing a good approximation to the distributional statistic v. Furthermore, when the estimated counterfactual v_c coincides exactly with $\overline{X}'_2\hat{\beta}_c$, equation (9) collapses to equation (8) because the counterfactual was correctly specified, and the error terms vanish (i.e. $\Delta v_S^e = \Delta v_X^e = 0$). Notice that if an intercept is included, so that $X_{t,1} = 1$ for $t = 1, 2$; the price effect presents a component given by $\left(\hat{\beta}_{2,1} - \hat{\beta}_{1,1}\right)$ that reflects changes in average returns to unobservable covariates.

5. Results

We begin by following Ferreira et al. (2021) and present some simple Mincer wage equations by year. Table 2 presents the results of OLS regressions on the logarithm of hourly earnings for four different years in our sample. Specifically, we estimate the following model for each year t = 1990, 2000, 2011 and 2017:

(10) $$\ln y_{it} = \alpha + \beta_{1,S} S_{it} + \sum_{n=2}^{4}\left(\beta_{n,S}\frac{S_{it}^n}{10^n}\right) + \beta_{1,E} E_{it} + \sum_{n=2}^{4}\left(\beta_{n,E}\frac{E_{it}^n}{10^n}\right) + D_{it}^{'}\delta + \varepsilon_{it}$$

where y_{it} is hourly earnings, S_{it} is the number of years of education, E_{it} is the years of potential experience, and $D_{it}^{'}$ is a vector of dummy variables for the following categorical variables: gender, minimum wage status, formal employment, rural area, economic sector, and region.[26] For these last variables the

[26] To conserve space, the results for these last two categorical variables are not shown in the table.

omitted categories in each equation are: male, above minimum wage, self-employed (or informal), urban, construction, and Santiago Metropolitan region.

Although difficult to see directly given the fourth order polynomial in years of education, Panel A of Figure 6 graphs the simulated returns to education from the parameters estimated in the equations of Table 2. Interestingly, the educational wage premium did not change much between 1990 and 2011, however the following decade shows an important decrease in this premium.

The opposite occurred with the experience premium as can be seen from Panel B of Figure 6. Although it also decreased during the sample period, this occurred mostly between 1990 and 2011. Other results from Table 2 indicate that the gender wage gap has remained relatively constant over time near 10%. The earnings penalty from having an hourly earnings rate below the minimum wage has decreased by around 12 percentage points.[27] Figure 7 shows the distribution of wages and the minimum wage for this period. It suggests that this minimum may have become more binding through time, reducing the dispersion in the lower end of the distribution, and generating a peak close to this limit.

The formal employment premium was reduced and became negative by 2017. We do not have an explanation for this except that perhaps self-employed workers who do not have to pay social security contributions (pensions and health) may have a net income higher than formal sector workers. The urban rural wage gap also seems to have fallen from 4.8% in 1990 to 2.9% in 2017.

Finally, the last row of Table 2 presents the root MSE of each regression. This statistic decreases through time, indicating that wage dispersion has decreased even after controlling for explanatory variables.

[27] Unlike Dube (2019) for the US, we cannot include the minimum wage directly in the specification since there is no cross-section variation in the value of this variable given that it is applied simultaneously across the whole country.

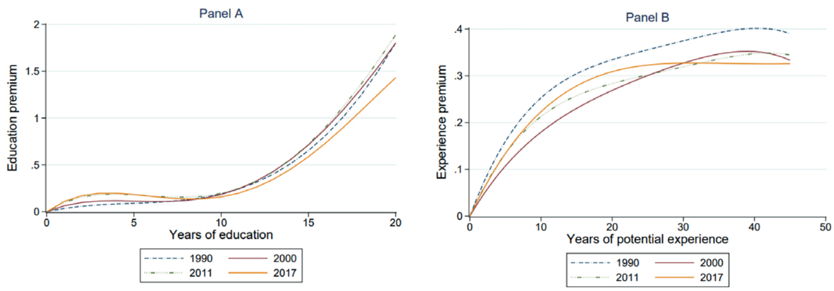
TABLE 2
MINCER EQUATIONS LOG-HOURLY EARNINGS (1990-2017)

	(1)	**(2)**	**(3)**	**(4)**
	1990	2000	2011	2017
Education	0.042***	0.080***	0.124***	0.138***
	(0.012)	(0.013)	(0.017)	(0.012)
Education^2/100	-0.733**	-1.814***	-2.658***	-3.049***
	(0.295)	(0.296)	(0.357)	(0.215)
Education^3/1000	0.521**	1.464***	1.972***	2.301***
	(0.255)	(0.247)	(0.277)	(0.154)
Education^4/10000	-0.017	-0.266***	-0.359**	-0.471***
	(0.071)	(0.067)	(0.071)	(0.037)
Potential Experience	0.041***	0.026***	0.034***	0.032***
	(0.005)	(0.005)	(0.005)	(0.003)
Potential Experience^2/100	-0.198***	-0.104***	-0.162***	-0.115***
	(0.045)	(0.040)	(0.041)	(0.028)
Potential Experience^3/1000	0.048***	0.026**	0.038***	0.017**
	(0.014)	(0.012)	(0.013)	(0.008)
Potential Experience^4/10000	-0.004***	-0.003**	-0.003**	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Female	-0.098***	-0.087***	-0.104***	-0.097***
	(0.009)	(0.009)	(0.009)	(0.006)
Below Hourly Minimum Wage	-0.938***	-0.891***	-0.819***	-0.819***
	(0.007)	(0.006)	(0.009)	(0.005)
Formal Employee	0.021***	0.017**	-0.053***	-0.038***
	(0.008)	(0.008)	(0.010)	(0.006)
Rural	-0.046***	-0.023***	-0.026***	-0.020***
	(0.010)	(0.007)	(0.008)	(0.007)
Constant	6.441***	6.983***	7.067***	7.330***
	(0.031)	(0.031)	(0.033)	(0.027)
N	32,203	70,803	71,071	81,539
Adjusted R^2	0.622	0.646	0.592	0.555
Root MSE	0.496	0.468	0.465	0.455

Note: All measures are calculated over the estimating sample (formal, informal, and self-employed of ages 18-65). Hourly labour earnings trimmed at the 1st and 99th percentiles by year. For the categorical variables in each equation the omitted categories are: male, above minimum wage, self-employed (or informal), urban, construction, and Santiago M.A. region. Survey frequency weights used in estimation. * *p<0.10*, ** *p<0.05*, *** *p<0.01*.

FIGURE 6

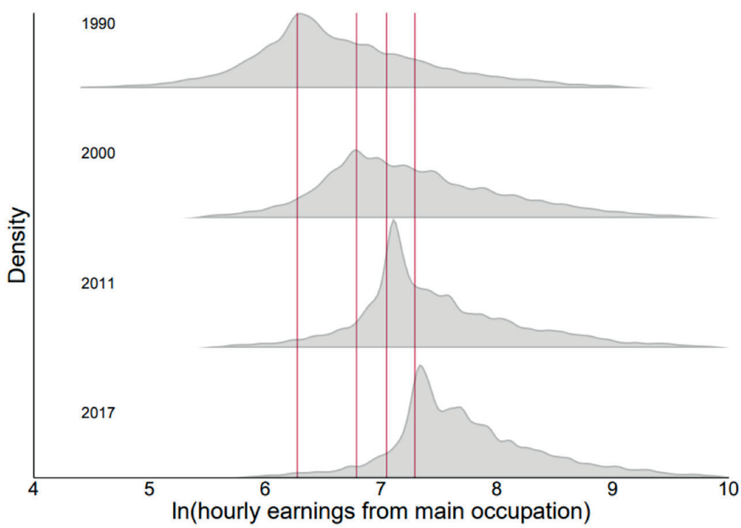
EDUCATION AND EXPERIENCE WAGE PREMIUMS BY YEAR



Note: Simulations based on the results of Table 2.

FIGURE 7

HOURLY WAGE DENSITY AND MINIMUM WAGE BY YEAR



Note: Vertical lines correspond to the logarithm of gross minimum hourly wage for the years 1990, 2000, 2011 and 2017. Gaussian kernel densities estimated. Hourly labour earnings from main occupation trimmed at the 1st and 99th percentiles by year. Survey frequency weights used.

We next present decomposition results for log HLE. The specification of the Mincer equations serves as a guide to the potential explanatory variables to use in the RIF decompositions. In what follows then, we use these same variables to determine possible factors driving the changes in the various inequality statistics.

Correct standard error estimation requires bootstrapping.[28] Since the CASEN surveys have a stratified and clustered sampling design, knowledge of this sampling structure was required to implement the bootstrapping method. However, for the 1990 CASEN survey the publicly available database does not include a strata variable nor a cluster variable. Therefore, in what follows, we estimate the decomposition using data from 1992 to 2017.

Table 3 presents the results of a classical Oaxaca-Blinder decomposition of the average log-hourly earnings. The first column presents the results for the whole period (1992-2017) while the three other columns present the results for sub-periods (1992-2000, 2000-2011 and 2011-2017, respectively).[29]

The decomposition for the whole period shows that log HLE increased by close to 0.91 between 1992 and 2017 (or 148% increase in real hourly earnings). Close to 41% of this difference was due to a composition effect (explained) while the other 59% points was due to changes in premiums (unexplained). This same pattern appears in the sub-periods with the exception of the 2000-2011 period where the compositional effect was larger than the change in premiums. Note that the specification error is small or statistically insignificant, while the reweighting error is significant but much smaller than the unexplained effect.

As for the compositional effect, years of education account for an important positive impact on earnings between 1992 and 2017. Rising years of education with the returns to education of the counterfactual scenario would have increased mean log hourly earnings by 0.21 log points. However, returns to education fell between 2011 and 2017 (pure unexplained), reducing the impact of rising educational attainment on wages during this last period. Thus, increasing years of education in the population did have an impact on average log earnings but due to the fall in the educational premium the net effect was reduced almost by half.

Compositional effects of potential experience also had a positive effect on mean earnings. However, this effect is much smaller than changes in educational levels and seems to be present mostly in the 1992-2000 period, when there were still high returns to potential experience. The fall in the returns to experience was much larger than the compositional effect, implying that the net effect of experience on average earnings was negative.

The increase in the female labour participation would have decreased mean log earning a bit. The gender wage gap during the period does not seem to have changed much as already noted above with the Mincer equation results.

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28 Estimations were undertaken using the oaxaca_rif module in Stata. See Rios-Avila (2020). The Probit reweighing option was used for the counterfactual. Categorical variables (economic sector and regional variables) were normalized as in Yun (2005).

29 It should be noted that these results are robust to changes in the excluded category.

As less workers earned an hourly wage below the minimum wage during the period, the compositional impact on hourly wages is positive. In addition, average earnings conditional on being below the minimum wage also rose during the period. This suggests a potential effect of minimum wages on hourly incomes for this group of workers.

There was a slight decrease in wages due to compositional changes in formality (workers with a formal contract). However, there was an increase in the formality wage premium during the whole period that more than compensated for the compositional effect.

The rural-urban earnings gap did not contribute much to the change in mean log earnings during the period, while there was a very small but positive compositional effect. The regional and economic sector did contribute something to the increase in log hourly wages through the compositional effect, although in the case of region it was more than compensated by the pricing effect.

By far the largest impact on mean log HLE is the change in the non-observable skills premium (the constant in the unexplained results).

In summary then, the decomposition of mean HLE during the 1992-2017 period is explained by a compositional effect due to an increase in years of education, an increase in years of experience, and a fall of workers earning below the minimum wage, together with a net effect due to changes in structural returns, being the returns to unobserved skills by far the most important, while the observed structural changes had a negative effect on earnings (mainly a fall in the returns to education and potential experience).

TABLE 3

RIF DECOMPOSITION – MEAN OF LOG HOURLY EARNINGS (1992-2017)

	(1) 1990-2017	**(2) 1992-2000**	**(3) 100-2011**	**(4) 2011-2017**
Overall				
Post	7.747***	7.295***	7.489***	7.747***
	(0.003)	(0.003)	(0.003)	(0.003)
Counterfactual	7.204***	6.941***	7.420***	7.610***
	(0.004)	(0.004)	(0.004)	(0.003)
Pre	6.838***	6.838***	7.295***	7.489***
	(0.004)	(0.004)	(0.003)	(0.003)
Difference	0.910***	0.457***	0.193***	0.259***
	(0.005)	(0.005)	(0.004)	(0.004)
Explained	0.366***	0.103***	0.125***	0.121***
	(0.006)	(0.006)	(0.005)	(0.004)
Unexplained	0.544***	0.354***	0.068***	0.138***
	(0.005)	(0.005)	(0.005)	(0.004)
Explained				
Total	0.366***	0.103***	0.125***	0.121***
	(0.006)	(0.006)	(0.005)	(0.004)
Pure Explained	0.351***	0.105***	0.123***	0.121***
	(0.005)	(0.004)	(0.004)	(0.003)
Specification Error	0.015***	-0.002	0.002	0.001
	(0.004)	(0.004)	(0.003)	(0.003)
Pure Explained				
Education	0.211***	0.086***	0.036***	0.089***
	(0.003)	(0.002)	(0.002)	(0.002)
Experience	0.026***	0.016***	0.004***	0.001**
	(0.001)	(0.001)	(0.001)	(0.001)
Region	0.002***	0.002***	0.002***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Sector	0.013***	0.008***	0.005***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Size	0.019***	0.013***	0.011***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Female	-0.008***	-0.003***	-0.004***	-0.005***
	(0.001)	(0.000)	(0.000)	(0.000)
Below Hourly Minimum Wage	0.090***	-0.017***	0.072***	0.038***

	(0.003)	(0.003)	(0.002)	(0.002)
Formal Employee	-0.004***	-0.001***	-0.003***	-0.006***
	(0.000)	(0.000)	(0.000)	(0.000)
Rural	0.002***	0.001***	0.000	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Unexplained				
Total	0.544***	0.354***	0.068***	0.138***
	(0.005)	(0.005)	(0.005)	(0.004)
Reweighting Error	-0.057***	-0.009**	-0.009**	-0.039***
	(0.004)	(0.004)	(0.004)	(0.003)
Pure Unexplained	0.601***	0.364***	0.078***	0.177***
	(0.003)	(0.003)	(0.003)	(0.003)
Pure Unexplained				
Education	-0.102***	0.002	-0.009	-0.108***
	(0.034)	(0.024)	(0.029)	(0.028)
Experience	-0.188***	-0.100***	-0.036***	-0.023*
	(0.016)	(0.017)	(0.014)	(0.013)
Region	-0.040***	0.002	-0.026***	-0.003
	(0.005)	(0.004)	(0.004)	(0.004)
Sector	0.041***	0.025***	-0.003	0.025***
	(0.005)	(0.004)	(0.004)	(0.004)
Size	-0.004***	0.000	-0.014***	-0.003***
	(0.001)	(0.001)	(0.002)	(0.001)
Female	-0.002	0.003	-0.004	0.006**
	(0.003)	(0.003)	(0.003)	(0.003)
Below Hourly Minimum Wage	0.036***	0.020***	0.013***	0.002*
	(0.002)	(0.002)	(0.002)	(0.001)
Formal Employee	0.029***	0.019***	-0.036***	0.012**
	(0.007)	(0.005)	(0.006)	(0.006)
Rural	0.000	0.001	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.830***	0.391***	0.194***	0.268***
	(0.039)	(0.031)	(0.034)	(0.032)
Post *N*	71,431	67,213	61,188	71,431
Counterfactual *N*	43,374	43,374	67,213	61,188
Pre *N*	43,374	43,374	67,213	61,188

Note: Education and experience are the sum of the coefficients from fourth order polynomials in years. Regional and economic sector categorical variables are normalized in the estimation and coefficients results are summed. A logit reweighting model is used to define the counterfactual. * *p<0.10*, ** *p<0.05*, *** *p<0.01*.

We next turn to the RIF decomposition of the Gini coefficient of hourly earnings. The results are shown in Table 4.[30] The specification error is significant in all the columns, but small in the three sub-periods. The reweighting error is small in all models indicating a good reweighting strategy defining the counterfactual for the decomposition.

The first thing to note is that there was a fall in the Gini coefficient of HLE during the whole period from 0.456 to 0.405, explained by decrease from 2000 to 2017 (it increased from 1992 to 2000). The second thing to note is that the effect of compositional changes would have increased inequality during the whole period, driven mainly by the years of education but countered to some extent by the fall in workers earning below the minimum wage.

Overall, earnings inequality only fell because there was a large effect from structural changes (price or premium changes) that more than compensated for the compositional effects.

Rising educational attainments would have significantly increased earnings inequality given the counterfactual returns to education. This is not wholly unexpected as more workers may shift to the convex part of the educational wage premium curve, increasing earnings inequality. This is what Ferreira et al. (2021) call the "The Paradox of Progress" (Bourguignon et al. (2005)). However, what is striking is that the change in the educational earnings premium would also have increased inequality. This implies that the fall in the educational premium was not equality enhancing.

Something similar can be said regarding potential experience. Both the compositional and the structural effects imply a more unequal earnings distribution although its magnitude is smaller than in the case of education.

[30] In addition, we further explore the effects of labour unionization in Appendix B, Table 8. The worker's labour union variable can only be constructed in the 1994 and 2017 CASEN waves. Our estimates suggest that unionization of workers does not have a significant effect on reducing labour income inequality. We also estimated the RIF models including the interaction of the economic sector dummies with the copper price for the respective year. The results were unchanged to those presented here.

TABLE 4

RIF DECOMPOSITION – GINI COEFFICIENT OF HOURLY EARNINGS (1992-2017)

	(1) **1990-2017**	**(2)** **1992-2000**	**(3)** **100-2011**	**(4)** **2011-2017**
Overall				
Post	0.405***	0.464***	0.438***	0.405***
	(0.001)	(0.001)	(0.001)	(0.001)
Counterfactual	0.483***	0.494***	0.449***	0.450***
	(0.001)	(0.002)	(0.001)	(0.001)
Pre	0.456***	0.456***	0.464***	0.438***
	(0.002)	(0.002)	(0.001)	(0.001)
Difference	-0.050***	0.009***	-0.026***	-0.033***
	(0.002)	(0.002)	(0.002)	(0.002)
Explained	0.027***	0.038***	-0.015***	0.012***
	(0.002)	(0.002)	(0.002)	(0.002)
Unexplained	-0.077***	-0.030***	-0.011***	-0.045***
	(0.002)	(0.002)	(0.002)	(0.002)
Explained				
Total	0.027***	0.038***	-0.015***	0.012***
	(0.002)	(0.002)	(0.002)	(0.002)
Pure Explained	0.086***	0.050***	-0.013***	0.019***
	(0.002)	(0.002)	(0.001)	(0.001)
Specification Error	-0.059***	-0.012***	-0.002	-0.008***
	(0.003)	(0.002)	(0.002)	(0.002)
Pure Explained				
Education	0.095***	0.036***	0.009***	0.034***
	(0.002)	(0.001)	(0.001)	(0.001)
Experience	0.009***	0.005***	0.001***	0.000
	(0.001)	(0.000)	(0.000)	(0.000)
Region	0.001***	0.001***	0.000***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Sector	0.005***	0.002***	0.003***	-0.001***
	(0.001)	(0.001)	(0.000)	(0.000)
Size	0.005***	0.004***	-0.004***	-0.000
	(0.001)	(0.000)	(0.001)	(0.000)
Female	-0.002***	-0.001***	-0.002***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Below Hourly Minimum Wage	-0.023***	0.004***	-0.017***	-0.009***

	(0.001)	(0.001)	(0.001)	(0.000)
Formal Employee	-0.004***	-0.001***	-0.004***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
Rural	-0.000	-0.000	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
Unexplained				
Total	-0.077***	-0.030***	-0.011***	-0.045***
	(0.002)	(0.002)	(0.002)	(0.002)
Reweighting Error	0.004***	0.000	0.003***	0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Pure Unexplained	-0.082***	-0.030***	-0.014***	-0.049***
	(0.002)	(0.002)	(0.002)	(0.002)
Pure Unexplained				
Education	0.119***	0.026*	0.020	0.048***
	(0.017)	(0.014)	(0.018)	(0.017)
Experience	0.066***	-0.002	0.034***	0.011
	(0.008)	(0.010)	(0.009)	(0.008)
Region	-0.016***	-0.009***	-0.000	-0.009***
	(0.002)	(0.003)	(0.003)	(0.002)
Sector	-0.002	0.004	-0.010***	0.007***
	(0.002)	(0.003)	(0.002)	(0.002)
Size	0.002***	0.000	0.002	-0.000
	(0.000)	(0.000)	(0.001)	(0.000)
Female	0.0002	-0.003*	0.003	0.003
	(0.002)	(0.002)	(0.002)	(0.002)
Below Hourly Minimum Wage	-0.016***	-0,007***	-0.012***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)
Formal Employee	-0,024***	-0.004	-0.016***	-0.027***
	(0.003)	(0.003)	(0.004)	(0.004)
Rural	0.001	-0.000	0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.214***	-0.034*	-0.034	-0-076***
	(0.020)	(0.019)	(0.021)	(0.020)
Post *N*	71,431	67,213	61,188	71,431
Counterfactual *N*	43,374	43,374	67,213	61,188
Pre *N*	43,374	43,374	67,213	61,188

Note: Education and experience are the sum of the coefficients from fourth order polynomials in years. Regional and economic sector categorical variables are normalized in the estimation and coefficients results are summed. A logit reweighting model is used to define the counterfactual. * *p<0.10*, ** *p<0.05*, *** *p<0.01*.

As already noted, rising minimum wages seems to have compressed the bottom of the earnings distribution. This may explain the fall in the number of workers earning below the minimum wage and decreasing inequality. In addition, the reduction in the wage penalty for these workers adds to this last effect, leading to an overall decrease in the Gini coefficient.

The rise in formal employment also reduced the Gini coefficient but only by a small amount. However, there was a significant effect from the change in the formality wage premium, which became negative at the end of our sample period.

By far the most important impact on the Gini coefficient was the negative and large effect of non-observable skills premium. Therefore, apart from the minimum wage and formality, the other observable variables that we are controlling for in the decomposition do not explain the fall in HLE inequality in Chile.

Table 5 presents the decomposition results for other distributional statistics of the earnings distribution for the 1992-2017 period. The first column presents the results for the interquantile ratio p90/p10, while the second column those for the interquantile ratio p95/p5. The last two columns present results for quintile p20 and p10, respectively.

In the case of the interquantile ratios, they both fell during the period. The p90/p10 ratio fell from 7.02 to 5.45, a drop of 22.4% while the p95/p5 ratio fell from 12.71 to 10.17 a drop of 20%. However, the composition effect was positive in both cases, indicating that that changes in the composition of workers would have increased these ratios, and they only fell due to structural (price) changes. These are mainly associated with changes in the experience premium, the fall in the wage penalty of earning below the minimum wage and some regional convergence in earnings during the period.

Notably the fall in the p90/p10 ratio is more strongly related to the minimum wage effect than in the other results, although changes in unobservable skills was also important. The same patterns hold for the p95/p5 ratio.

TABLE 5
RIF DECOMPOSITION – OTHER DISTRIBUTIONAL STATISTICS
OF HOURLY EARNINGS (1992-2017)

	(1)	(2)	(3)	(4)
	p90/p10	p95/p5	p20	p10
Overall				
Post	5.453***	10.171***	1467.396***	1127.574***
	(0.045)	(0.119)	(2.770)	(4.985)
Counterfactual	9.878***	19.267***	627.839***	472.747***
	(0.081)	(0.179)	(3.131)	(2.818)
Pre	7.018***	12.712***	520.106***	392.625***
	(0.071)	(0.200)	(2.239)	(2.181)
Difference	-1.565***	-2.541***	947.290***	734.950***
	(0.084)	(0.233)	(3.561)	(5.441)
Explained	2.860***	6.555***	107.733***	80.122***
	(0.108)	(0.268)	(3.849)	(3.564)
Unexplained	-4.425***	-9.096***	839.557***	654.828***
	(0.093)	(0.215)	(4.180)	(5.726)
Explained				
Total	2.860***	6.555***	107.733***	80.122***
	(0.108)	(0.268)	(3.849)	(3.564)
Pure Explained	4.047***	10.072***	84.403***	55.920***
	(0.087)	(0.243)	(2.784)	(2.566)
Specification Error	-1.186***	-3.517***	23.329***	24.202***
	(0.122)	(0.335)	(2.634)	(3.468)
Pure Explained				
Education	3.962***	9.512***	2.765**	4.399***
	(0.075)	(0.207)	(1.165)	(1.578)
Experience	0.442***	0.973***	-0.524	0.173
	(0.030)	(0.083)	(0.569)	(0.770)
Region	0.013	0.050*	0.223	1.244***
	(0.009)	(0.027)	(0.202)	(0.311)
Sector	0.183***	0.622***	-1.655***	-0.851
	(0.031)	(0.086)	(0.599)	(0.808)
Size	0.367***	0.679***	-1.262**	-2.489***
	(0.026)	(0.075)	(0.553)	(0.748)
Female	-0.040***	-0.210***	-1.328***	-3.510***
	(0.015)	(0.043)	(0.311)	(0.434)
Below Hourly Minimum Wage	-0.711***	-1.069***	83.733***	51.596***

	(0.025)	(0.056)	(2.295)	(1.474)
Formal Employee	-0.165***	-0.422***	2.238***	4.015***
	(0.013)	(0.036)	(0.227)	(0.348)
Rural	-0.005	-0.062*	0.213	1.344***
	(0.012)	(0.034)	(0.245)	(0.337)
Unexplained				
Total	-4.425***	-9.096***	839.557***	654.828***
	(0.093)	(0.215)	(4.180)	(5.726)
Reweighting Error	0.148***	0.326***	-44.149***	-27.687***
	(0.057)	(0.098)	(3.908)	(2.700)
Pure Unexplained	-4.573***	-9.422***	883.706***	682.514***
	(0.083)	(0.203)	(0.896)	(4.480)
Pure Unexplained				
Education	2.106**	7.481***	-23.699***	-31.154
	(0.852)	(2.119)	(8.864)	(44.510)
Experience	-1.318***	-2.782***	-35.457***	62.789***
	(0.405)	(1.006)	(4.254)	(20.749)
Region	-0.730***	-1.543***	-1.665	-3.682
	(0.122)	(0.303)	(1.279)	(6.268)
Sector	0.347***	0.970***	1.762	8.169
	(0.115)	(0.287)	(1.177)	(6.219)
Size	-0.055***	0.050	-0.373**	-0.759
	(0.018)	(0.043)	(0.187)	(0.884)
Female	0.308***	-0.068	-0.240	-19.005***
	(0.081)	(0.201)	(0.848)	(4.167)
Below Hourly Minimum Wage	-2.632***	-3.659***	-42.011***	-197.932***
	(0.050)	(0.117)	(0.580)	(2.724)
Formal Employee	-0.402**	-0.715*	8.067***	206.044***
	(0.170)	(0.424)	(1.771)	(8.959)
Rural	-0.008	-0.273***	-0.887**	-0.885
	(0.034)	(0.084)	(0.364)	(1.666)
Constant	-2.191**	-8.883***	978.207***	658.930***
	(0.996)	(2.477)	(10.385)	(51.779)
Post *N*	71,431	71,431	71,431	71,431
Counterfactual *N*	43,374	43,374	43,374	43,374
Pre *N*	43,374	43,374	43,374	43,374

Note: Education and experience are the sum of the coefficients from fourth order polynomials in years. Regional and economic sector categorical variables are normalized in the estimation and coefficients results are summed. A logit reweighting model is used to define the counterfactual. * *p<0.10*, ** *p<0.05*, *** *p<0.01*.

As for the earning of the first quintile and decile, these both increased significantly during the period. However, in both cases endowment changes explain only a small fraction of this increase. Rather almost all of the increase can be attributed to structural changes of which the returns to non-observable skills is by far the most important, together with formalization of workers in the case of the 20th quintile.

Given the educational group common time effects discussed in Section 3, a question arises as to what extent these time effects may explain the results found in this section related to increases in unobservable skill premiums. To this end, separate mincer equations were estimated for each educational group including a common time effect. Then, the wage rate for each observation was stripped of its corresponding educational group year effect. With these last observations, the Gini coefficients were recalculated and compared to those of the original data. The results are presented in Figure 8.

FIGURE 8

GINI COEFFICIENTS OF HOURLY WAGES WITH AND WITHOUT EDUCATIONAL GROUP COMMON TIME EFFECTS

Note: All measures are calculated over the estimating sample (formal, informal, and self-employed of ages 18-65). Hourly labour earnings trimmed at the 1st and 99th percentiles by year. Labour earnings refer to monthly earnings reported in the main occupation. Hourly earnings is the last figure divide by monthly hours worked.

It can be seen from this last figure that the Gini coefficient without the common educational group time effects has a similar evolution compared to those form the raw data. If at all, inequality would have been lower without the common time effects during the last period of the data. Therefore, the unexplained fall in the Gini coefficient of labour income inequality in Chile does not seem to be related to these time effects, although more research is warranted on this issue.

6. Conclusions

In this paper we have described the changes in workers' hourly earnings distribution for Chile from 1990 to 2017. Consistent with other Latin American experiences, there was a significant fall in earnings inequality after the year 2000. The Gini coefficient on hourly labour earnings decreased by around 15% between 1990 and 2017. This period is also characterized by a significant increase in educational attainments and average earnings. While the increase in educational attainment explains part of the increase in average earnings, we find this was countered by a fall in the returns to education with a small overall effect.

A decomposition of the changes in earnings inequality reveals that most of the fall in in- equality cannot be attributed to changes in observed endowments of workers (compositional changes) or changes in the returns to observable skills (structural changes). The significant increase in educational attainment and the fall in the educational earnings premium, would both have increased earnings inequality. Something similar occurs for experience. Overall, these variables do not explain the fall in earnings inequality. Neither does the observed increase in female labour participation or the decrease in the gender wage gap.

There does seem to be an effect related to the minimum wage, formalization, and some regional convergence in reducing earnings inequality. However, most of the fall (as well as the increase in average earnings) is explained by unobservable effects. This may due to changes in policy or premiums in skills that we are not controlling for. Common educational group time effects do not seem to explain this fall either.

One possible hypothesis for our results are changes in the quality of education. There is some evidence that standardized test scores have narrowed between children of families in the upper- and lower-income quintiles (Wales et al. (2014)). Thus, it may well be that wages among workers of the same educational level change among cohorts. This is also suggested by Figure 4. Low education workers' wages have increased for younger cohorts while they have remained the same for high educational workers. However, due to space limitations we leave this issue for future research.

Another possibility is that a rise in public employment or in the public sector wage premium occurred during this period and this may help explain the fall in inequality.[31] It is common in Latin America for the public sector to pay higher salaries to less educated persons than those paid by the private sector, and lower salaries for qualified professionals. This generates two very different wage distributions (private versus public) with the overall distribution being the sum of both.[32]

We tested this idea by first identifying public sector workers in our data (either in the central or local governments). This was only available from 2000 to 2017. During this last period, we see a monotonic fall in the share of public sector workers, from 8.6% in 2000 to a minimum of 5,9% in 2009, rising monotonically reaching 8.7% in 2017. Therefore, public sector employment had a U-shaped dynamic with no increase in the share of public employment between 2000 and 2017. To test whether a wage premium effect might be present, we estimated the RIF regressions for the mean of log incomes using a public sector dummy variable and although both the compositional effect and the wage premium effect were statistically significant, the coefficient estimates were very small and did not change our overall conclusions.

Although the idea that public sector employment generates two different distributions does not seem to be consistent with the data, the general idea of a mixture of distributions of subpopulations is intriguing. Chumacero and Paredes (2005) find that the heterogeneity in the population in Chile can be characterized by, at least, two populations, with different returns to schooling and different volatilities. This could be explained by differences in the quality of education for each group. Depending on how changes in the composition of the population evolved, this could also account for the decrease in inequality. For example, if more of the population transitioned towards the first distribution, one would expect decreases in inequality because of the reduced variance of the unobservable component of that distribution.

In sum, it is still an open question as to what caused the unexplained fall of labour earnings inequality in Chile. More research is required to ascertain what these unobservable effects are. For example, they could be related to improvements in the quality of elementary and secondary education or technological change that favoured the unobservable skills of younger less educated workers, or changes in the composition of sub-populations characterized by different

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31 We thank Claudio Sapelli for suggesting this explanation. He commented that his research for Uruguay seems to point in this direction, with a bi-modal distribution owing to the public sector wage structure.

32 For the modelling of the bi-modal income distribution in Chile using a mixed distribution see Chumacero and Paredes (2005).

distributions of unobservables. Another possibility is that the local approximation of the RIF decomposition approach is not flexible enough to capture the long-term dynamics of labour earnings inequality in Chile.

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Appendix

A. Top household incomes

In this Appendix, we explore whether the CASEN survey data may contain a bias due to an increasing difficulty in measuring top incomes. The point we want to explore here is a dynamic one. It is probable that the richest 1% of households are underrepresented in the CASEN survey or, when surveyed, they do not reveal their true income. This would bias the level of any income inequality measure but not its evolution –which is our interest in this paper– unless this under-reporting has increased through time.

Table 6 presents the number of observations in each year of the survey of households earning more than 5 million CLP per month. This number represents roughly 1,5% of the highest household income level in 2017.

TABLE 6

PERCENTAGE OF HOUSEHOLDS REPORTING OVER 5 MILLION CLP

	(1)	(2)	(3)	(4)
	%	%	%	%
1990	0.30	0.35	0.00	0.00
1992	0.59	0.75	0.00	0.00
1994	0.47	0.78	0.00	0.00
1996	0.46	0.98	0.00	0.00
1998	0.54	0.87	0.00	0.00
2000	0.46	1.51	0.18	0.52
2003	0.64	1.30	0.13	0.30
2006	0.59	1.17	0.08	0.18
2009	0.43	1.50	0.15	0.50
2011	0.91	1.55	0.32	0.56
2012	1.18	2.02	0.55	1.02
2015	1.52	1.88	0.72	0.88
2017	1.72	2.00	0.92	1.00
Trimming	No	No	Yes	Yes
Exp. Factors	No	Yes	No	Yes

Note: The percentages in the third and fourth columns are calculated trimming household income at the 1st and 99th percentiles each year.

The first two columns of the table present the percentage of households earning more than 5 million CLP before trimming the 1st and 99th percentiles of each years' data. The first column presents the raw percentages while the second uses the survey expansion factors. There is no evidence that the number of high-income households in the survey has decreased during the period. Naturally, as incomes have risen the number of high-income households has increased in tandem. The third and fourth columns of the table show the same information but after trimming the data each year. Again, there is no evidence that the top earning households have diminished in the sample.

The data of Table 6 may not be very informative as incomes have risen through time. However, Table 7 shows the average income of households earning more than 5 million CLP per month. There is no discernible pattern that points to a potential under-reporting of incomes for this group. Average monthly incomes have remained fairly constant throughout this period for this group of households.

TABLE 7

PERCENTAGE OF HOUSEHOLDS REPORTING OVER 5 MILLION CLP

	(1) CLP	**(2) CLP**	**(3) CLP**	**(4) CLP**
1990	7,704,447	7,468,650		
1992	7,628,787	7,571,488		
1994	10,196,431	9,796,880		
1996	7,380,248	7,285,126		
1998	8,968,972	8,356,178		
2000	8,374,909	7,753,978	5,487,549	5,540,792
2003	9,385,429	8,792,003	5,267,166	5,266,357
2006	8,114,511	7,548,902	5,153,000	5,183,402
2009	7,188,909	7,575,726	5,418,999	5,345,266
2011	7,439,235	7,217,802	5,441,190	5,379,669
2012	7,846,929	7,679,414	5,652,764	5,700,459
2015	7,740,785	7,735,459	5,669,175	5,689,454
2017	8,237,981	8,454,179	5,781,648	5,816,401
Trimming	No	No	Yes	Yes
Exp. Factors	No	Yes	No	Yes

Note: The percentages in the third and fourth columns are calculated trimming household income at the 1st and 99th percentiles each year.

B. Additional specifications

TABLE 8

RIF DECOMPOSITION – LABOUR UNION EFFECTS (1994-2017)

	Mean log-Hourly Earnings			Gini Coefficient of Hourly Earnings		
	(1)	(2)	(3)	(4)	(5)	(6)
	1992-2017	1994-2017	1994-2017	1992-2017	1994-2017	1994-2017
Overall						
Post	7.747***	7.747***	7.747***	0.406***	0.406***	0.406***
	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.001)
Counterfactual	7.204***	7.346***	7.354***	0.472***	0.486***	0.487***
	(0.004)	(0.004)	(0.004)	(0.001)	(0.001)	(0.001)
Pre	6.838***	7.023***	7.023***	0.449***	0.464***	0.464***
	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)
Difference	0.910***	0.724***	0.724***	-0.043***	-0.058***	-0.058***
	(0.005)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)
Explained	0.366***	0.322***	0.322***	0.023***	0.021***	0.023***
	(0.006)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)
Unexplained	0.544***	0.402***	0.402***	-0.066***	-0.080***	-0.081***
	(0.005)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)
Explained						
Total	0.336***	0.322***	0.322***	0.023***	0.021***	0.023***
	(0.006)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)
Pure Explained	0.351***	0.320***	0.319***	0.115***	0.108***	0.109***
	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)
Specification Error	0.015***	0.003	0.003	-0.092***	-0.087***	-0.086***
	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
Pure Explained						
Education	0.211***	0.202***	0.203***	0.129***	0.129***	0.129***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Experience	0.026***	0.0025***	0.024***	0.012***	0.011***	0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Region	0.002***	0.005***	0.005***	-0.003***	-0.001	-0.001
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Sector	0.013***	0.014***	0.014***	0.006***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Size	0.019***	0.020***	0.019***	0.008***	0.010***	0.010***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Female	-0.008***	-0.010***	-0.010***	-0.003***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

Below Hourly Minimum Wage	0.090***	0.069***	0.069***	-0.029***	-0.033***	-0.033***
	(0.003)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Formal Employee	-0.004***	-0.005***	-0.005***	-0.006***	-0.007***	-0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Rural	0.002***	0.001***	0.001***	0.000	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Labour Union			-0.000***			0.000
			(0.000)			(0.000)
Unexplained						
Total	0.554***	0.402***	0.402***	-0.066***	-0.080***	-0.081***
	(0.005)	(0.005)	(0.005)	(0.002)	(0.002)	(0.002)
Reweighting Error	-0.057***	-0.062***	-0.063***	0.007***	0.014***	0.014***
	(0.004)	(0.004)	(0.004)	(0.001)	(0.001)	(0.001)
Pure Unexplained	0.601***	0.464***	0.465***	-0.074***	-0.094***	-0.095***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Pure Unexplained						
Education	-0.102***	-0.121***	-0.125***	0.105***	0.126***	0.126***
	(0.034)	(0.031)	(0.031)	(0.017)	(0.017)	(0.017)
Experience	-0.188***	-0.058***	-0.057***	0.062***	0.072***	0.072***
	(0.016)	(0.015)	(0.015)	(0.009)	(0.009)	(0.008)
Region	-0.040***	-0.062***	-0.059***	-0.008***	-0.004***	-0.004***
	(0.005)	(0.005)	(0.005)	(0.001)	(0.001)	(0.001)
Sector	0.041***	0.027***	0.026***	0.007***	-0.002	-0.001
	(0.005)	(0.004)	(0.004)	(0.002)	(0.002)	(0.002)
Size	-0.004***	0.000	0.000	0.001*	0.001***	0.001***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Female	-0.002	0.029***	0.030***	0.001	0.009***	0.009***
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
Below Hourly Minimum Wage	0.036***	0.047***	0.047***	-0.020***	-0.022***	-0.022***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Formal Employee	0.029***	0.019***	0.022***	-0.024***	-0.027***	-0.026***
	(0.007)	(0.007)	(0.007)	(0.003)	(0.003)	(0.003)
Rural	0.000	-0.001	-0.002	0.001	0.001	0.001

	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Labour Union			0.012			-0.011***
			(0.007)			(0.004)
Constant	0.830***	0.584***	0.572***	-0.198***	-0.247***	-0.240***
	(0.039)	(0.036)	(0.037)	(0.020)	(0.020)	(0.020)
Post *N*	71,431	71,431	71,431	71,431	71,431	71,431
Counterfactual *N*	43,374	52,856	52,856	43,374	52,856	52,856
Pre *N*	43,374	52,856	52,856	43,374	52,856	52,856

Note: Education and experience are the sum of the coefficients from fourth order polynomials in years. Regional and economic sector categorical variables are normalized in the estimation and coefficients results are summed. A logit reweighting model is used to define the counterfactual. * $p<0.10$, ** $p<0.05$, *** $p<0.01$.

Median labor income in Chile revised: Insights from Distributional National Accounts*

Ingreso mediano en Chile revisado: Un análisis con Cuentas Nacionales Distributivas

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Abstract

A commonly used figure to highlight inequality in Chile is the median income of the Chilean socioeconomic household survey (known by its acronym in Spanish, CASEN). According to this survey, in 2017 the median monthly income per worker was CLP (Chilean pesos) 400,718 pesos, which compares to average income per worker from National Accounts of CLP 1,350,000 in the same year. For this difference to be correct, the implied Gini coefficient would be 0.7, which much above the Gini implied by the same survey. However, surveys, such as CASEN, often underreport income, particularly for middle- and high-income earners, leading to an underestimation of the median income. This study compares various data sources, including national accounts, household surveys, and administrative records, to create a more accurate picture of income distribution and median income. The corrected data shows higher median incomes and greater inequality than previously reported. On average, the underestimation of gross wages in the Chilean national household survey as compared to national accounts is 40%, significantly larger than other countries. About a quarter of this gap is attributed to the "missing rich" in the survey. For 2017, this equates to an estimated median gross income for dependent labor of CLP 600,000 and CLP 570,000 for all workers. The corrected mean-median income ratio (Gini) is 26% (17%) larger than in the raw survey of 2017 and falls only 6% (3%) between 2006 and 2017 compared with a larger decline of 12% (11%) in the original data.

Key words: *Income inequality; median income; national accounts; income surveys; Distributional National Accounts.*

JEL Classification: *D31, D33, E01.*

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Resumen

Una cifra comúnmente utilizada para resaltar la desigualdad en Chile es el ingreso mediano según la Encuesta de Caracterización Socioeconómica Nacional (CASEN). Según esta encuesta, en 2017 el ingreso mediano mensual por trabajador era de 400.718 pesos, en comparación con el ingreso promedio por trabajador de las cuentas nacionales, que era de 1.350.000 pesos en el mismo año. Para que esta diferencia sea correcta, el coeficiente de Gini implícito sería 0.7, mucho más alto que el Gini que sugiere la misma encuesta. Sin embargo, las encuestas como CASEN a menudo subestiman los ingresos, particularmente para los hogares de ingresos medios y altos, lo que conduce a una subestimación del ingreso mediano. Este estudio compara varias fuentes de datos, incluidas las cuentas nacionales, encuestas de hogares y registros administrativos, para crear una imagen más precisa de la distribución del ingreso y del ingreso mediano. Los datos corregidos muestran ingresos medianos más altos y una mayor desigualdad de la reportada previamente. En promedio, la subestimación de los salarios brutos en la encuesta nacional de hogares de Chile en comparación con las cuentas nacionales es del 40%, significativamente mayor que en otros países. Aproximadamente una cuarta parte de esta brecha se atribuye a los missing-rich en la encuesta. Para 2017, esto equivale a un ingreso bruto mediano estimado de 600.000 pesos para el trabajo dependiente y 570,000 pesos para todos los trabajadores. La proporción corregida de ingreso promedio a ingreso mediano (Gini) es un 26% (17%) mayor que en la encuesta original de 2017, y solo disminuye un 6% (3%) entre 2006 y 2017 en comparación con una disminución mayor del 12% (11%) en los datos originales.

Palabras clave: *Desigualdad de ingresos; ingreso mediano; cuentas nacionales; encuestas de ingreso; Cuentas Nacionales Distributivas.*

Clasificación JEL: *D31, D33, E01.*

> *"While we often must focus on aggregates for macroeconomic policy, it is impossible to think coherently about national well-being while ignoring inequality and poverty, neither of which is visible in aggregate data. Indeed, and except in exceptional cases, macroeconomic aggregates themselves depend on distribution."*
>
> *Angus Deaton. Nobel Prize Lecture, 2016*

1. INTRODUCTION

In Chile, income distribution features prominently in academic research, public policy, and the media. In addition to a few recognized inequality indicators, one statistic routinely cited in discussions about the well-being of the population is the median income of workers or households. The median captures a dimension on inequality when compared to the mean, but it also reflects aggregate income. However, survey data used to represent national income has significant inconsistencies that are seldom acknowledged but are revealed by the huge gap between labor income reported in national accounts and labor income effectively reported surveys. For example, in 2017, the Chilean socioeconomic household survey (known by its acronym in Spanish, CASEN)[1] reported a net average monthly employee compensation of 570,000 Chilean pesos (CLP), whereas the gross figure derived from the national accounts for the same year was CLP 955,000.[2] Even when taking taxes and social security into account, this represents a difference of over 40%. The disparity between these two statistics, and the fact that the survey captures only half of national income, raises doubts about the median income of workers, an almost omnipresent statistic, estimated at CLP 400,000 in the CASEN and other surveys (INE, 2019). Policymaking needs to be grounded in accurate data. For example, the distribution of labor income is important in the determination of minimum wages and social transfers. But, at the same time, the limitations of the data must be made explicit to avoid misinterpretation. Furthermore, despite the inconsistencies that arise in the calculation of inequality and income levels, it is widely recognized that Chile's average income has increased significantly since the return of democracy in 1990 and that poverty and inequality have been reduced (UNDP, 2017).

In this context, any conclusions about the substantial improvements in the standard of living and inequality levels in Chile since 1990 require a reappraisal given the various shortcomings of the data sources on which they are based. Notwithstanding numerous efforts to measure poverty and income share of the super-rich adequately, the measurement of inequality and income levels in the middle of the distribution are subject to two noteworthy limitations. The first limitation is the large gap between figures presented in national accounts, which are focused on macroeconomic aggregates, and those presented in poverty and inequality studies, which use data from surveys or administrative records, and which often present figures that are not consistent with

1 CASEN is the most important income and socioeconomic characterization survey available for Chile.

2 As a reference in 2017 the exchange rate was 650 pesos (CLP) per dollar. After the social unrest and later the pandemic the CLP weakened to 760 CLP per dollar in 2021.

macro-aggregates. The second limitation is that socioeconomic surveys tend to underestimate the income of the richest households to a greater extent than the income of middle- and lower-income earners, unlike tax records. Although underestimation is higher for top-income, middle-income earners also underreport in surveys for fear of additional taxation or mere bad accounting. Preliminary evidence suggests these deficiencies are especially acute in Chile.

In order to address these measurement issues, this paper compares and combines different data sources—national accounts, household surveys and administrative records (tax and social security)—to generate a consistent series of income distribution in Chile, focusing on the middle of the distribution. In this way, the known deficiencies of each data source can be corrected, and the advantages of each source can be exploited to achieve a coherent and unified empirical framework that allows the definitions and phenomena captured in micro and macroeconomic data to be effectively reconciled. In our central scenario, using 2017 CASEN corrected survey data, the result is a median gross income for all active workers of CLP 570,000, CLP 600,000 for dependent workers, and CLP 440,000 for independent (self-employed) workers. This equates to an increase of at least 40% compared to the figures reported in the original 2017 CASEN survey data. As a consequence of the corrections, inequality rises from a Gini of 0.52 and a mean-median-ratio of 1.65, to 0.6 and 2.09, respectively. These income gaps are very unusual in developed countries, especially for wages where Zwijnenburg et al. (2017) estimates an average gap around only 10% for a subset of OECD countries.

This paper proposes three innovations with respect to the existing income distribution literature. First, and for the first time using Chilean data, national accounts, household surveys, administrative records (tax and social security) are combined to analyze the complete distribution of income, and not only the income share of the super-rich as in Fairfield and Jorratt (2016)[3]. Second, this is the first study focused on the middle of the income distribution range that incorporates other data sources in addition to income surveys in order to examine the aforementioned problems with the microeconomic data. Third, the research covers the period between 2006 and 2020 in order to have medium-term trends, although 2020 should be treated with caution considering the uncertainty introduced by the social unrest in 2019 and the COVID-19 shocks. The results show the average gap between statistics presented in income surveys and comparable figures in national accounts is up to 45% for dependent labor, with larger gaps for capital and mixed income. Careful tax and social security simulations provide more plausible results than those presented in previous

[3] At the time writing, De Rosa et al. (2020) have a work in preparation that uses a similar methodology but the analysis is at a Latin-American level, providing less detail on Chile specifically.

studies. Our methodology serves as a basis for other developing countries with similar data quality and availability issues.

Controversy surrounding the magnitude of inequality in a country is usually generated because of conceptual and methodological differences between studies that give rise to contradictory results. There are numerous examples. Chile's Gini coefficient, as reported by the World Bank, suggests that inequality decreased between 1990 and 2015, falling from 0.57 to 0.45. And between 1990 and 2013, the CASEN survey shows that the real income of households in the 10th percentile increased by 4 times but that of the 90th percentile only increased by 2.8 times (Larrañaga and Rodríguez, 2014).[4] Some studies, however, such as Atria et al. (2018), contradict the evidence from income surveys and conclude that inequality increased after 2000. And in Fairfield and Jorratt (2016), the publication with access to the most detailed information, it is estimated that income concentration remained constant between 2003 and 2012. The literature also provides estimates of the income share of the richest 1% in a strikingly wide range, between 8.7% and 33%. The lower bound is calculated from raw total net household income from CASEN 2015, and the upper bound is obtained from López et al. (2013) and includes attributed capital gains. These discrepancies are caused in part by differences between the sample and the definitions of income used. They are, however, also a consequence of the difficulties associated with obtaining accurate information and designing reliable methodologies.

Given the inconsistency in results when data from national accounts, household surveys, and administrative records are used separately, it is very difficult to consistently estimate how economic growth has been distributed to the population in Chile. This inconsistency between sources is universal to a certain extent but mainly affects countries with lower income or statistical development. Numerous international efforts have been made to standardize income measurement in national accounts and household surveys separately or using multiple sources. Notable examples are the 2008 revision of the System of National Accounts (United Nations, 2008), the Canberra Group Handbook on Household Income (UNECE, 2011), and the Distributional National Accounts (DINA) concepts and methods developed in Alvaredo et al. (2020). All three will be used throughout this work.

Ultimately, our research is motivated by the need to improve the measurement of well-being in Chile. Indeed, there is a growing consensus among economists and policymakers to do so from a broader perspective that considers vertical, horizontal, and opportunities inequality, as well as subjective well-being, economic security, sustainability, trust, and social capital, in addition to the

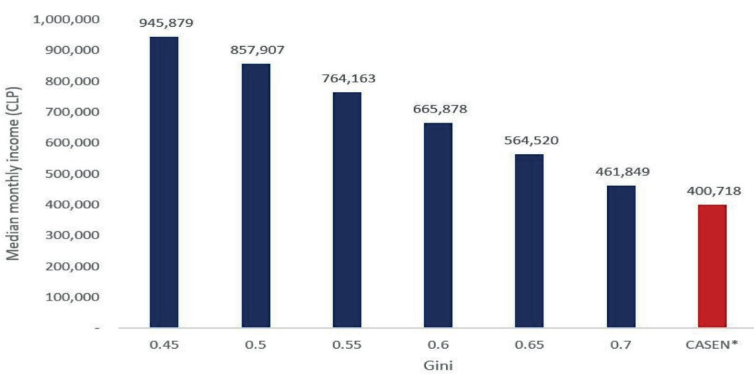
4 These statistics correspond to the measurement of income as defined by the CASEN survey and are adjusted for inflation but not to national accounts.

usual focus on income, consumption, and wealth (Fitoussi et al., 2018). These authors highlight DINA as one of the most significant recent advances in the measurement of well-being. Although restricted to the monetary dimension, DINA generate income distributions that are comparable between countries and alleviate the known problems of the different sources they incorporate. The results obtained using DINA should always be interpreted in a context that considers other aspects of well-being.

To gain understanding of the relationship between aggregate or average income and inequality we perform a simple statistical exercise following Pinkovskiy and Sala-i-Martin (2009). Using a standard distribution (lognormal or Weibull), a Gini coefficient greater than 0.7 would be needed to generate the average income reported in national accounts (CLP 1,350,000) and the median income reported by CASEN (CLP 400,000) (Figure 1). The methodology used to obtain this result is detailed in the Appendix. The extreme levels of inequality implied by a Gini of 0.7 do not seem consistent with empirical evidence, even considering reasonable uncertainty. The highest Gini coefficient calculated for Chile in the literature is 0.63 (López et al., 2016). It is therefore sensible to conclude preliminarily that the CASEN survey significantly underestimates income in the middle of the distribution.

FIGURE 1

PARAMETRIC SIMULATION OF MEDIAN AUTONOMOUS GROSS INCOME, 2017



Note: Own elaboration based on data from the 2017 CASEN survey and the Central Bank of Chile. The median income for each Gini coefficient level corresponds to own calculations based on Gross National Income (GNI), capital depreciation, and indirect taxes described in the Appendix. The x-axis shows the Gini coefficients necessary for each median income.
* The last column corresponds to the income from capital and from gross dependent and independent labor as reported by CASEN, indicating that the Gini coefficient implied by this mean-median combination is greater than 0.7.

It is important to recognize that there is still no consensus on whether aggregates obtained through national accounts are more accurate than those obtained through consumption surveys or income surveys. And advocates of each highlight valid conceptual problems with their nonpreferred source (Pinkovskiy and Sala-i-Martin, 2016). That being said, for the exercise displayed in Figure 1 it is assumed that national accounts aggregates are more accurate. Since some components of national accounts household income, such as measures of capital income and self-employment, are residual, the precision that can be expected from them is lower other items measured directly. For the construction of other components, such as wages, multiple sources are used, contrasted, complemented, and updated in the same coherent conceptual framework. For each type of economic activity, depending on the characteristics of the activity, specialized surveys, accounting and administrative records, sworn statements, and sector indicators are used, harmonized, and adjusted to concepts, definitions, classifications, and methodologies established in the SNA 2008 (Central Bank of Chile, 2017). Surveys, on the other hand, are based on self-reporting and have multiple known problems related to precision, representativeness, and systematic individual biases (Moore et al., 2000; Hurst et al., 2014).

National accounts also capture substantially more income than surveys for independent (self-employed) and informal labor income. Income from independent work presents particular accounting and statistical challenges that make its measurement in surveys, national accounts, and tax records difficult. These difficulties are related to the imperfect accounting of income and expenses, voluntary or involuntary omission when declaring income, and even the blurred boundary between informality and illegality (Hussmanns, 2004). National accounts in Chile explicitly estimates the informal sector using imputation methods based on employment and small entrepreneurship surveys.

Notwithstanding the advantages described, macroeconomic aggregates provided by national accounts only present the total of each variable without reporting its distribution. Hence, it is not possible to obtain population characterizations beyond averages. One population statistic that is particularly useful for summarizing information on variables associated with well-being is the median. From a statistical perspective, the median is not sensitive to extreme values, so it is less likely to be affected by errors in the sample. Moreover, it is more than adequate to measure economic well-being because, in general, it is positively affected by growth and negatively by inequality (Birdsall and Meyer, 2015). The median is therefore frequently used as a reference in public discussion because it is commonly understood and recognized as a good summary statistic.

In order to generate better approximations to the well-being of populations, various efforts have been made to achieve conceptual and methodological compatibility between surveys and national accounts. For example, until 2011, the CASEN survey adjusted five components of income to their theoretical counterparts in national accounts. The adjusted components were wages and salaries, independent income, social security benefits, property income, and imputed rent. These adjustments were discontinued because, among other reasons, they reduced the poverty rate by more than 1.5 percentage points (pp) for some years, and there was not sufficient certainty about their methodological validity (Campos et al., 2013).

This study primarily uses the DINA methodology developed in Alvaredo et al. (2020). The objective of the DINA project is to create a systematic conceptual framework to obtain homogeneous and internationally comparable income series in the same way that the SNA (United Nations, 2008) guidelines allow the precise comparison of GDP levels and other macroeconomic aggregates between countries. Other projects, such as the Luxembourg Income Study Database (LIS), provide harmonized and systematized distributional data and explain conceptual differences; however, the data is not standardized so the comparison between countries is less straightforward.

At the time of writing, the only study that follows DINA guidelines for the full distribution in Latin America is Morgan (2017), who characterizes inequality in Brazil. Our investigation serves as the basis for improving the measurement of capital income and at- tributing the components of GDP that are not directly accrued by households, following the complete DINA methodology. We do not distribute some income components to individuals to avoid relying excessively on arbitrary assumptions and jeopardizing accuracy.

The rest of the paper is organized into seven parts. Section 2 reviews the literature on the use of national accounts and taxes in generating microeconomic statistics. Sections 3 and 4 provide the conceptual framework necessary to understand the relationships between the different definitions of income that will be used. Section 5 presents a selection of sample statistics on income. The gap between income measured by the CASEN survey and the GNI is also described and quantified. Section 6 explains the methodology used to correct survey biases, and Section 7 presents the main results, with an emphasis on the median income for the different categories of workers. Finally, Section 8 concludes and establishes some areas for future research.

2. Literature Review

The harmonization and integration of national income measurement has been going on for decades and continues to develop. The first international effort to coordinate and standardize the measurement of aggregate income was the SNA, first published in 1953. Before this, some household surveys were undertaken, and partial national accounts and administrative tax records were collected, but none of these data provided an adequate level of international comparability.

Aiming to improve the measurement of income in Latin America, two pioneering papers by Oscar Altimir (Altimir (1986, 1987)) proposed an explicit methodology of adjustment for five specific income components captured in surveys to their theoretical counterparts in national accounts. Following the publication of these papers, detailed discussions on the different ways to perform these adjustments have been undertaken by Székely et al. (2000), Ravallion (2000), Deaton and Dreze (2002) and others, who describe the advantages, limitations, and alternative methods of harmonization. It is still an active research topic and as yet there is no consensus on the best way, or indeed whether it is desirable, to carry out these adjustments. Moreover, the informational requirements to perform the adjustments in an optimal manner are costly; thus, for researchers the decision is often between adjusting inadequately or not adjusting at all.

Many of issues with income surveys stem from the fact that they are susceptible to multiple errors and biases, such as survey design errors, sampling errors, questionnaire errors, or data treatment errors. Additionally, one fundamental problem is the nonresponse and underreporting bias associated with socioeconomic characteristics. Interviewees—particularly independent (self-employed) workers—often do not record the accounting information necessary to answer appropriately. In addition, misrepresentation or omission of information, whether done voluntarily or involuntarily, is a significant problem (Moore et al., 2000). These biases are usually greater and more relevant for the upper part of the income distribution range (Ruiz and Woloszko, 2016; Lustig et al., 2020).

Despite multiple methodological problems and inaccuracies associated with the use of national accounts averages with survey distributions, until the 2010s the majority of inequality and poverty studies simply used GDP per capita as a proxy for the average income of individual households.[5] More recently, the consensus has been not to adjust to national accounts when estimating world poverty. Lakner and Milanovic (2016) and Ravallion (2012), for example, use different methods to harmonize definitions and correct biases. However, the statistical techniques and methodological corrections used to estimate incomes, with or without adjustment to national accounts, are generally simple due to the large volume of data and sources used. Although measuring income on a global scale, trying to estimate world poverty, for instance, poses challenges for a more detailed treatment of the information. When investigating a

5 The most relevant studies that use this method are Bourguignon (2011), Pinkovskiy and Sala-i-Martin (2009), Dowrick and Akmal (2005), and Chotikapanich et al. (1997)

specific country, it is feasible to reconcile the different definitions, magnitudes and methodologies with greater precision, which favors the decision to adjust to national accounts. The CASEN survey, for example, adjusted to national accounts from 1990 to 2011, but this decision was repeatedly questioned, most notably by Bravo and Valderrama (2011).

The Bravo and Valderrama paper, which reconstructed CASEN databases from 1990 to 2006 without adjustments, showed that the effect of adjusting to national accounts reduced poverty by 0.6 pp and increased the Gini coefficient of total household income by 3.4 pp. And the same year the paper was published, the Central Bank of Chile shifted the base year of the SNA from 1993 to 2008. A change that revealed the arbitrariness of the adjustment.[6] Between 2000 and 2011, a spliced series was used for the adjustment to national accounts that combined the growth rates of the new accounts with the base of the year 2000. Over time, spliced accounts came to represent only 69% of current year accounts. With the change in the reference series from SNA 1993 to SNA 2008, the adjustment factors increased to considerably higher values: from 1.09 for dependent income and 2.05 for independent income (using spliced accounts) to 1.31 for dependent income and 3.79 for the independent income (using updated accounts). The 20% increase in dependent income (wages and salaries) and the more than 100% increase in independent income (self-employed) could only be a consequence of an external change in methodology, making it impossible to establish continuity between the inequality and poverty estimates from previous surveys. It was therefore decided that adjustment to national accounts for the CASEN survey would cease, only the correction for nonresponse was retained.

The hegemony of national accounts in international average income comparisons suggests they are implicitly considered more accurate than surveys at the aggregate level. However, adjusting survey data to national accounts is not recommended when there is no adequate information on the equivalent aggregate to be used (Eurostat, 2018). Similarly, even if the total magnitude of the difference and compatibility of the specific component is known, adjustments are not recommended if it is suspected that the biases of the survey are not uniform throughout the distribution (Ravallion, 2016; Milanovic, 2012). Assigning the income difference proportionally, for example, can artificially inflate the income of the lowest deciles; thus, incorrectly reducing the proportion of low-income earners in the distribution.

In accordance with one of its main objectives, CASEN characterizes poverty in Chile as well as the evolution of poverty over time, and as discussed, it no

6 The main changes between SNA 1993 and SNA 2008 affected the measurement of financial services, insurance (except life insurance), and production for own use. These changes increased GDP for OECD countries by an average 3.8%.

longer adjusts any income components to national accounts. When the focus is on the middle and upper sections of the distribution, however, international comparability is more important, and it is necessary to implement a methodology that addresses the known biases that affect household surveys, as well as the methodological differences between them.

Székely and Hilgert (1999) review the methodological and conceptual differences between income surveys undertaken in Latin America. They found that wages in formal employment are underreported by up to 57% when compared to data from national accounts, and show important heterogeneities. In a more recent study, Del Castillo (2015) found an average underestimation of wages by household surveys in Mexico of up to 47% compared to this component in national accounts data. Castillo proposes to correct difference between survey-reported wages and national accounts by assigning the share of the gap to three employment groups in a new apportionment, favoring concentration in higher income categories. Specifically, and in a justified but ultimately arbitrary manner, the allocation is 80% to officials, managers, and bosses; 15% to professionals and technicians; and 5% to the least qualified workers. To close the gap with national accounts, each observation is multiplied by a constant according to its category. With these corrections, it is estimated that the underreporting of median income is 47%. Another approximation to the underreporting problem is provided by Lustig et al. (2020) who analyzes the biases that most affect the high-income, missing rich in household surveys, as well as the magnitude and these biases, and potential correction methods. Lustig distinguishes between correction approaches within the survey and those that combine survey data with external sources, generally tax, in a similar way to the correction proposed in this paper. Atkinson (2017) recognizes, however, that bias found in household surveys may not only be limited to high income earners but may also extend to low-income earners where the bias could be even more intense.

Currently, the most prominent methodology for measuring income and inequality is DINA, developed by Alvaredo et al. (2020). Although they recognize that the concepts of national accounts are not the most appropriate to measure economic well-being, DINA uses the SNA 2008 guidelines to maximize the comparability and consistency of income measures between countries. Thus, underestimating the income of countries with the highest spending on public goods is avoided, for example, because this component is not usually captured in surveys. Likewise, we recognize that globally speaking higher incomes are underrepresented in surveys while tax records are less prone to this problem and, national accounts are able to better capture aggregates.

3. Income Definitions

As discussed, some of the disparities in estimates for average income and inequality are due to variation in the definitions of income. Aside from conceptual differences, there are differences in data sources, collection timing, and estimation techniques. In general, no major effort has been made to ensure that the definitions of income or the size of the different components of income from microdata are compatible with national accounts. This section provides the rationale for our proposed methodology that combines the three different data sources used in the paper.

Taxable income varies according to the specific laws of each country. Income surveys also vary from country to country according to institutional needs or simply by lack of proper standardization. Several income and tax questions are often arbitrarily included or excluded from surveys (UNECE, 2011). Considering this and to facilitate understanding, we present the definitions and relationships between the main income categories according to surveys, national accounts, and administrative records, in the Chilean setting.

3.1 National Accounts

Gross Domestic Product (GDP) is generally used to measure income or production in a country. Yet, even if non-monetary dimensions are not considered, GDP is only an approximation of the well-being of individuals and households. A significant proportion of the components that make up GDP are not consumable or do not allow the accumulation of wealth. The most significant examples of nonconsumable components are capital depreciation and net factor payments abroad. Other components, such as indirect taxes and profits not distributed by companies, constitute gross income for the household sector; yet, it is complex, and even arbitrary, to assign a distribution to these components at the individual level. For many of the components, the data necessary to obtain distributive welfare measures consistent with national accounts are not available for Chile.[7]

Ideally, DINA assign a fraction of the consumable components of gross national income to each individual; in practice, however, the information requirements to achieve this are expensive and often unavailable so simplified versions are developed. Indeed, there are a wide range of sophisticated versions of DINA used to allocate these components, but the simplest are usually selected as there are no adequate justifications to the contrary. For example, by

[7] There are no regularly published estimates for capital depreciation, withdrawals from income of quasi-corporations, operating surplus of the homeownership sector and mixed income, among others. This issue will be discussed in Section 4.

assigning a constant fraction of government expenditure to all individuals and other proportional to income or the retained earnings proportionally to those distributed. The focus of this study is on the middle of the income distribution range, therefore we concentrate in labor income. This is because capital earnings are only a relevant source for the richest households (the first four quintiles of autonomous income in CASEN receive only CLP 3,000 in average monthly capital income). And, in addition, the interconnected structure of companies and individuals, together with tax evasion,[8] impose drawbacks that are difficult to remedy.

In order to use national accounts concepts to measure the income of individuals, it is necessary to understand the relationship between the household sector and the other sectors that make up the national economy. According to the generation of income account (SNA 2008), GNI from the perspective of income is equal to the compensation of employees, gross mixed income, gross operating surplus, and net indirect taxes on production (value added tax, import duties, subsidies, among others) that are generated by the economy. Then, the allocation of primary income account records how production is distributed to households and other sectors (private nongovernmental organizations (NGOs), nonfinancial companies, financial companies, government, and the rest of the world, not included in the GNI). In the same account, property income, receivable and payable, is distributed generating only a resource reallocation resulting in the balance of primary income. In the secondary distribution of income account, the income tax, social contributions, and benefits and transfers are incorporated. Social transfers in kind are recorded in the income redistribution account in kind. And, finally, in the income use account, individual consumption, collective consumption and savings of each sector are reported. In this investigation, we will use components from the three accounts to generate our estimates.

Within the income generation account, compensation to employees is defined as the total compensation (wages and salaries), in cash and in kind, paid by an employer to an employee in exchange for the work performed by the latter during the accounting year. It includes bonuses and housing allowances, as well as income tax and social security contributions that the employer makes on behalf of the employee. Some goods and services that employees receive but are obliged to use at work are excluded. For each productive sector, the information on wages is obtained from administrative records and statistics on employment and labor costs. Specifically, the annual income tax return, the sworn statement on the salaries paid by employers, and the tax income and expenses reports from the General Treasury of the Republic are used. These data

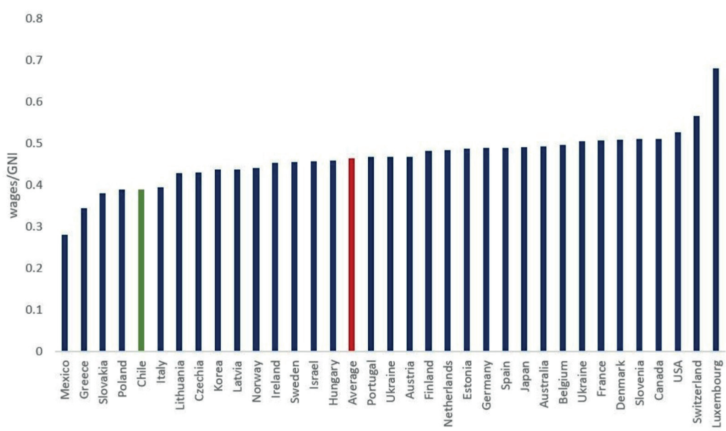
8 According to Fairfield and Jorratt (2016) the evasion of the complementary global tax would reach more than 45%.

are complemented by employment statistics that from National Employment Survey (known by its acronym in Spanish, ENE) and the Labor Cost Index (Spanish acronym, ICMO), both provided by the National Institute of Statistics (Spanish acronym, INE) (Central Bank of Chile, 2017). In this way, multiple sources are integrated, reducing the probability that errors will persist.

Figure 2 shows the share of wages in GNI according to national accounts for OECD countries. Chile has the fifth lowest share out of the 35 countries, at 39%. This equates to 8 pp less than the group average and is indicative that the share of labor with respect to capital in the product is low. The indicator shown in Figure 2, however, does not correspond to the labor share in production. To estimate it, the depreciation and indirect taxes net of subsidies must be subtracted from GNI leaving the net national income (NNI) at factor cost. NNI is equivalent to the compensation of employees (attributable to work) plus the net operating surplus (attributable to capital), and the net mixed income (attributable to capital and labor). Considering this, the share of wages in GNI is expected to be higher in countries with greater economic development because of the lower rate of informality and concomitant lower mixed income. Still, available estimates of the labor share in Chile are low. Guerriero (2019) reports comparable labor share values between countries using different methodologies, estimating that the participation in Chile is 0.55 whereas the median for the world is 0.7.[9]

FIGURE 2

WAGE SHARE OF GNI, OECD AVERAGE, 2006–2017



Note: Own elaboration using data from the UN statistical Database.

9 This results correspond to the LS4 calculation in Guerriero (2019) that considers an imputation of the same share of the rest of the economy for the mixed income, equivalent to the ratio of wages and GNI minus mixed income.

Regarding capital income for activities with market production, the levels of gross operating surplus are obtained as a residual between production, intermediate consumption, salaries, taxes and subsidies. Estimates of this variable gathered in the production accounts are complemented with information from the annual income tax return. In Chile, this surplus is not recorded separately from mixed income for each sector. This implies that when quantifying mixed income and gross surplus, errors are more likely to be made because they are not measured directly.

3.2 Household Surveys

The CASEN Survey reflects international standards for income statistics established in the Handbook on Household Income Statistics (UNECE, 2011). In the Handbook, household income is defined as all income, monetary and in kind, that households receive at annual, or more frequent, intervals, excluding irregular and one-time payments (such as inheritances and earnings from gambling). This income must be available for present consumption and must not reduce net wealth or deteriorate equity positions.

In line with these standards, CASEN covers income from labor, capital, self-provision of household goods, and various transfer payments. Labor income is therefore considered to be all earnings obtained by people in their occupation from wages and salaries (monetary and in kind), earnings from independent work, and the self-provision of goods produced by the household. Autonomous income is defined as labor income plus interests, dividends, withdrawals from corporations, pensions, assistance funds, and current transfers between individuals. Cash income incorporates state subsidies. Finally, total income includes the imputed rental value of the home. Capital and labor income, both dependent and independent, is always recorded after deducting income tax, health contributions, social security, fees.

CASEN provides very detailed information on labor income. To capture income from dependent work the survey includes up to 10 questions about additional income (overtime, bonuses, tips, etc.), as well as up to 13 questions about income in kind (housing, transportation, food, etc.). For independent income, 6 comprehensive questions are included. Given this extensive survey detail, it is not reasonable to assume that the underestimation of the aggregate level of wages is because the questionnaire does not capture some income items obtained by individuals. The only notable exception is the omission of questions regarding third (and subsequent additional) dependent job. In any case, the aggregate magnitude of income third or higher job is expected to be small.

The COVID-19 pandemic posed significant challenges for all statistical systems and, particularly for CASEN 2020, resulting in major methodological changes. In response to the health restrictions, the 2020 version was conducted in a mixed sequential mode with three phases: face-to-face pre-contact, telephone application of the questionnaire and face-to-face recovery. This differences in the application mode imply possible changes in various aspects related to measurement, that makes difficult the comparison.

3.3 Tax Records

Tax income, according to Chilean income tax law, consists of all benefits, profits, and increases in equity that are received or accrued, whatever their nature, origin or denomination. It incorporates income from work and property, and also includes capital gains which do not constitute income in surveys or national accounts. Despite what is stipulated in general terms by law, in practice a few items are exempted. Among them, mortgage interest is deductible and income from the rental of DFL-2 homes[10] does not constitute taxable income. Additionally, legal contributions for health, social security, and voluntary social security savings are discounted. The composition of income, without considering the exempt items, does not affect the total tax payment because the Chilean tax system was fully integrated until 2016 and semi-integrated for some types of companies since 2017.[11]

3.4 Tax And Social Security Structure

The main direct tax in Chile is the income tax, which is broken down into three different levies: a flat rate on company profits, called the First Category Tax (known by its Spanish acronym, IPC); a tax on dependent labor withheld monthly and paid by the employer, called the Second Category Tax (Spanish acronym, ISC); and a general tax that is levied on all taxable income generated by natural persons, called the Complementary Global Tax (Spanish acronym, IGC). There may be small differences in the tax paid depending on the regime adopted and the source of the income. In the case of IGC or ISC, these differences are inflation-related because the ISC is paid month to month by the employer and the IGC is paid annually.[12] Likewise, as mentioned, there is also

[10] All houses below 140 square meters have special tax and real estate contributions exemptions.

[11] As of January 2017, companies that meet certain conditions, including public limited companies, are required to use the semi-integrated tax regime where the maximum marginal rate (for persons) is 44.5% instead of 35%.

[12] The ISC paid monthly serves as a tax credit for the IGC for payments at the end of the year in case the taxpayer has more than one source of income.

a difference between the attributed income regime and the semi-integrated regime when taxing income from capital combined with other sources.

In addition to direct taxes, dependent workers are subject to legal deductions charged to their employer: 10% for mandatory pension savings; 7% for public or private health insurance; 0.6% for pension insurance paid by the employer; close to 2.5% for insurance against work accidents, and disability or survival insurance, also charged to the employer; and a variable fee close to 1% paid as commission to private companies that administer the pension funds (known by their acronym in Spanish, AFPs). For simplicity, all the discounts will be called “social security”, despite the fact that the OECD only considers 7% of health contributions as social security. It will be assumed that all dependent workers with a contract are subject to these contributions, even there are particular situations that exempt some taxpayers from contributing to some components, as well as employers who evade them.

4. Relationship Between Sources

In order to incorporate the different datasets into a coherent conceptual framework that takes advantage of the information provided by each source, it is necessary to generate harmonized income definitions and establish equivalences between the different sources. Income as measured by the CASEN survey will be used as a point of reference because the proposed adjustments will be applied to CASEN data.

All income variables in CASEN are explicitly or presumably recorded net of tax and deductions. To obtain the net taxable income, capital gains must be added to the autonomous income given in the survey, and compensation in kind and the lease of DFL-2 real estate must be subtracted.[13] Income is recorded net of social security contributions, which are tax exempt. Additionally, the CASEN survey does not record the effective payment of taxes; thus, to obtain gross income certain assumptions about tax evasion and compliance must be made. One last minor difficulty is that voluntary tax-deductible pension savings are also not reported, so it is assumed that this component is reported as part of net income.

Even if the missing variables discussed are ignored, to reconstruct GNI or other national accounts concepts based on the components captured in surveys requires certain assumptions to be made, and, occasionally, it is not possible to achieve complete compatibility. This is because some differences in scope, gaps in data collection, or quality problems remain, such as underreporting in the case of surveys and indirect or residual measurement in the case of national

[13] Information on the lease of DFL-2 real estate is not available in the survey.

accounts (UNECE, 2011). The degree of comparability between surveys and national accounts varies according to the particular component of income being compared. Wages, social security, and earned income taxes have high comparability; and income from self-employment, property, transfers, and imputed rent have medium or low comparability. High comparability means that the concepts can be homologated without adjustments. Low and medium comparability implies that there are elements measured in one source that are not in the other and vice versa. Elements that do not coincide between sources are not measured, so it is not possible to refine the concepts until they are completely comparable (Eurostat, 2018). Concept comparability may be correlated with reporting biases in surveys, but it is not the same, as two perfectly equivalent concepts can be measured incorrectly in one source.

Before turning to labor income, we propose a compatibility exercise between survey income and GNI.[14] By performing this exercise, it is possible to distinguish between differences attributed to omitted elements and differences attributable to the sum biases. Taking into account the above, GNI is equal to the sum of gross disposable income of each sector that is, primary income plus redistribution accounts. Thus, the elements of the household account that are not measured, as well as the income flows that are retained or finally spent by another sector, must be added to the accounts actually measured in CASEN. Income measured by CASEN is added to income tax and social security contributions and other income items not measured in the survey, such as financial intermediation services indirectly measured (FISIM)[15], and others[16], to obtain the gross disposable income of households.

4.1 Wages

Achieving conceptual compatibility in this income component requires only minor considerations. According to the SNA 2008, compensation to employees includes wages and salaries payable in cash or in kind and contributions to social security systems paid by the employer or employee, recorded gross of income tax or other discounts. The variables necessary to construct wages are directly accessible in the CASEN survey and in national accounts. Information regarding the tax and social security burden, however, is not available as it is not directly queried in the CASEN survey questionnaire.

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14 We are thankful for the comments from the ECLAC Department of Statistics on this matter.

15 The gross value added for other services is calculated as the charge for the service minus intermediate inputs. For financial services it is recorded in the same way but adding property income received, less paid, to account for the opportunity cost of resources that are not explicitly charged.

16 Specifically: Gross operating surplus of the housing sector (minus imputed rentals, gross saving of companies, income attributed to insurance policy holders, gross operating surplus of the government, consumption of NGOs and a price level correction.

4.2 Independent Income

The construction of independent income from national accounts concepts and its homologation to the concepts measured in CASEN is more complex than it is for wages. In contrast to wages, for example, no individual component in national accounts corresponds exactly to this independent income. Another difficulty is that, unlike the other accounts specified in the SNA, there are sizable disparities in the treatment and categorization of some elements that make up independent income. Finally, even if a single conceptual framework existed, it would not be feasible to individually measure some of the components necessary to construct independent income from the information available.

Recognizing potential irreconcilable differences between survey independent income and its national accounts counterpart, the convention to construct it is to use the sum of gross mixed or net income (codes B3b or B3n in SNA 2008) plus the income of quasi-corporations (code D.422 in SNA 2008) that are received by the household sector. Income from unincorporated corporations—that is, quasi-corporations—can potentially be found in two SNA categories: net mixed income and withdrawals from income of quasi-corporations. Knowing in which of the two categories the income of quasi-corporations is accounted for requires access to methodological notes for the country under investigation. When using both accounts together (code D.422 and B3b), however, it is not problematic to be unaware of the location of this component.

Due to the cost of measuring each subcategory in national accounts separately, in Chile less detail is provided for some items. No official estimates of depreciation are provided at the aggregate level; thus, these estimates are not available for mixed income either, only gross mixed income (B3b) is reported. Another important information deficiency is that gross mixed income is reported in conjunction with the gross operating surplus (B2b). In any case, information is provided for the gross surplus and mixed income of the household sector and for the gross surplus of the housing sector. Similarly, item D.422 is not accounted for separately from dividend income (code D.42 in SNA 2008).

Considering that dividend income is not separated from quasi-corporation income, to construct the second part of independent (self-employed) income—the income of quasi-corporations—it is necessary to assign a fraction of the dividends to arrive at the aggregate independent (self-employed) income. In an adjustment implemented until 2011, ECLAC as-signed 90.7% of total distributed income to independent (self-employed) workers for all years, without outlining the justification for this adjustment.[17] It can therefore be concluded

[17] The only reference to this adjustment is in an internal ECLAC Excel spreadsheet stating that it corresponded to a "historic coefficient".

that this adjustment is the main reason why ECLAC reported moderate adjustment magnitudes for capital income and unreasonable values for independent (self-employed) income. See Table 7 and the discussion that accompanies it for clarification of this argument.

Despite the difficulties independent (self-employed) workers have in keeping an adequate accounting record for their income flows and costs, it is not plausible that they report less than a third of their net income. Moreover, there is abundant evidence that income from capital is heavily underreported in surveys. Thus, we decided for the central calculations, in a more credible but also arbitrary manner, that 20% of the income distributed from national accounts corresponds to quasi-corporations. In any case, we perform a sensitivity analysis.

Considering these limitations, a national accounts equivalent was prepared for independent (self-employed) income. It is not free from inaccuracies or arbitrariness. It is, however, an improvement over the old CASEN adjustment methodology developed by ECLAC. The mixed income of households is obtained by subtracting the gross surplus of the homeownership sector from the gross surplus and mixed income of the household sector. A fraction of the dividends paid by companies (D.42) is added to approximate the required item, D.422. As specified, 20% is selected to correspond to quasi-corporations in the central scenario, a conservative estimate to avoid overestimating the income of independent workers.[18] A higher value would give a quotient between the total of national accounts and the total of the CASEN survey greater than 2, which is not realistic. We recognize that the choice is therefore arbitrary and has a considerable impact on independent (self-employed) income. For instance, if the value is set at 90% the ratios between the aggregates are close to 4, as shown by the ratios calculated by ECLAC[19]. Table 7 shows the evolution of the calculated ratios, or adjustment factors, of independent income considering different fractions of D.42. Depending on the proportion of the component that is imputed, the adjustment factor can take values between 1 and 3.9.

An effort was made to construct an equivalent aggregate for independent income, but important inaccuracies persist. Accordingly, we present the results of dependent and independent employment income separately, and highlight that dependent income is much more precise and that independent income should only be used as a reference. It would be a significant improvement to integrate in a more clear, complete and disaggregated way the elements of national accounts necessary to adequately measure the independent sector. The investigation of the independent and informal sector from the micro- and macroeconomic perspective is a separate topic and is in its early stages in Chile.

18 This figure is 27% less than the same ratio using comparable US national accounts data in 2016.

19 See Literature Review

4.3 Capital Income

Capital income measured in the CASEN survey taken to national accounts concepts corresponds to interests received by households (D.41) net of FISIM and distributed income of the companies corresponding to dividends (D.421). Between both these items in national accounts, equivalent to the income of capital measured in the survey, a maximum of 15% of GNI is reached in the years analyzed.

The Central Bank of Chile does not regularly publish FISIM for household deposits, but it does for the Chilean economy as a whole. To approximate the proportion of FISIM that corresponds to household income, the average of the years for which information is available for FISIM income account prepared by ECLAC between 2008 and 2013 (29.8%) was used, approximated to 30%. Constructed FISIM makes up less than 4% of capital income, so attributing a different fraction to FISIM does not significantly alter the results.

Nonresidential property and machinery leases are not recorded as property income in national accounts. Because the gap between capital income in CASEN and in national accounts is higher than 300%, all related items in capital income from the CASEN survey are included. In the Online Appendix, all the series used, their sources, and the relationships between the variables used for the adjustment to national accounts are given.

5. Descriptive Statistics

This section describes the sources and provides relevant descriptive statistics from the CASEN survey and national accounts, and data reported by Chile's Internal Revenue Service (known by its acronym in Spanish, SII). Additionally, following the guidelines set out in Section 4, the gap between income captured in the CASEN survey and national accounts is quantitatively decomposed. We use 2017 as our references since it is the last year with data unstained by methodological adjustments and macroeconomic effects due to the pandemic.

In Table 1 statistics from the CASEN survey and the SII for income of dependent and independent workers and net taxable income are reported. Notably, the last two rows of the table show that the average net taxable income measured in the CASEN survey is only 6% lower than the same statistic as reported by the SII. The gap between the 90th percentile, however, increases to 29%. Similarly, the share of income of the richest 1% is almost 2% higher in absolute terms and 16% higher in relative terms according to data from SII, reflecting the missing rich phenomenon. Taking into account that the tabulated tax base includes 600,000 more individuals than CASEN[20], the gap between the richest in tax data and the richest in CASEN is greater if the comparison is made by number of individuals rather than percentiles or shares. On the other hand, median taxable income (P50) is 12% lower according to the SII data[21].

The information in Table 1 allows us to conclude that income captured by the upper end of the distribution is underreported in the CASEN survey. It also shows that, income measurement is apparently more accurate for the middle and lower income brackets in the survey. One reason for this is that the tax-exempt bracket starts from approximately the 75th percentile and below, and therefore the incentives to report or audit correctly are weaker below this percentile.

Table 1 also highlights some differences between labor income from dependent and independent workers. Dependent workers are a much more homogeneous category than independent (self-employed) workers, which is reflected by the fact that the income share of the top 1% dependent workers is just 9%, almost half that of independent (self-employed) workers. Another difference highlighted by the table is that although the 90th percentile of both categories is very similar, the median of dependent workers is 40% higher. This difference is not only caused by gaps in human capital but also by the considerable heterogeneity in the use and ownership of physical capital for independent workers. As a group, independent workers include low-skilled informal workers together with employers and entrepreneurs of different sizes that may have much higher incomes.

It is also useful to consider the distribution of income that is provided by official administrative records. Figure 3 shows the average and median salaries for November 2017, according to the records of Chile's private national pension system (known by its acronym in Spanish, AFP), the unemployment insurance (Spanish acronym, AFC) and the CASEN survey, together with the monthly average of national accounts. The 27% gap between the monthly average wage in national accounts and the two other data sources (AFP and AFC) is partially explained by nontaxable income and unrecorded year-end bonuses. The primary explanation, however, is by the evasion of state-mandated social security contributions. The difference between national accounts and AFP and AFC is approximately 3% smaller if untaxed income in kind (2%) and year-end

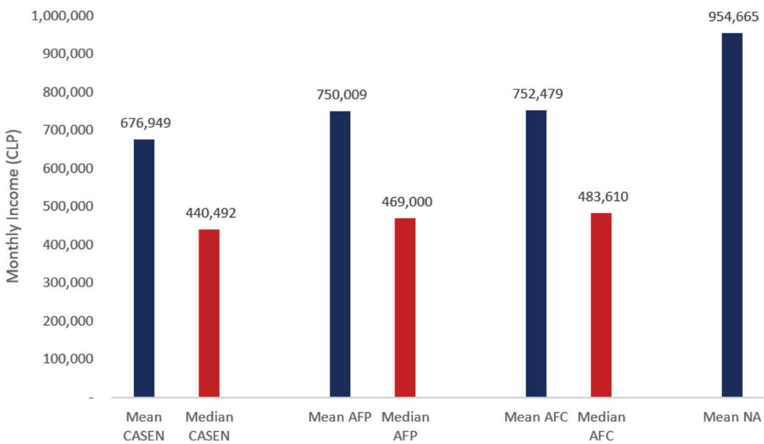
20 The income difference between high earners in CASEN and the SII is even larger when comparing by ranking rather than fractions (e.g., the thousandth richest individual). The population of tax fillers is mechanically larger because it includes every individual who received taxed income in at least one month instead of just November.

21 The median, or P50, for the SII data is calculated using the generalized Pareto interpolation method with data tabulated from P75, so it is less precise.

salary bonuses (< 1%)[22] are considered. Moreover, the CASEN survey records information on 6 million worker salaries, whereas there are only 5.3 million AFP records and 4.6 million AFC records. This suggests that approximately 700,000 workers do not pay the state-mandated retirement contributions and that another 1,400,000 do not pay compulsory unemployment insurance. The difference of 11% for the average and 10% for the median between the income of the CASEN and the AFPs and AFC is because the effect of underreporting in the survey exceeds that of evasion. A more thorough study of the phenomena is necessary to quantify the employer contribution evasion; given the data presented here, it is expected to be significant.

FIGURE 3

AVERAGE AND MEDIAN WAGE IN CASEN, ADMINISTRATIVE RECORDS, AND NATIONAL ACCOUNTS, 2017



Note: Own elaboration based on CASEN, Pensions Superintendence, and Central Bank data. The average of national accounts corresponds to item D.1 (wages) divided by the number of salary recipients in the CASEN survey. The median of the AFP and unemployment insurance (known by its acronym in Spanish, AFC) affiliates is calculated using a sample that corresponds to 4% of the universe, and the average is obtained directly from the statistics calculated by the Pensions Superintendence to avoid the bias caused by the data truncated in the taxable maximum.

Table 2 shows the total gap between GNI and CASEN (fourth row) and between its theoretical equivalent constructed from the survey (fifth row). This implies that the survey captures on average only half of GNI (fourth row) and three quarters of the components it effectively measures (fifth row). The data

22 For simplicity, this is calculated as the difference between the average salary in December and the average salary in November divided by 12. This variable is not included in CASEN.

shown corresponds to nominal, per capita, monthly income (the total amount was divided by 12 to obtain monthly data). The first row corresponds to income from work, property, self-provision of household goods, miscellaneous transfers, and imputed rent, always net of taxes and contributions, and measured in CASEN. The theoretical equivalent, shown in the second row, includes those items that, due to their definitions, are not measured in the survey but are included in the GNI from the income perspective. These are income tax (D.5), social contributions paid by households to the government and financial companies (D.61),[23] gross savings from financial and nonfinancial companies (B.8), taxes net of subsidies (D.2 minus D.3), property income attributed to holders of household insurance policies (D.44), NGO consumption, income from FISIM[24] of households, and the depreciation of government assets. Finally, a correction is applied for the differences in price level over the whole year in question compared to the month in which the survey is conducted. If there are no measurement errors or differences in definitions that cannot be reconciled, rows 2 and 3 should return the same values.

Considering results in Table 2, the average underreporting of the components measured in the survey ranges is between 16% and 36%, demonstrating a decreasing trend. This includes some components that are overestimated, such as the imputed rent of houses inhabited by their owners. The percentages in the last row should not be interpreted as only the bias of the quantities measured in the CASEN. Although national accounts are considered to be more accurate, both forms of measurement are subject to bias. This exercise is meant as a preliminary study to better understand the relationship between survey income and GNI; it is not, however, the core of this research.

6. Methodology

This section outlines our methodology, which is inspired by DINA (Alvaredo et al., 2020) but adapted to reflect labor income and median income more accurately. Since our focus is not on detailed treatment of the super-rich, inequality indicators are reported as complementary analysis. The methodology consists of five steps. First, using tabulated tax data, synthetic fractiles[25] of net taxable income are formed through generalized Pareto interpolation, as described in Blanchet et al. (2022b). Second, the net taxable income from

23 This corresponds to contributions for pension savings and other discounts paid to AFPs.

24 As explained in the previous section, this income comes from, for example, imputed interest income associated with servicing a bank account.

25 This general term corresponds to the concepts of quintile, decile, percentile, etc. They are expressed in base 100 notation, as percentiles, but allow decimals.

the survey, including imputations for capital income in constructed. Then, the underreporting and nonresponse at the top of the CASEN survey distribution, or missing rich, is corrected with the synthetic data generated following Blanchet et al. (2022a). Fourth, gross tax revenues are calculated considering the tax-rate structure and evasion determinants of the CASEN survey to obtain a theoretical collection very similar to the effective one. Finally, the different income streams are proportionally adjusted until the magnitude measured in national accounts is reached.

In this paper, the CASEN survey is used as the base data source for the adjustments proposed. It is also possible to use tax data as a base for adjustments. In jurisdictions where administrative tax data is accessible and accurate, such as France and the US, it is natural to use these records as a starting point, even for the lower part of the income distribution and informal workers. However, in countries where tax bases are tabulated, evasion is relatively high, or the informal sector is significant, it is advisable to use income surveys as an initial reference (Alvaredo et al., 2020). The choice of base data source dictates whether the high-income segment is corrected or the middle and low income segments are corrected. The nature and availability of the data for Chile suggest that surveys should be used as a starting point.

As surveys are selected, the data correction methodology fundamentally depends on whether or not there is an interval where both survey data and tax data are considered accurate or reasonably free of reporting bias. If the survey results are reliable up to an income limit that is much lower than the lower limit at which the tax data are reliable, Piketty et al. (2019) recommend to use an adjustment that extrapolates the income distribution in the bracket where no source is known to be reliable. For example, when tax records provide information only for very high-income taxpayers, above the 99th percentile, as they do in the case, for example, of China. Alternatively, when there is an overlap in the income range in which both sources are accurate, it is recommended to use a methodology that is data driven in all percentiles of the final distribution.

In Chile, reasonably accurate tabulated tax information is published starting from the 75th income percentile. Below this percentile, evasion and underreporting of income to the SII means that there are more individuals above the taxable income bracket in the CASEN survey than in the administrative tax data (Candia, 2018). Thus, surveys are the most reliable data source up to a certain percentile and it is only more reliable to use tax data for the upper percentiles, despite the fact that tax data are available for lower incomes.

For these reasons, we decided to use the methodology where the final distribution is based on data, and not on estimated parameters, for all income levels. In what follows, we outline a five-step adjustment specially designed to fully harness available data.

Step 1. A synthetic full distribution of taxable income is generated. The SII publishes information on the average gross income, number of individuals, and the tax collection for each from the seven or eight income brackets[26]. Using the gross annual income and the tax paid for each tranche on average, the net income for each tranche is constructed. The limits of each net income interval are easily inferred from the tax structure.

From the tabulated data for net income, 127 synthetic income fractiles are constructed: 99 fractiles for the first 99 percentiles; 9 fractiles for each tenth of a percentile between 99 and 99.9; 9 fractiles for each hundredth of a percentile between 99.9 and 99.99; and 10 fractiles for the remaining thousandths of a percentile. By allowing the Pareto co- efficient to vary between each fractile, continuous, smooth, and realistic distributions are obtained for the upper part of the curve (Blanchet et al., 2022b). This interpolation exceeds the simple Pareto interpolation because "the shape and thickness of the tail" better fits the empirical data, especially for countries with high inequality (Blanchet et al., 2022b). This is demonstrated by the lower mean relative error compared to the other three commonly used methods of interpolation.[27] In general, the true density at the top of the distribution is greater than that estimated density from a simple Pareto interpolation.

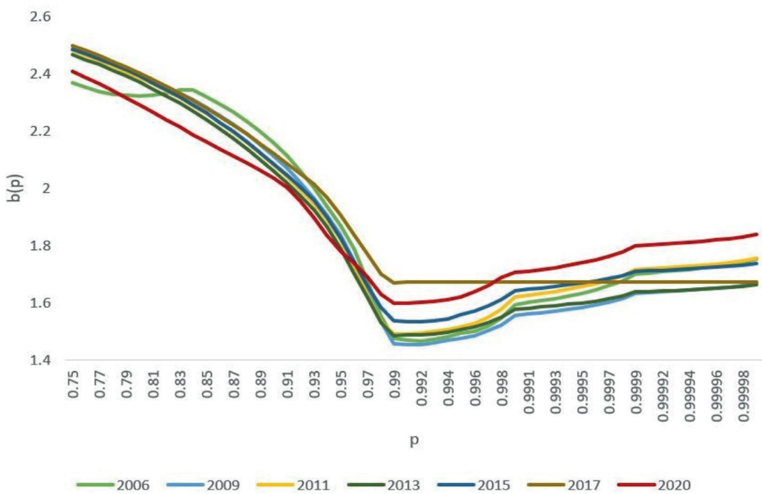
Figure 4 shows the generalized Pareto coefficients $b(p)$ obtained for each percentile. The data comes from SII tabulated data and covers CASEN survey years (i.e., every three years) from 2006 onward. These coefficients correspond to the ratio between the average income of the incomes that are above p percentile and the income corresponding to that percentile. To illustrate, if the 90th percentile receives CLP 10,000,000 and if from that point $b(p) = 2$ for all $p > 90$, the average income of the top 10% of individuals is CLP 20,000,000. Informally, $b(p)$ is a measure of the speed with which income grows at that point in the distribution; thus, the average coefficient, based on a percentile, can be interpreted as a local measure of inequality.

26 The seven brackets correspond approximately to those separated by percentile 75 (tax exempt section), 90, 96, 98, 99, and 99.5. The eighth bracket (99.7 percentile) was removed by law in 2017.

27 The code to implement this interpolation is publicly available from the World Inequality Database (https://wid.world).

FIGURE 4

GENERALIZED PARETO COEFFICIENTS (B(P)) FROM NET TAXABLE INCOME



Note: Own elaboration based on data from the SII. On the y-axis, b(p) corresponds to the ratio between the average income of the incomes that are above the p percentile and the income corresponding to that percentile.

Notably, the curve plotted in Figure 4 is not constant. This suggests that precision would have been lost if a simple Pareto interpolation from an arbitrary percentile had been used. The second feature to note is that unlike for gross income from tax data[28], the estimated Pareto coefficient decreases rapidly between the 75th and 99th percentiles and then grows moderately. This is consistent with the progressive effect of the Chilean tax system dominating the increasing concentration of income up to the 99th percentile. And from the 99th percentile even net income becomes more concentrated at the top of the distribution.

Step 2. Using the CASEN survey, we construct net taxable income, so it is comparable to the synthetic base generated in **step 1**.[29] To correct for the significant underreporting of capital income we propose a simple strategy, similar to the adjustment used by ECLAC until 2011. The ECLAC adjustment consisted of adding between 2.8% and 12.9% of autonomous income to the highest income quintile from 1990 to 2006 (Bravo and Valderrama, 2011). The problem, however, was the discontinuous nature of the imputation, adding zero

[28] For gross income, the Pareto coefficient b(p) is increasing in income. This demonstrates that the empirical distribution is more unequal than a standard Pareto distribution.

[29] The taxable income corresponds to the income from dependent and independent work, excluding payment in kind, plus dividends, shares, withdrawals, and property leasing. It is not possible to separate the tax-exempt DFL-2 house rental from taxable rentals.

to the 79th percentile and increasing income from the 80th percentile upwards by approximately 5%.

Based on this imputation strategy, we implement an alternative where the proportion of added capital is linearly increasing in income in such a way that the adjustment is continuous even at its starting point. The correction adds capital income proportional to total income, independently of the declared capital income. To the richest individual a fraction, *k*, of the ratio between the equivalent capital in national accounts and the total autonomous income measured in the survey is imputed, which equates to close to 25% for the years under study. The imputed capital then decreases linearly until it reaches zero at the 80th percentile and below. Accordingly, a continuous adjustment is generated that is consistent with the fact that capital participation tends to grow with income. Capital income is only added to individuals below the 80th percentile if they report it. After this correction, aggregate capital income is still considerably lower in the CASEN survey than it is in national accounts, and top income earnings higher in the tax base.

If this step is not completed, the missing rich correction will incorporate more high- wage individuals at the top of the distribution to the detriment of individuals with high capital incomes. Table 6, in the next section on results, and the accompanying discussion should clarify this argument.

Step 3. Following the methodology proposed in Blanchet et al. (2022a), the net taxable income is used as common variable to adjust for the underreporting and nonresponse of the richest individuals—that is, the missing rich. The tax data is assumed to provide a credible lower limit for the number of individuals who are above certain income level.[30] The 95th percentile is chosen as the confidence limit for the CASEN survey in the central scenario. For the 95th percentile and above it is assumed that the number of individuals represented by each observation is underestimated. As a result, new population weights consistent with the income from the tax records from the selected percentile are obtained.[31] The literature on the concentration of income and wealth of the super-rich suggests that the missing rich phenomenon in surveys is relevant only from the 90th percentile and up (Ruiz and Woloszko, 2016).

It should be noted that the missing rich problem is generated because of the *omission of individuals* who should be represented, as well as the underreporting of income *to a greater degree than in the rest of the distribution*. To correct the representation issue, it is assumed that individuals who did not answer the CASEN survey necessarily declared taxes, which is reasonable. It is not

[30] Of course, the nature of evasion implies that the real number is higher. Fairfield and Jorratt (2016) estimate an evasion level of 46% for the complementary global income tax.

[31] We decided not to use the multiplicative adjustment of income because the factor is greater than 1.5 for less than 5 observations, the average is 0.9999, and the standard deviation is less than 0.005. The adjustment was therefore deemed unnecessary.

assumed, as it would be very unrealistic, that the tax data source includes all taxable income. Tax underreporting is corrected, together with survey biases, in the proportional adjustment to national accounts outlined in **step 5**.[32]

One of the virtues of this calibration algorithm is that it allows the point from which the tax data replaces survey data in the final distribution to be found endogenously. Blanchet et al. (2022a) estimate that the merging point is close to the 80th percentile for the CASEN survey. Adjusting CASEN survey from the 80th percentile is the best choice only when using the CASEN and tax data as only sources, and not national accounts. And because in a later step of the algorithm income is adjusted for national accounts, the objective here is only to correct the additional biases not all biases. For this reason, an intermediate scenario, the 95th percentile, is selected as the merging point.

The methodology used here minimizes a combination of the distortions of the original sample and the deviations with respect to levels of the administrative tax record, maintaining the representativeness of the survey for selected variables. The proportion and number of contributors, dependent workers and independent workers are maintained because the survey is assumed to be representative in those variables.

Performing the missing rich correction adds observations to the top of the distribution. The population weights are rescaled to maintain the representativeness of the total number of individuals and the number of individuals in each income category. Rescaling the population is not relevant for calculating income shares, Gini coefficients, and other distributive analyzes.[33] It is important, however, when calculating the aggregate magnitudes necessary for the adjustment to national accounts. And, regarding this adjustment, although rescaling the population is not neutral in distributional terms, it is a correct approach in order not to generate a population larger than the effective one.[34]

To illustrate the effect of this step on the income distribution, Figure 5 shows the Lorenz curve of total net taxable income before and after correcting for representativeness. The replacement of observations in the upper part of the distribution shifts the entire Lorenz curve to the right, increasing the concentration in the top incomes In this way, the Gini coefficient of net taxable income increases from 0.49 to 0.53 when including the imputed capital and then to 0.56 when correcting for the missing rich.[35] The effect on the median income and on lower percentiles is much smaller or virtually nil.

32 Tax evasion is not calculated separately because evasion is not a central research objective of the paper and several additional assumptions are required.

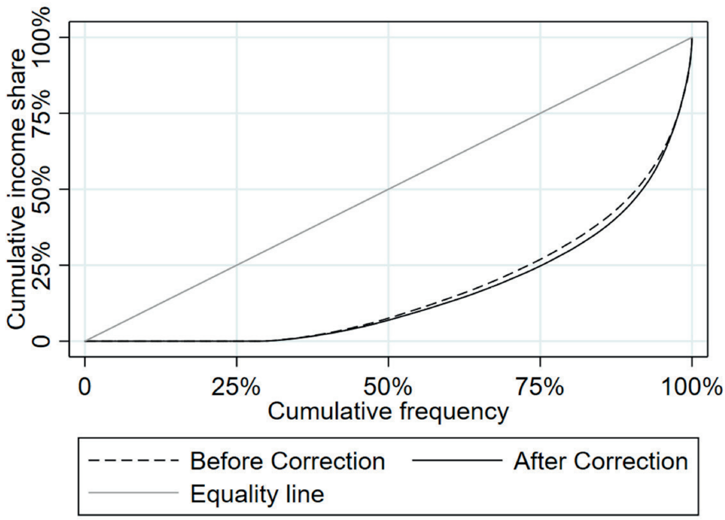
33 It does not affect median income, Gini coefficients, or the shares of each fractile.

34 The effect of rescaling is small because the methodology considers that the original population is similar to the corrected one.

35 The reported Gini is slightly higher than 0.47 from the 2017 CASEN survey data for two reasons. One reason is that taxable income does not include subsidies and the other is that it uses the individual as the unit of observation rather than the household.

FIGURE 5

ORIGINAL AND BFM-CORRECTED LORENZ CURVE FOR TAXABLE INCOME IN CASEN 2017



Note: Own elaboration from CASEN and SII data. BFM is an abbreviation for the authors of Blanchet et al. (2022a).

In order to separate the effects of the adjustment to national accounts from the effects obtained by correcting for the missing rich, results will also be shown omitting this step (3). These effects, however, are not fully separable because the reassigned weightings mainly affect the upper part of the distribution and also shift the entire curve. In the results section, the values obtained when applying this step will be denoted by the abbreviation BFM in reference to Blanchet, Flores, and Morgan, the authors of the paper in which this methodology was developed.

Step 4. Having generated the net income and corrected for underreporting and nonresponse from households with higher income, the next step is to obtain the wages and other income gross of tax comparable with national accounts. For this, the inverse of the tax structure is simulated based on a procedure used by the Chilean Ministry of Social Development. We use variables reported in the CASEN survey to quantify tax and social security contributions evasion. Approximately 15% of dependent workers report they do not have an employment contract. For those, their net income equals their gross income.

The construction of the questions in the CASEN survey means that each variable reported is net of taxes and contributions. It is assumed that dependent employees with contract pay income tax in full. Independent, self-employed workers are supposed to pay tax only if they issue a tax invoice. And social security contributions are imputed only for independent workers who respond that they are registered to an AFP or another pension provider.

All income flows are annualized by multiplying reported values by 12, and then the inverse of the tax structure of the complementary global tax is applied. This requires the assumption that each income stream net of taxes is reported by applying the average rate to it and that the tax is only charged once on all components of income.

Step 5. In the final step, the aggregates calculated for each variable are compared to their counterparts in national accounts. The gap between each of these two aggregates corresponds to the extent of underreporting in the CASEN survey. Conventionally, it is assumed that after the BFM correction the total underreporting should be proportional to income. This implies that the correction consists simply of multiplying by the quotient between each pair of aggregates.

Adjusting to national accounts after adjusting for the missing rich has the advantage that underreporting to the SII is also corrected, which is especially relevant for capital income which is underestimated by around 400% on average.

Of that bias in the original data, approximately 200% is corrected with the capital charged in step 3, 40% is corrected when rebalancing the survey weights, and the rest is corrected in the final adjustment to national accounts. When multiplying by the quotient we assume that the remaining biases are proportional throughout the distribution (of each component); thus, acknowledging there is tax evasion for all income but particularly for capital income.

There are numerous alternative assumptions for the distribution of the gap with national accounts. Some authors perform this adjustment by maintaining the poverty rate of the original sample so as not to "statistically eliminate people living in poverty". One pragmatic reason not to perform the adjustment in this way is because it would be arbitrary, similarly to the capital income adjustment outlined previously, to generate a discontinuous adjustment around a particular point. But there is also a more compelling reason: strongly negative saving rates for the poorest households are calculated by considering consumption surveys and unadjusted income (INE, 2018).

Finally, to evaluate the quality of the simulation, the different aggregates that have been constructed are compared with the corresponding official social security records and the data from the SII.[36] The figures obtained for total deposits and total tax collection are very close to the effective ones. As a reference, the Gini coefficient obtained for 2017 is 0.6 considering gross income and corrections for imputed capital, the missing rich, and national accounts. A data appendix is provided with all the aggregate variables used, their sources, and how they were constructed. The code, also available, allows the adjustment

[36] The social security records were obtained from the OECD.

parameters to be changed and automatically updates the graphs and tables presented in an Excel file. It is therefore possible to verify the dependence of the results on the basis of the assumptions made.

7. Results

This section discusses the main results and provides a robustness analysis. First, the adjustment factors are analyzed in Table 3. Then, Figure 6, Figure 7, Figure 8, and Figure 9 show the evolution of the median and the evolution of the 90*th* percentile for independent and dependent workers between 2006 and 2020. Table 5 summarizes the main results for all active workers in 2017. A sensitivity analysis of the results is performed in Table 6, a varying the two relevant parameters. Finally, Figure 12 motivates a discussion about the implications of our methodology for inequality.

The results and conclusions are focused on the median income of each component, so measurements for high income and inequality are shown only as a reference and to facilitate an understanding of the effects of the methodology at relevant points of the distribution. For wages, the gap between national accounts and the CASEN survey is broken down into 30% corresponding to the proportional correction and 10% corresponding to the missing rich. For independent workers, 56% corresponds to the proportional correction and 7% to the missing rich. In our central scenario, this translates to a median gross income of CLP 600,000 for dependent workers and CLP 570,000 for all active workers. In the proposed sensitivity analysis, the median gross income for active workers is between CLP 540,000 and CLP 600,000. There is at least 30% underreporting in the original 2017 CASEN survey (including taxes and imputed contributions). The underreporting will be referred to as the adjustment factor minus one in order to establish a clear relationship between these two values throughout this section.

The adjustment factors shown in Table 3 correspond to the quotient between the comparable aggregate in national accounts and the total amount reported in the CASEN survey. To understand the effects of each step in the methodology, the ratios between aggregates are presented for before correcting for high income and after the BFM correction. A significant fraction of the gap between the CASEN survey and national accounts is caused by the very low probability of CASEN survey participation of the richest households, as well as their underreporting of income. Both phenomena are corrected by applying **step 3**. The rest of the gap is proportionally adjusted according to **step 5**. The total difference between the CASEN survey and national accounts is at least 26% for wages and up to 85% for independent workers (self-employed).

Notably, wages are underestimated by around 40% in the CASEN survey.

This number must be interpreted in conjunction with the tax and social security evasion reported in Table 4. For all years, except 2006, the simulated tax burden was slightly higher than the actual tax burden; thus, the underreporting could also be somewhat higher. If a higher tax burden is simulated, the gross income before correcting for national accounts grows. In any case, these results show that the CASEN survey bias is quite high.

For social security payments, we see the same happen: if a higher tax or a higher social security burden is simulated, the adjustment factor required is lower. This implies that gross adjustment factors, despite being the most reasonable estimates, are subject to a greater degree of error than gross income itself. The only effect of imputing a higher tax burden is greater inequality in gross income after the BFM correction and less inequality in corrected net income. As both adjustments go in the same direction for gross income, it is less problematic to have a small uncertainty about the exact separation.

The income adjustment factor for independent (self-employed) workers is even higher than wages, reaching more than 80% in some years with an average near 60%. These values are in line with the theoretical arguments associated with imperfect accounting that were set out in Section 4. The figures produced by this investigation, however, are more reasonable than those produced by ECLAC, which showed over 300% underreporting of income for some years. Fairfield and Jorratt (2016) find a ratio of 1.5 (equating to 50% underreporting of income) for 2009 tax data as compared to national accounts.

In order to obtain consistent estimates of gross income and employee compensation from the net variables reported in the CASEN survey, it is essential to appropriately allocate income tax and social security contributions. Accordingly, effective collection was compared with simulated collection for pension discounts and taxes. Table 4 shows that simulated complementary global tax collection was up to 20% higher than its effective collection. For social security evasion, in addition to those who declared not to contribute, those who contributed did not necessarily paid the full amount required every month. That is, they paid social security contributions for a few months income or only declared a part of actual income each month. To correct for partial payment of contributions, each individual payment was divided by the ratio of effective social security collection and the simulated one (after controlling for those who paid zero). Unlike social security contribution, tax payment was not adjusted so as not to underestimate the gross income of the upper percentiles. It should be noticed that the number reported in Table 4 for social security evasion does not attempt to measure actual evasion. The objective of this correction is to obtain simulations that match the real amount of total contributions, but the estimated magnitude of evasion is not strictly separable from wages and independent income mismeasurement.

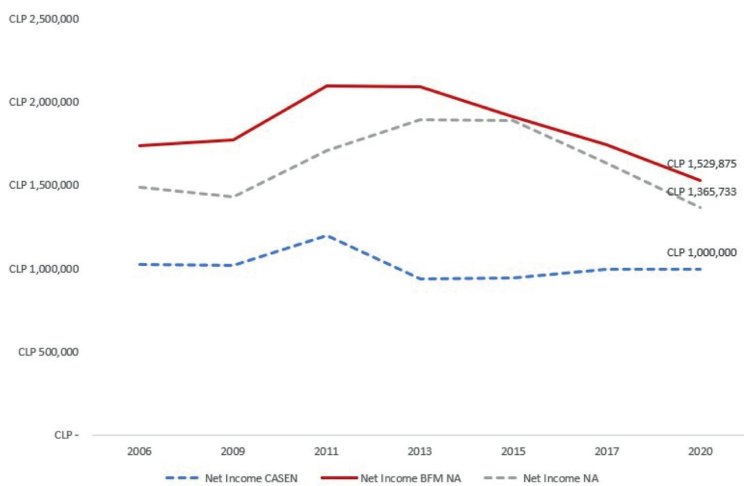
7.1 Main Results

A series of tables and graphs are now presented to show the estimated median income and the income of the 90*th* percentile for both dependent and independent workers. These statistics were chosen because they are common benchmarks for the middle- and upper-end of the distribution. The main occupation for each worker was used for categorization to ensure the categories are exclusive. It should be considered that each worker can also earn self-employed income despite being dependent on his main occupation and vice versa. Accordingly, another option is to report all workers who earn dependent income in one group and, all who earn independent income in another. The results do not change significantly whether the exclusive or the overlapping categorization are used. All results are in constant 2017 CLP for each year.

Figure 6 and Figure 7 show the evolution of three definitions of the net income of independent workers. Variables net of social security contributions are shown because of the high level of evasion. Gross variables are almost identical but not necessarily subject to additional error. The evolution of each definition of income is less regular than in the case of wage earners but the BFM correction has a similar effect. In 2017, the average gap was 63% but with the BFM correction it is distributed heterogeneously, reaching 75% for the 90*th* percentile.

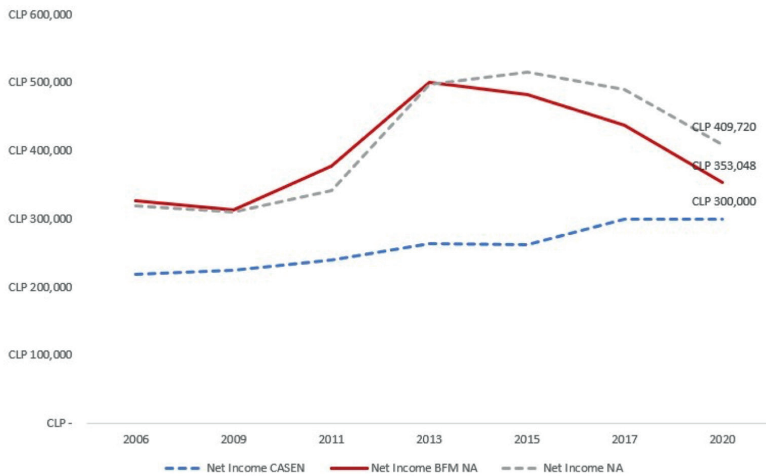
FIGURE 6

INCOME OF THE 90TH PERCENTILE OF INDEPENDENT WORKERS



Note: Own elaboration based on data from the CASEN survey, the Central Bank of Chile, and the SII. NA is national accounts. All figures are in 2017 CLP.

FIGURE 7
MEDIAN INCOME OF INDEPENDENT WORKERS



Note: Own elaboration based on data from the CASEN survey, the Central Bank of Chile, and the SII. All figures are in 2017 CLP.

As mentioned, the income of independent workers (self-employed) is considerably less equal than dependent workers. This is because independent income is a heterogeneous category that not only includes informal workers but also professionals and unincorporated businesses with very diverse earnings. In addition, independent workers are more acutely affected by the economic cycle because they lack stabilizing mechanisms, such as an employment contract. After applying the corrections, the median income of independent workers decreased slightly between 2015 and 2017. This decrease is because the aggregate of equivalent national accounts grew less than the number of self-employed workers (7% versus 13%).

One hypothesis to explain the decrease in the average income between 2015 and 2017 is that the higher number of reported self-employed corresponds to people who started a low-paid activity. This idea is consistent with the fact that the income distribution share of the richest 1% of independents grew from 14.6% to 16.7% between these years. Income reported by independent workers is considered to be less precise due to the nature of their working lives and because the information used to make the correction is of lower quality. It is beyond the objective of this investigation to provide a better justification for these phenomena that affect estimates of independent worker income.

Figure 8 and Figure 9 show the main results for dependent workers. In this case it is possible to impute taxes and social security with greater precision, and the adjustment to national accounts is more reliable. The required adjustment for the 90*th* percentile is found to be greater than the required adjustment for the median when performing the BFM correction. For the 2017 CASEN survey, the adjustment was a total of 54% for gross income for the 90*th* percentile, and 33% for the median, which equates to a gross income of CLP 2,004,000 and CLP 598,000, respectively. For reference, the Gini coefficient obtained from autonomous income using the corrected series is 0.6, and the concentration of the richest 1% of total income is 19%. In the last subsection we will discuss the implications of our methodology to inequality estimations.

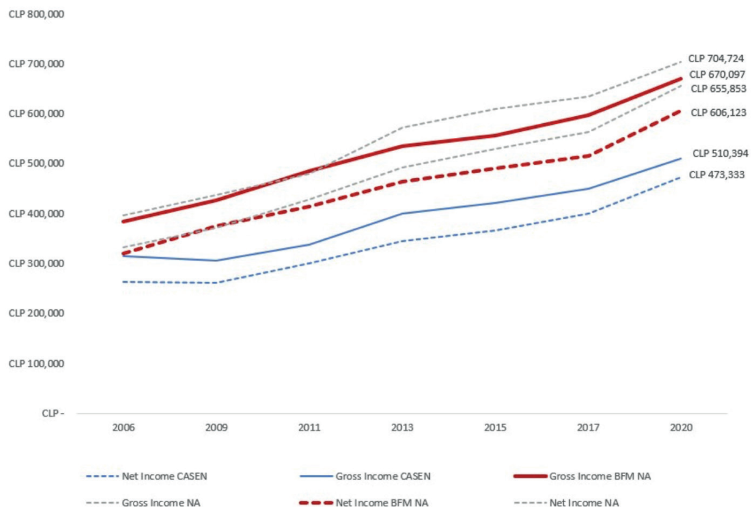
FIGURE 8

LABOR INCOME OF THE 90TH PERCENTILE OF DEPENDENT WORKERS

Note: Own elaboration based on data from the CASEN survey, the Central Bank of Chile, and the SII. All figures are in 2017 CLP.

FIGURE 9

MEDIAN LABOR INCOME OF DEPENDENT WORKERS



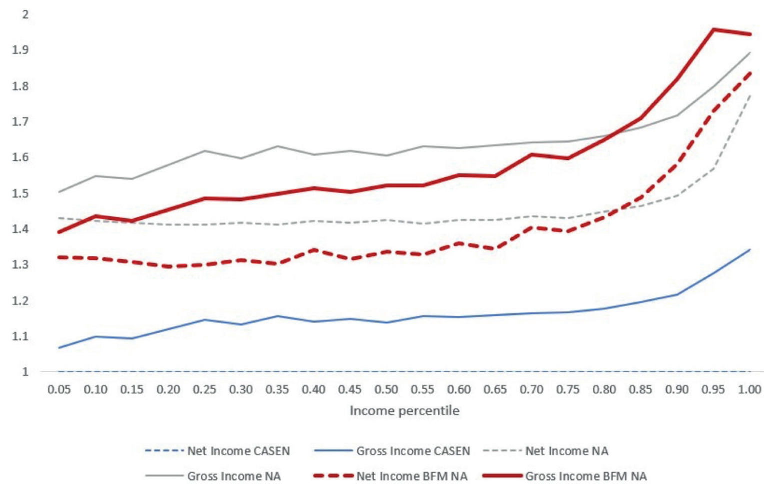
Note: Own elaboration based on data from the CASEN survey, the Central Bank of Chile, and the SII. All figures are in 2017 CLP.

In Figure 6 to Figure 9 it is also possible to see the effect of each adjustment. For example, in 2017, the median income of formal workers would be CLP 635,000 if the gap between the CASEN survey and national accounts were to be distributed proportionally. Considering the missing rich correction, gross median income would be close to CLP 600,000, which would equate to about CLP 515,000 net, discounting the partial payment of social security contributions. This net figure is 28% higher than the net income of CLP 400,000 reported in the 2017 CASEN survey, which is frequently quoted as the median income for workers in Chile.

Figure 10 shows the effect of each of the corrections at the percentile level for labor income of dependent workers. The original net income from the CASEN survey is normalized to one and the respective ratios are displayed. The ratios are increasing in the income percentile for two reasons. First, the progressivity of the income tax causes that the gap between net and gross variables is proportionally larger for higher incomes. Moreover, roughly 15% of workers report they do not have an employment contract, so their net income is equal to gross income. These informal workers are concentrated in the bottom of the distribution and have an average income around 50% smaller. Second, the missing rich re-weighting produces corrections that are larger than above the 80th percentiles and smaller below that percentile.

FIGURE 10

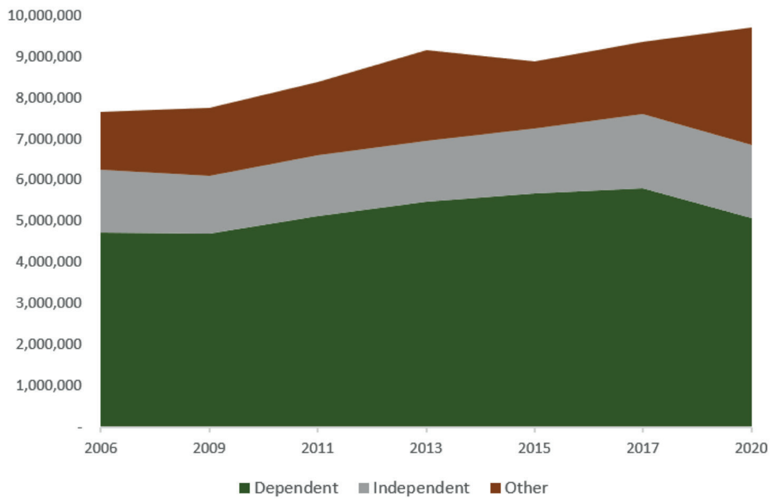
LABOR INCOME OF DEPENDENT WORKERS



Note: Own elaboration based on data from the CASEN survey, the Central Bank of Chile, and the SII. Each line represents the ratio of the corresponding definition of income for dependent workers with the original Net Income from CASEN.

It is interesting that between 2017 and 2020, dependent workers did not experience any fall in their average income in spite of the COVID-19 crisis. Moreover, the median wage evolved with a similar growth rate than in 2006 to 2017 and, the 90*th* percentile grew by nearly 30% in those three years. However, this significant increase has to be weighed against the decline of over 12% in the number of employed workers, as Figure 11 shows. Total real wages increased by barely 3% in those three years, but they were distributed unevenly to less workers. On the contrary, the number of independent workers decreased by just 1% but their median income corrected by national accounts fell by 9%. This is consistent with the hypothesis of counter-cyclical informal (proxied by independent) employment (Loayza and Rigolini, 2011).

FIGURE 11
NUMBER OF INCOME EARNERS BY TYPE



Note: Own elaboration based on data from the CASEN survey. Dependent and independent workers are defined using mutually exclusive categories. Other includes all people who receive some autonomous income such as interests, dividends and rentals.

The results for independent workers are presented separately to underline that the results are subject to greater uncertainty. It is, however, equally useful to describe workers in a single group. Different measures of workers' income are therefore shown in Table 5. Overall, the average net income of all workers is underreported by 53% compared to national accounts. Thus, the median gross income of workers, after correcting for the missing rich and national accounts, is 39% higher than in the original 2017 CASEN survey; it is CLP 570,000 or CLP 595,000 when the correction for high income earners is not applied.

7.2 Robustness

The four figures (Figure 6, Figure 7, Figure 8, Figure 9) and Table 5 illustrate what we consider the best estimates for the evolution of income of independent and dependent workers. However, results change when we change some key parameters, so we perform a sensitivity analysis of the assumptions for the year 2017. Specifically, it is difficult to achieve a high degree of certainty regarding capital income because the CASEN survey underestimates this component by up to 400% as compared to national accounts. Therefore, different combinations of the percentile from which capital income is corrected with tax data following BFM (p), and the magnitude of the imputed capital attributed to the highest income quin tile (k), were considered. The definitions of income presented in Table 6 are the same as in the previous figures and table.

On the basis of the proposed analysis, when looking at the extremes, the joint effect of the parameters *p* and *k* is up to 13% on wages and up to 24% on the income of independent workers. In the most conservative scenario, the gross median wage is CLP 555,000—that is, 23% higher than the gross median wage captured by the CASEN survey. At the highest point, the median wage reaches CLP 625,000 and is only 2% lower without the BFM adjustment. In Table 6 the central parameter combination, also used in the figures, is highlighted. This combination was chosen because it is considered to be a reasonable lower limit for the median income of each of the three groups in the table: dependent, independent, and all workers.

It follows that for the estimated median income of both independent and dependent workers there is a monotonic relationship with respect to the parameters *p* and *k*. The median is increasing with respect to *p* because the BFM correction increases the weight of fewer high-income observations, and this causes the gap and the consequent adjustment to national accounts to be greater. It is also increasing with respect to *k* because, when *k* is higher, the BFM-correction increases the weight of individuals with income from capital to the detriment of those with high salaries. Thus, before correcting for national accounts, there is a lower total wage bill and the adjustment factor is higher.

The effect of parameters *p* and *k* on the 90*th* percentile of both dependent and independent workers' income is somewhat less regular. The tendency is to be decreasing in *k* and *p*. The argument for *k* is analogue to the one presented for the median. When *k* is less, the corrected missing rich are found to have a greater share of labor income than if *k* is large, thus increasing the 90*th* percentile. With a higher *p*, simply a smaller number of individuals is adjusted from the upper part, so the effect is diluted for the 90*th* percentile.

As an additional robustness check, a higher inequality scenario than the one analyzed was also considered. The results for 2017 indicate that even with a Gini coefficient of 0.6 and top 1% income share of 19%, the result is a median gross income of CLP 570,000, which is 39% more than in the original 2017 CASEN survey. A yet more extreme inequality scenario, a Gini coefficient of 0.65 and a top 1% income share equal to 27%, results in a median gross income of CLP 500,000, which is still 23% higher than the 2017 CASEN survey. The Gini coefficients used in these two scenarios represent the highest inequality figures available in the literature for Chile, using the same definition of income. If capital gains and undistributed profits are included higher Gini coefficients and shares of 1% are calculated, but CASEN does not include the necessary data to perform an imputation.

Finally, Table 7 contains the independent income adjustment factors that result from including different fractions of the distributed income of companies (D.42) in their comparable aggregate in national accounts. All the values found for the independent workers decisively depend on this fraction[37].

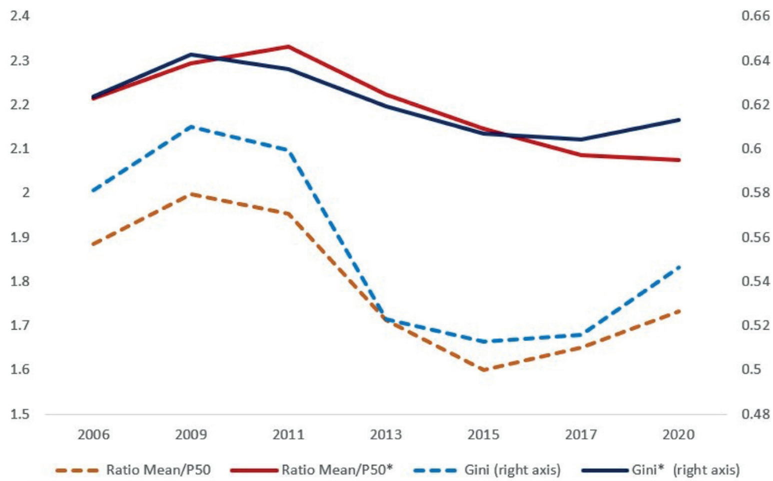
7.3 Implications For Inequality

The methodology and results we develop are designed to measure income accurately and reliably especially for the middle of the distribution. However, it is constructive to analyze the impact of all adjustments on the level and trend of inequality indicators. In addition to the standard Gini coefficient, we consider useful giving attention to the mean-median ratio as simpler inequality indicator. Figure 12 illustrates that the reduction of inequality between 2006 and 2017 is robust in our computation with the trend observed in CASEN. However, this reduction is smaller than the original survey. Between 2006 and 2017, the uncorrected mean-median ratio of gross income falls from 1.89 to 1.65 (12%) while the Gini coefficient did so from 0.58 to 0.52 (11%). Considering corrections, the ratio only falls from 2.21 to 2.09 with the Gini coefficient going from 0.62 to 0.6. Looking at 2017, the correction causes a 26% and 17% increase in the ratio and Gini, respectively. The rapid decline in inequality observed after 2011 is substantially offset when including top income and national accounts corrections. In 2020 there was a partial reversal in the decline in inequality as COVID-19 had a heterogeneous impact across households and workers, related to the ability to work from home, age, gender and other characteristics.

[37] See **Section 4.2**. for details on the construction of the comparable aggregate of national accounts for independent workers.

FIGURE 12

GINI AND MEAN-MEDIAN RATIO OF GROSS INCOME



Note: Own elaboration based on data from the CASEN survey, the Central Bank of Chile, and the SII.
* Asterisks and solid lines denote series corrected for missing rich and adjusted to match national accounts. Dashed lines correspond to CASEN survey income with simulated taxes and social security.

Besides its simplicity, the ratio of the mean to the median provides a reasonably good indicator of a country's income distribution (Birdsall and Meyer, 2015). Gini has more robust theoretical properties, as, for example, the ratio fails the Pigou-Dalton transfer principle.[38] However, the mean-median ratio is easier to understand and, in usual distributions (such as the lognormal and Weibull) is associated directly to inequality. Another benefit in our context is that it is not sensitive to changes in the share of the top 1% that hold the average, unlike the Gini coefficient. We emphasize that the Gini coefficient is more sensitive to the assumptions made for allocating capital income and to the top of the distribution in general.

38 Namely that a transfer of income from a richer to a poorer person, so long as that transfer does not reverse the ranking of the two, will result in greater equity.

8. Concluding Remarks

This is the first study in Chile to compare and combine administrative records, national accounts, and surveys in a consistent theoretical framework to obtain estimates of dependent and independent worker income in the middle of the distribution. By harnessing the advantages and correcting the limitations of these data sources it is possible to generate better estimates than when using each source separately. The methodology serves as a basis to implement distributional national accounts in countries with similar data quality limitations.

We find that the average gap between income in the CASEN survey and national accounts is larger for independent workers than it is for dependent workers, 59% and 40% respectively. The missing rich phenomenon explains 10% of this gap for dependent income and 5% for independent income. Considering this, in the main scenario for 2017, the median gross income was approximately CLP 600,000 for dependent workers (employees) and CLP 440,000 for independent workers (self-employed). This equates to a joint median gross income of CLP 570,000. In each scenario analyzed, between 2006 and 2017, the median real wage grew by between 4% and 5% annually, which is 2% more than both the income of the 90*th* percentile and real GDP per capita. Between 2017 and 2020, the median real wage had a similar growth and the 90*th* percentile grew by nearly 10% but the number of active employees declined by 12%. The trend in our inequality estimations fall between Fairfield and Jorratt (2016) (flat) and official data from the world bank (important fall) with a reduction from 0.62 in 2006 to 0.60 in 2017 instead of 0.58 to 0.52 in the CASEN survey with imputed taxes.

The methodology applied in this study addresses the fact that underreporting of income is particularly prevalent among high income earners, although the practice is present throughout the whole distribution. The tax and social security simulation performed generates revenues similar to the real administrative records. Social security contributions are realistically imputed and scaled up to match administrative records, resulting in greater reliability. To account for the numerous assumptions still required to get precise results, a sensitivity analysis was proposed and implemented to consider deviations from the central estimations.

The deficiencies that prevent income surveys capturing higher income are well recognized, but it is also necessary to incorporate the conclusions of this study regarding middle income earners into public discussion and policy design. A larger income, whether 40% more or even 20% more, significantly impacts the standard of living for low- and middle-income families. Despite the progress made in this investigation, the data series that have been presented here should be understood as prototypes for which it is possible and desirable to incorporate improvements. The same is also true for the national accounts and other sources of information. Our results depend on some relatively arbitrary parameters; however, there are four dimensions where it is possible to improve the methodology used if more data were available. First, precision for independent (self-employed) workers would be substantially improved if primary source data were available for mixed income, separated from household operating surplus and quasi-corporation income. Second, the imputation used for capital income is unrealistic and is only functional when studying income close to the median. Third, the point at which survey data are mixed with tax data—that is, the merging point of the two data sources—can be determined endogenously by considering the two types of biases present, as discussed in the methodology section. Finally, the simulation of the tax structure can also be adjusted by modeling tax evasion in a more sophisticated way or, ideally, directly imputed by matching individuals from the survey data to the tax data.

The question of whether economic growth experienced by Chile has benefited different socioeconomic groups and to which extent is a controversial issue. This paper sheds light on the matter by arguing that median income is much higher than what CASEN shows, and which is used in popular media. There is evidence also that inequality has declined, but to a lesser extent than in CASEN data. Whether this is enough or not is a value judgment, but the discussion needs to be grounded in sound evidence making clear the data limitations. Beyond these considerations, Chile is still a country with relatively high levels of inequality. Future research should aim at a more detailed treatment of top income earners and impute a distribution to the excluded components of GNI, such as direct taxes and withheld capital income, to improve comparability with other countries. Future stages of this project will aim to incorporate tax microdata and unpublished national accounts.

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9. Tables

TABLE 1

AVERAGE MONTHLY NET INCOME (CLP) ACCORDING TO CASEN SURVEY (C) AND SII (I), 2017

2017	Average	P50	P90	N	Share 1%
Wages of dep. workers (C)	CLP 589,397	CLP 400,000	CLP 1,101,667	5,793,314	8.9%
Total wages (C)	CLP 564,112	CLP 378,333	CLP 1,027,500	6,011,892	9.0%
Income of ind. workers (C)	CLP 493,262	CLP 285,623	CLP 1,000,000	1,803,263	16.5%
Total independent income (C)	CLP 477,361	CLP 274,923	CLP 1,000,000	2,282,220	16.7%
Net taxable income (C)	CLP 529,451	CLP 335,000	CLP 1,000,500	9,339,690	11.3%
Net taxable income (I)	CLP 564,169	CLP 299.118*	CLP 1,286,763	9,941,065	13.1%

Note: Own elaboration based on data from CASEN survey, and SII for the last row.
*Calculated from a generalized Pareto interpolation with tabulated data from P75. P50 and P90 denote the corresponding percentiles so that P50 equals the median. N corresponds to the number of individuals represented by the CASEN survey using the standard (regional) expansion factor. The difference between the number of individuals in the first column and the second column, or the third and fourth, is due to the fact that some individuals that receive salaries despite being independent in their main occupation, and vice versa.

TABLE 2
NOMINAL MONTHLY INCOME PER CAPITA IN NATIONAL ACCOUNTS AND CASEN SURVEY (CLP)

	2006	**2009**	**2011**	**2013**	**2015**	**2017**
1. Total household income CASEN (CLP)	185,609	226,351	254,549	324,769	371,638	433,577
2. Subtotal CASEN and NA complements*(CLP)	329,935	407,943	479,009	566,054	662,850	743,372
3. GNI (CLP)	381,558	456,637	570,134	641,966	741,037	813,582
1. : 3. (Ratio HS to NA)	0.49	0.50	0.45	0.51	0.50	0.53
(3. - 2.) : 1. (HS to NA gap/total HS income)	0.28	0.22	0.36	0.23	0.21	0.16

Note: Central Bank of Chile and CASEN Surveys. GNI corresponds to the annual Gross National Income divided into twelve from National Accounts.
*The online appendix provides details on the components and magnitudes of this line.

TABLE 3
NATIONAL ACCOUNTS ADJUSTMENT FACTORS, WITH AND WITHOUT BFM CORRECTION

	2006	**2009**	**2011**	**2013**	**2015**	**2017**	**2020**
Wages	1.26	1.43	1.43	1.43	1.44	1.41	1.38
Wages BFM	1.22	1.34	1.38	1.34	1.30	1.29	1.21
Self-employed income	1.46	1.35	1.42	1.85	1.82	1.63	1.37
Self-employed income BFM	1.49	1.33	1.57	1.76	1.64	1.46	1.18

Note: Own elaboration based on data from CASEN, the Central Bank of Chile, and SII.

TABLE 4

RATIO SIMULATIONS TO ADMINISTRATIVE RECORDS

	2006	2009	2011	2013	2015	2017	2020
Tax revenue IGC BFM	1.18	0.94	0.94	0.84	0.83	0.91	0.91
Social Security Evasion BFM	0.24	0.21	0.35	0.36	0.38	0.35	0.55

Note: Own elaboration based on data from CASEN, the Central Bank of Chile, and SII.

TABLE 5

LABOR INCOME OF ACTIVE DEPENDENT AND INDEPENDENT WORKERS, 2017

	Mean (CLP)	Median (CLP)	P90 (CLP)
Net Income CASEN	579,357	370,167	1,090,000
Gross Income CASEN	664,149	408,615	1,252,511
Net Income BFM NA	886,833	511,861	1,768,609
Gross Income BFM NA	967,029	568,414	2,004,139
Net Income NA	884,302	544,119	1,633,849
Gross Income NA	966,826	593,956	1,828,474

Note: Own elaboration based on CASEN, SII and Central Bank. BFM stands for the Blanchet et al. (2022a) correction and NA stands for National Accounts corrections. All figures are in 2017 CLP.

TABLE 6

SENSIBILITY ANALYSIS FOR GROSS INCOME, 2017

		Dependents p50	Dependents p90	Independents p50	Independents p90	All Workers p50	All Workers p90
CASEN[1]		450,345	1,302,293	300,000	1,007,393	408,384	1,250,000
$p = 0.9$	$k = 0.5$	554,309	2,115,156	391,217	1,956,086	545,222	2,115,156
	$k = 0.9$	576,258	1,998,850	424,454	1,899,253	565,938	2,013,136
	$k = 1.2$	593,877	1,986,959	454,087	1,793,945	591,412	1,986,959
p=0.95	$k = 0.5$	572,958	2,067,182	403,846	1,807,754	538,699	2,070,588
	k=0.9	**598,330**	**2,004,139**	**436,940**	**1,747,760**	**568,414**	**2,004,139**
	$k = 1.2$	622,183	1,934,057	469,971	1,753,167	583,296	1,925,604
$p = 0.99$	$k = 0.5$	609,872	1,830,973	442,080	1,649,148	568,853	1,801,112
	$k = 0.9$	620,223	1,827,207	466,094	1,737,037	580,633	1,808,245
	$k = 1.2$	626,638	1,835,134	486,573	1,724,638	587,760	1,815,095
Without BFM[2]		635,098	1,836,554	490,155	1,645,928	596,513	1,828,436

Note: Own elaboration based on data from the CASEN survey, the Central Bank of Chile, and the SII. The parameter p corresponds to the percentile from which the BFM correction is applied, and k to the proportion of capital attributed to the highest income quintile. For a more detailed description see the methodology section.
1: CASEN estimates presented in the first row include taxes and imputed contributions as well as all rows.
2: Last row shows the estimates without correcting for missing rich and adjusting for national accounts. All figures are in CLP.

TABLE 7

INDEPENDENT INCOME ADJUSTMENT FACTORS FOR DIFFERENT FRACTIONS OF D.42

%D.42	2006	2009	2011	2013	2015	2017	2020
0%	1.15	1.00	1.01	1.33	1.30	1.19	1.08
20%	**1.46**	**1.34**	**1.42**	**1.85**	**1.82**	**1.63**	**1.36**
40%	1.77	1.69	1.83	2.38	2.34	2.08	1.65
60%	2.08	2.03	2.24	2.91	2.86	2.52	1.94
80%	2.39	2.38	2.65	3.44	3.38	2.97	2.22
100%	2.70	2.72	3.06	3.96	3.90	3.42	2.51

Note: Own calculations based on the Central Bank and CASEN. D.42 corresponds to the distributed income of corporations (D.421) and quasi-corporations (D.422).

Appendix

10. Parametric Estimation Of Median Income

This section details the theoretical foundations used to elaborate Figure 1 and the results presented in the introduction. We propose a simple exercise is to illustrate the implications of the gap between numbers reported by national accounts and by CASEN. The exercise consists of imputing a parametric distribution to the aggregate income of national accounts, assuming a given level of inequality, and comparing the result with the distribution actually captured in the 2017 CASEN survey.[39] Using a parametric distribution, it is possible to obtain an approximation of median income from labor and capital that is consistent with the mean of national accounts at different levels of inequality. Given an average income, greater inequality (represented by the Gini coefficient) is necessary for a lower median, leaving the type of distribution constant. This exercise is an extremely simplified version of DINA that uses only two variables and a fixed distribution as inputs. This is only an exercise to show inconsistencies because to have a better assessment DINA uses many variables and sources to impute a micro distribution to macroaggregates in a much more sophisticated and precise way.

Figure 1 shows the gross median income for Chile calculated using a parametric distribution, different Gini coefficients and the average national income as reported by national accounts.[40] It also displays the median of the income from labor and capital as reported in the 2017 CASEN survey as comparison (in red). According to national accounts, the average national income, for 8.2 million factor income earners, is close to CLP 1,350,000 per month, and the GNI components not included, indirect taxes and capital depreciation, amount to about CLP 350,000. To combine this parameters, Pinkovskiy and Sala-i Martin (2009) argue that the lognormal and Weibull distributions are the best choice to fit to empirical data. We select the Weibull distribution because it has lower medians for a given mean and the displayed Gini coefficients.[41]

The true or empirical distributions of a country's income have different degrees of fit to known probability distribution functions. For the purposes of this exercise, only two parameter distributions are used, as they are the most commonly used type.

[39] A similar endeavor, on a global scale, is undertaken in Pinkovskiy and Sala-i Martin (2009) using average income from national accounts and different parametric distributions.

[40] The comparable income of national accounts equals GNI minus capital depreciation and indirect taxes, which is equivalent to the factor compensation of capital and labor, net of depreciation and indirect taxes.

[41] Although this relationship is not monotonic and does not hold outside the interval of Gini coefficients we display.

In past research, the Weibull distribution was found to be the best fit for data from OECD countries (Bandourian et al., 2002). In Pinkovskiy and Sala-i Martin (2009), a larger sample of 191 countries is considered and they find that the lognormal is generally more precise. An additional benefit is that there are analytical expressions of these distributions for all statistics of interest, which clarifies the analysis.

Table 8 shows the density, mean, median, and Gini function in terms of the parameters k, α, σ and μ, and of Γ and Φ, which correspond to the cumulative standard normal and gamma functions respectively. These two distributions have the property of being closed for multiplication—that is, $X \sim f(x) \rightarrow cX \sim \mathrm{f}(x)$—which is attractive if you want to make a proportional fit. The Gini coefficient (for any distribution) is also insensitive to scale.

TABLE 8
DENSITY FUNCTION AND STATISTICS FOR WEIBULL AND LOGNORMAL DISTRIBUTIONS

	Weibull	**Lognormal**
Density function	$k\alpha\left(kx\right)^{\alpha-1}\left(e^{-kx}\right)^{\alpha}$	$\left(x\sigma\sqrt{2\pi}\right)^{-1} exp\left(-\frac{\left(ln\left(x\right)-\mu\right)^{2}}{2\sigma^{2}}\right)$
Mean	$\Gamma\left(1+1/\alpha\right)$	$\exp\left(\mu+\frac{\sigma^{2}}{2}\right)$
Median	$\log\left(2\right)^{\{1/\pm\}}/\mathrm{k}$	$\exp\left(\mu\right)$
Gini	$1-2^{\left(-\frac{1}{\alpha}\right)}$	$2\Phi\left(\sigma/\sqrt{2}-1\right)$

Note: Own elaboration based on Lubrano (2017).

Regarding the information in Table 8, if two of these statistics are known, it is possible to clear all the parameters of the distribution and, consequently, obtain the missing statistic. The median calculated in this way complies with being monotonically increasing in the mean and monotonically decreasing in the Gini coefficient, both good properties. It is desirable to perform goodness-of-fit measures to find the most appropriate distribution for the population's income.

TABLE 9
PARAMETRIC MEDIAN FROM MONTHLY GNI PER WORKER 2017

Gini	**Median1**	**Median2**
0.45	CLP 893,515	CLP 980,653
0.5	CLP 810,413	CLP 885,336
0.55	CLP 721,858	CLP 779,589
0.6	CLP 629,014	CLP 665,474
0.65	CLP 533,267	CLP 545,873
0.7	CLP 436,281	CLP 424,657

Note: Own calculations based on data from the Central Bank and Ffrench-Davis et al. (2016) using Table 8. Average monthly income corresponds to GNI less indirect taxes and capital depreciation. This amount was divided by 12 to obtain monthly data. Median1 assumes a Weibull distribution, and Median2 assumes a lognormal distribution. All monetary figures are in CLP.

Table 9 shows the median calculated for different Gini coefficient values, leaving the mean fixed. For the average, GNI is used, discounting indirect taxes and 12.3% of GNI for capital depreciation. The value for depreciation is obtained from Table 4 in Ffrench-Davis et al. (2016), averaging the depreciation calculated for the 2011–2015 interval, using 2008 prices. Total income is divided by the number labor and capital income earners. In other words, all the calculations consider that the population consist of all individuals with an autonomous income stricter than zero.[42]

The rationale for discounts made the income is that most micro definitions of income do not include income that is used to finance capital depreciation. For example, according to the SNA 2008, income is defined as the maximum amount that a household or other entity is capable of consuming in goods and services without reducing its stock of assets or increasing its financial and non-financial liabilities. It is reasonable to assume that a very small fraction of the income reported in surveys (including earnings, withdrawals, and other income) is used to later cover capital depreciation.

[42] The chosen distributions are defined for positive values, and the probability defined for x = 0 is identical to zero. In order to include values equal to zero, censored distributions must be used, which complicates the analysis unnecessarily.

Teacher Quality and Learning Inequality*

Calidad Docente y Desigualdades de Aprendizaje

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Abstract

This paper explores the contribution of teachers to student performance in Chile's college admission test (PSU). Our analysis is based on a unique teacher-student matched dataset and decomposition methods. The findings suggest that teachers' performance on the PSU and the characteristics of their educational degrees are significant predictors of students' success. When controlling for students' and predetermined school characteristics, the gapbetween voucher and public schools is reduced. Productivity differences emerge as key factors driving the disparities across school types. The analysis underscores the crucial role of teacher-student interactions in shaping student outcomes.

Key words: *Student performance, teacher characteristics, sorting, education inequalities.*

JEL Classification: *I2, I24, J24*

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Resumen

Este documento explora la contribución de los profesores al desempeño estudiantil en la prueba de admisión universitaria de Chile (PSU). Nuestro análisis utiliza un conjunto de datos único de profesor-estudiantes y métodos de descomposición. Los resultados sugieren que el desempeño de los profesores en la PSU y sus títulos educativos son predictores significativos del éxito estudiantil. Al controlar por las características predeterminadas de los estudiantes y la escuela, la brecha entre colegios subvencionados y públicos se reduce. Las diferencias de productividad surgen como factores clave que impulsan las disparidades entre los tipos de colegios. El análisis subraya el papel crucial de las interacciones entre profesores y estudiantes en los resultados educacionales.

Palabras clave: *Rendimiento estudiantil, características del profesor, selección, desigualdades educativas.*

Clasificación JEL: *JEL: I2, I24, J24.*

"The art of teaching is the art of assisting discovery",
Mark Van Doren

1. Introduction

Education plays a vital role as a determinant of personal and societal development (Heckman 2000), with teachers identified as a critical input in this process (Rockoff 2004; Rivkin, Hanushek, and Kain 2005; Aaronson, Barrow, and Sander 2007; Chetty, Friedman, and Rockoff 2014a, 2014b; Jackson 2018; Gilraine and Pope 2021; Petek and Pope 2023). Moreover, research consistently demonstrates that the learning environment and resources provided by schools profoundly impact student outcomes (Jackson, Johnson, and Persico 2016). However, understanding the complex dynamics between schools, teachers, and student achievement remains an essential question with implications for policy initiatives and educational reforms.

This paper examines the factors that determine student achievement, focusing on the impact of teachers and schools on students' outcomes. To address this question, we use a unique dataset from Chile, which gathers administrative information from multiple sources. The extensive dataset includes records of students, teachers, and schools. However, what makes this data unique is the availability of detailed variables describing teachers' performance in high-stakes college admission assessments at the age of 17-18, how high they ranked "education" as their career of choice when applying to college, their high school GPA, and detailed information on their professional degree in education. This granular level of information merged with student-level results on Chile's college admission exams allows us to go beyond what the literature has explored about the teacher-student dyad.[1]

We investigate whether there are differences among schools in their ability to enhance student academic performance and to what extent these differences can be attributed to teacher quality. To do this, we employ a multi-step approach. First, we estimate a production function for student achievement using a value-added specification. We then explore how each input contributes to reducing the performance gap between public and voucher school students. Subsequently, we examine whether teacher quality can account for the disparities in the test score distributions across different school types. To achieve this, we utilize both classical and RIF Oaxaca-Blinder decompositions. Finally, following the methodology outlined in Firpo, Fortin, and Lemieux (2018), we implement an empirical strategy that decomposes the achievement gap into a composition effect (due to differences in the distribution of observed characteristics) and a structure effect (due to differences in the productivity of observed characteristics). This approach enables us to analyze mean performance differences between students in each type of school and to explain the gap across the entire performance distribution.

Given the pronounced levels of segregation within Chile's educational system and the substantial disparities in student outcomes, this paper contributes to the literature on multiple fronts. While previous studies have highlighted the influence of socioeconomic factors in explaining the performance gap across school types (Mizala and Romaguera 2000; Contreras 2002; Bravo, Mukhopadhyay, and Todd 2010; Iturra and Gallardo 2022), we examine the role of teachers. We address this gap by delving into granular information within the performance production function, focusing on the college admission test performance as our variable of interest. Due to the complex, many-to-many nature of the student-teacher relationship and our high-stakes outcome, we concentrate on high school students. Our sample comprises over 400,000 test-takers between 2013 and 2021. A limitation of our study is that we only have access to information on college admission assessments from 2006 onward. Consequently, our analysis is confined to investigating the role of young teachers, as only for them can we observe their performance in the same test their students are taking.

[1] For more structural analysis of the teacher-student relationship and the process of accessing higher education in Chile, see Montaño et al. (2023).

This research yields several findings. First, the value-added model demonstrates significant transmission of college admission test performance (PSU) from teachers to students. Additionally, other characteristics of teachers, such as being more experienced or having a higher proportion of them with a formal education degree, are associated with higher student performance. However, even after accounting for student background characteristics and a comprehensive set of teacher attributes, the type of school attended in high school continues to play an essential role in explaining PSU performance. This suggests that students' and teachers' characteristics alone cannot fully explain the performance gap observed between students attending public and private-subsidized schools in Chile.

Then, we delve into estimating the decomposition of the PSU-performance gap across school types into its contributing components, such as students' family characteristics and previous standardized test performance, teacher characteristics, and school-specific PSU take-up rate. The Oaxaca-Blinder analysis reveals that we can explain 15 out of the 23-point gap in math and 12 out of the 28-point gap in Spanish solely by accounting for the observed characteristics between the two groups. These differences emerge when comparing each group's mean college admissions test performance. When we apply the RIF Oaxaca-Blinder decomposition to the average performance, we find that teachers' influence prominently manifests in the form of a price effect, suggesting differences in the productivity of teachers by school type, particularly in math. This finding indicates that teachers with similar characteristics exhibit greater effectiveness in voucher schools, thereby contributing to performance disparities.

Exploiting the RIF Oaxaca-Blinder decomposition, we further examine the role of each contributing component throughout the entire distribution of test scores. For teacher characteristics, we identify the heightened significance of the structure effect in the high-end of the performance distribution. Specifically, we find that at the top 80% of the test score distribution, the teacher structure effect explains up to 30 points of the school-type performance gap in mathematics, indicating that teacher characteristics substantially influence student performance among high-achieving students. On the other hand, for Spanish, we document that the effect of teachers explaining the gap is more important on the lower part of the distribution but much smaller in magnitude. Finally, we find evidence suggesting complementarity between students' past performance and teachers' characteristics, suggesting that teachers' productivity effect is more prominent when students have better baseline performance.

To the best of our knowledge, this is the first paper to explore the transmission of teacher-student performance in the context of college admission tests in Chile. In a previous study, Contreras (2002) investigated the impact of school type on college admissions test scores; however, teacher characteristics were not included in the analysis. Other studies conducted in Chile have analyzed the effects of teacher characteristics on lower-stake exams (Toledo and Valenzuela 2015; Canales and Maldonado 2018; Barrios Fernández and Riudavets 2021). In addition to examining a higher-stake exam, our paper also considers teachers' performance on the college admissions test as a relevant factor in explaining the performance gap across students attending public and voucher schools.

The remainder of the paper is organized as follows. Section 2 describes the institutional background of the educational system in Chile. Section 3 summarizes the previous literature, and Section 4 describes the data. Section 5 presents the methodology and results of an exploratory analysis of the main factors that determine student performance on the college admission test. Section 6 presents the methodology and the decompositions of the achievement gap across school types for different moments of the distribution, and Section 7 concludes.

2. Institutional Background

The Chilean educational system consists of eight years of primary and four years of secondary education. There are three types of schools: public schools, funded and administered by the government; voucher (private-subsidized) schools, which receive partial funding from the government through a voucher system and are administered by the private sector; and private fee-paying schools, funded and administered by the private sector. Regarding the distribution of students, approximately 40% are in public schools, 50% are in voucher schools, and only 10% are in private fee-paying schools.

Throughout primary and secondary education, students undergo SIMCE examinations (Sistema de Medición de la Calidad de la Educación), standardized assessments conducted nationally to evaluate education quality and school performance. These assessments cover subjects relevant to each grade level, including mathematics and reading comprehension.

Successful completion of secondary education is a prerequisite for admission to higher education institutions in Chile. Most higher education institutions select their students using a centralized deferred acceptance admission system that only considers the performance of students in secondary education and a standardized national university entrance exam (PSU).[2,3] The PSU is

[2] There are some few exceptions that include Special Admissions, which are reserved slots for students who meet specific criteria, such as athletes, indigenous students, or students with disabilities, and Admission by Merit, reserved for students with exceptional academic achievements or talents in specific fields.

[3] In the recent years the PSU has been reformed, but the admissions system remained the same. For the years considered in this study, PSU is the relevant test.

usually taken during the last year of secondary education (12th grade) at the end of the academic year. It consists of two mandatory sections, Mathematics and Language and Communication (Spanish), and at least one of the other sections, Scientific Reasoning or History, Geography, and Social Sciences. Some private universities do not participate in the centralized system and have admission tests or criteria that may differ from the PSU.

It is crucial to note that many students attend “preuniversitarios”, institutions preparing them for the PSU, offering content review, test-taking strategies, and simulations. While our study primarily focuses on teachers within traditional academic settings, we acknowledge the potential interplay with “preuniversitarios”, despite a lack of available data to assess this issue.

Successful completion of secondary education is a prerequisite for admission to higher education institutions in Chile. Most higher education institutions are part of a centralized deferred acceptance admission system, in which students’ performance in secondary education and the standardized national university entrance exam (PSU) are the main factors for acceptance. Student admission to each program depends on individual performance, the reported ranking of program-university bundle according to their preferences, and available slots.

Despite recent reforms addressing inequality, challenges persist in the Chilean education system, marked by disparities in access, educational quality, and funding among public, voucher, and private schools. While public schools often serve disadvantaged populations, voucher schools attract better teachers, enjoying more hiring autonomy and curriculum development flexibility (Elacqua 2012; Behrman et al. 2016). Efforts to mitigate disparities, including increased funding for disadvantaged students, are ongoing, but challenges remain, especially regarding school segregation despite the introduction of a centralized school admission system (Kutscher, Nath, and Urzúa 2023).

3. Literature Review

There is a long-standing literature documenting how the quality of teaching significantly impacts students’ academic performance (Hanushek et al., 2007; Chetty et al., 2014). The evidence suggests that teachers are among the most influential factors in explaining student achievement (Hanushek 2011). In particular, several studies have shown that an improvement in teacher quality by one standard device leads to a roughly 0.1 standard deviation increase in student test scores (Rockoff 2004; Rivkin, Hanushek, and Kain 2005; Aaronson, Barrow, and Sander 2007).

The impact of teachers extends beyond academic performance. Research by Jackson (2018) and Petek and Pope (2023) reveals that teachers also influence nontest score behaviors, such as absences and suspensions. These dimensions of teacher quality have been found to have a lasting impact on students' long-term outcomes. In a different context, Chetty, Friedman, and Rockoff (2014b) show that students assigned to better teachers are more likely to go to college and earn higher salaries.

Although there is broad consensus on the importance of teacher quality, accounting for it remains challenging, and studies differ on the extent of specific teacher factors in enhancing students' outcomes. In recent years, the adoption of Value-Added Models (VAMs) has become prevalent in educational research. For example, for the United States, Chetty, Friedman, and Rockoff (2014a) estimate that a standard deviation improvement in teacher value-added increases normalized test scores by 0.14 and 0.1 standard deviations in math and English, respectively. However, a common criticism of VAMs is their limited focus, namely, identifying the general contributions of teachers to learning but providing little information on which teacher characteristics contribute more to improving student outcomes (Wei et al. 2012). We aim to contribute to this issue by analyzing the impact of different dimensions of teacher characteristics on high-stakes test score performance.

Most studies on the impact of teacher quality have focused on the US context. However, a handful of studies have focused on the case of Chile. For example, Canales and Maldonado (2018) finds that teacher quality significantly affects eighth-grade standardized test scores, especially in math. They found no significant effect of teacher credentials but showed that the impact of teachers increases with professional experience. Similarly, Toledo and Valenzuela (2015) show that attributes such as short-term specific professional training and better curriculum coverage positively impact the performance of fourth-grade students. Barrios and Riudavets (2021) conduct teachers' VAMs and find that higher-quality teachers positively affect student test scores, high school graduation, higher education attendance, and the type of higher education institutions attended.

In a recent study, García-Echalar, Poblete, and Rau (2023) used VAMs to investigate the impact of teachers on gender gaps in standardized test scores. Their results reveal that, in general, teachers do not account for the existing math or Spanish score gaps between the genders. Interestingly, their research uncovers variations dependent on school type, with teacher value-added measures mitigating gender gaps in voucher schools but showing no such effect in public schools. This finding also motivates us to examine the impact of the school type in our context.

In this paper, we take one step further and analyze whether teacher quality can explain the performance gap observed by different types of schools in Chile. Previous studies have examined the test achievement gap across school types in primary and secondary education in Chile, using standardized test scores for students in the fourth, eighth, or tenth grades. For example, Bellei (2005) explored the relationship between school type and student performance in the fourth and tenth grades. Their findings indicate that, once accounting for sorting students due to selective admission processes and the exclusion of retained students, private schools are not more effective than public schools and may be less effective. Furthermore, Mizala and Romaguera (2000) analyzed the performance gap in the SIMCE test scores. Their research revealed that the test score gap between vouchers and public schools disappears when controlling for family socioeconomic characteristics.

Investigating college admission test results is pertinent, as they represent a high-stakes assessment in the educational context. Consistent with this, Contreras (2002) explores the influence of the type of school on college admission tests in conjunction with other SES variables. The findings reveal that the school's effect on student performance in college admission tests is notably substantial and statistically significant, even after controlling for parental education levels.

In this paper, we exploit a much richer dataset that allows us to control for a more comprehensive set of teacher variables, including teachers' performance in college admission test assessments. Recent evidence by Neilson et al. (2022) shows a positive and concave relationship between pre-college academic achievement and subsequent teacher productivity. Their evidence suggests that college entrance exams could be helpful to select or recruit students entering teacher colleges. This result underscores the potential role of including teachers' standardized college admission performance as a proxy for their productivity.

4. Data

We integrate data from multiple sources to investigate the factors influencing students' PSU performance. A time-invariant individual masked identifier allows us to establish connections between students, their teachers, and their historical performance and educational decisions, remaining consistent across various administrative datasets and over time. This section details the information we can extract from each dataset and the sample restrictions required to define our study sample.

We have access to DEMRE (Departamento de Evaluación, Medición y Registro Educacional) data on the national college admission test results for all students taking the PSU between 2006 and 2021. We use these data to identify teachers' performance on this test before entering higher education and assess students' performance in cohorts between 2013 and 2021. As some students retake the PSU, we only keep their first scores. It is important to note that not all graduating students take the PSU, as it is not mandatory.

We merge eighth-grade SIMCE records for each student in math and Spanish tests and information on their gender and their mothers' highest educational degree attained (high school, technical, professional, post-graduate), which we will use as a proxy for socioeconomic status (SES). Due to the SIMCE assessment design, only six out of nine cohorts of students with PSU score data underwent an eighth-grade SIMCE examination. Our methodology, relying on a value-added specification, considers the entire history of students' past input before high school. Consequently, we limit our analysis to students who completed the SIMCE test in eighth grade and subsequently took the PSU on time in their senior year, while also attending school each year of high school.

We retrieve each teacher's subject information for each classroom, grade, and year from administrative records, identifying whether a teacher is responsible for teaching Spanish or math to the students in our sample. These records include additional attributes such as gender, age, years of teaching experience, and whether they have a formal degree in Education. DEMRE datasets provide information related to teachers' PSU performance, how high they rank Education as their program of choice ranking in college applications, and the institution they select.

Given the multidimensional context, where each student can potentially have multiple teachers for various subjects, and each teacher instructs several students, we aggregate teacher characteristics throughout their secondary education. This involves sequentially averaging the characteristics of teachers of the corresponding subject at the classroom level for each grade. If no teacher information is available for a classroom, we attribute information based on the average characteristics of other classrooms in the same cohort, grade, and school, and the school average across grades and years if information is missing. This approach considers each student as the primary unit of observation.

It is essential to acknowledge some sample limitations. First, our analysis is restricted to exploring the impact of young teachers since we only have PSU data from 2006 onward. We use teachers' performance in this test as a critical determinant of students' PSU performance. Therefore, we can only use the subsample of teachers observed as students taking the test and, years later, as teachers in a secondary school classroom. Second, as not all students have a young teacher, we assign information on the average teacher characteristics at the cohort-school level to those for whom we do not observe the actual teacher's characteristics. Third, for comparability in the results, we focus on students in the regular education system, excluding those attending special education due to a disability or incarceration and those attending night school.

Consequently, our final sample comprises 428,973 observations for math and 415,315 for Spanish, with 307,169 students appearing in both subject samples.

4.1 Descriptive Statistics

Table 1 presents the summary statistics of all student characteristics (Panel A) and average teacher characteristics (Panel B) for the sample of students considered in the analysis. Columns (1) to (4) refer to characteristics of public school students in the sample, while columns (5) to (8) refer to attributes of voucher school students, in the sample, with columns (1) and (5) showing average values for the math sample in each type of school, and (3) and (7) for Spanish.

The first row in Panel A presents the statistics for the main dependent variable, the PSU score. We see that the difference in average math and Spanish scores between voucher and public schools is about 23 and 28 points, respectively, representing a difference of about 0.2-0.3 standard deviations. To further put into perspective how large this gap is, consider that the average difference in year-to-year changes in cutoffs for admission into undergraduate programs is about 15 points, and the median of this difference is only 10 points. Figure 1 presents the distribution of the PSU scores for the students in the sample in math and Spanish, showing that the gap between schools is present not only for the mean value but for most of the distribution.

The remaining rows in Panel A present additional characteristics. On average, public school students outperformed voucher school students in the eighth-grade SIMCE knowledge test by 0.22 standard deviations in math and 0.12 standard deviations in Spanish. These differences can be seen in Figure 2, where the difference in the distributions across groups for math is much more severe than that for Spanish. The lagged fraction taking each subject-specific PSU in each type of school also differs, with only 72% of students in public schools taking the tests, while the proportion in voucher schools reaches 78%. Other characteristics appear to be much more balanced across the school types, with around 55% of the test-taker students being female, and with 7-10% of mothers holding a technical degree, 28-30% holding a professional degree, and 3-5% of them having a post-graduate degree and the rest, 55-62% holding at most a high school degree.

From Table 1, Panel B, we also learn about the differences in the average characteristics of teachers. Voucher school teachers, especially Spanish teachers, score much higher than public school teachers in the PSU of the subject they teach. We also observe this pattern in Figure 3. At the same time, public school teachers had higher grade point averages when graduating from high school than voucher school teachers, although these differences are minor compared to the ones observed for the PSU scores. Additionally, public school teachers are two to three percentage points less likely to hold a degree from a highly selective institution but slightly more likely to have an education degree. Interestingly, it is more common for Spanish teachers to list education as a top 3 choice in their college application ranking than for math teachers, and teachers in public schools show a lower tendency to list education in their top application ranking than voucher school teachers. Finally, we observe that the teachers in the sample are about 31 years old and have only three to four years of teaching experience in both types of schools. This pattern is consistent with the fact that the teachers in our sample took the college admissions test after 2005, so they are relatively young. We should remember this fact when interpreting the results, as we cannot easily extrapolate the findings to all teachers in the system.

5. Predicting Academic Success: Exploratory Analysis

In this section, we explore the factors that influence student achievement in college admission tests, particularly emphasizing the impact of teachers and schools. It is well-established that socioeconomic characteristics, schools, and particularly teachers, strongly predict students' performance. When examining the characteristics of teachers that predict student performance, previous research has often concentrated on years of experience and academic credentials. In addition to these usual teachers' characteristics, we also study the potential role of teachers' performance in the college admissions test and whether education was among their preferred choices when applied to college.

We incorporate teachers' performance in the college admissions test and students' application preferences when they apply to college, which is a novel contribution to the existing literature. To the best of our knowledge, we are the first to attempt to study the relationship between student performance in college admission tests and teachers' performance in the very same test.

We estimate the following VAM separately for each subject, math and Spanish, to understand college admission performance:

$$Y_{i,s,t} = \beta_0 + \beta_1 Voucher_{i,s,t} + \beta_2 \mathbf{SES}_{i,s,t} + \beta_3 \mathbf{Teacher}_{i,s,t} + \beta_4 SIMCE^{8b}_{i,s,t} + \beta_5 PSU^{take-up}_{s,t-4} + \gamma_t + \varepsilon_{i,s,t} \quad (1)$$

where i denotes a student, s a school, and t a year where the outcome of interest $Y_{i,s,t}$ corresponds to the PSU score of the student i' in the year t graduating from high school s. $Voucher_{i,s,t}$ is an indicator variable taking value one if students attended a voucher school in high school, zero if it is public.[4] This variable captures any gap between comparable students in each type of school. $\mathbf{SES}_{i,s,t}$ is a categorical variable we construct from the student's mother's highest level of education (no higher education degree, technical tertiary degree, university degree, or graduate degree). We use this variable to proxy for the socioeconomic status of the student. $\mathbf{Teacher}_{i,s,t}$ represents a vector that encompasses the mean characteristics of the teacher observed throughout the high school years of a student. This vector incorporates several factors, including the average performance of teachers in the PSU subject in which they teach, the average high school GPA (measured on the PSU scale), the fraction of teachers who have an education degree, the fraction of teachers who ranked education among their top three choices in college applications, and the proportion of teachers who attended a selective university.[5] Additionally, this variable includes the usual characteristics used in the literature, such as average teacher experience, age, and the proportion of female teachers. The variable $SIMCE_{i,s,t}^{8b}$ captures the students' performance on the eighth-grade SIMCE test for the corresponding subject. Including a baseline performance measure allows us to interpret the results as a value-added specification, where SIMCE is a sufficient statistic for the educational input of students before high school (Todd and Wolpin 2003). Lastly, to control for possible selection on the PSU take-up across schools, we control for the proportion of students in the school who took the PSU test four years earlier, captured by $PSU_{s,t-4}^{take-up}$. We calculated it lagged to reduce concerns about potential endogeneity issues.[6] We also include in the estimations the gender of the student and year-fixed effects, γ_t, to capture aggregate shocks to PSU results at the national level.

5.1 Results

Table 2 presents the results of estimating equation (1) using students' PSU performance as the dependent variable. We begin by examining the impact of the type of high school attended by students and gradually incorporate other

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4 Only 6.19% of students in our sample switched from a voucher to a public school, or vice-versa. For these students, we consider the school they graduated from.

5 The select universities considered are Pontificia Universidad Católica de Chile (PUC) and Universidad de Chile (UCH), which are the most selective institutions in the country (Bordón, Canals, and Mizala 2020).

6 As Table 1 indicates, approximately 70% of high-school students in our sample take the PSU, which might raise concerns about the impact of self-selection on test taking in the college admission test performance. Since we are interested in examining the impact of school type, we cannot use school-fixed effects to account for this potential source of bias. However, we interpret our lagged measure of school-specific PSU take-up rate and students' pre-high school performance as sufficient statistics accounting for this self-selection into testing.

relevant variables into subsequent columns. In all specifications, we include year-fixed effects. Column (1) presents the results, including only the voucher school indicator variable. The voucher coefficient indicates an average math PSU score difference of 23.3 points between the two school types. In Column (2), we observe that the PSU gap decreases to 22 points when controlling for student background variables, such as gender and maternal education.

Column (3) controls for teacher information. The average teacher's math PSU result is a robust positive predictor of student math PSU performance. A one-standard-deviation increase in the teacher's score is associated with a rise of 9 points, approximately 0.1 standard deviations. The proportion of teachers with a formal education degree also exhibits a positive, statistically significant relationship with the PSU score, indicating that a 10% increase in the fraction of teachers with an education degree corresponds to a 3.17-point increase in the PSU score. The interplay between average years of experience and average teacher age almost cancels each other out, possibly due to the teacher sample's youth and some collinearity. Notably, other teacher characteristics, such as having a degree from a selective institution, selecting education in their top 3 college application choices, and the proportion of female teachers, are not significant predictors after controlling for the aforementioned variables.

Even after accounting for student SES characteristics and a comprehensive set of teacher features, the type of school attended continues to play a crucial role in explaining PSU performance. In Column (4), with the inclusion of eighth-grade math SIMCE scores, the school gap reduces to 9.4 points. The coefficient for SIMCE in eighth grade suggests that a one-standard-deviation higher math SIMCE score is associated with a 62-point increase in the predicted math PSU score. This result indicates the significant role played by the educational inputs students received in primary education, reducing the relevance of the high school attended. Additionally, the inclusion of past test scores transforms the estimate into a Value-Added Model (VAM), indicating a substantial increase in the model's goodness-of-fit. It is essential to highlight that the eighth-grade test score not only captures pre-high school academic preparation but also incorporates other educational investments, such as parental involvement and innate talent, influencing better performance in standardized tests.

Finally, in Column (5), the inclusion of a proxy for the school's propensity to have students taking the PSU further reduces the gap to 7.5 points. The estimate for this lagged PSU take-up variable is statistically significant and positive. Consequently, the reduction in the gap aligns with the fact that voucher schools, as indicated in Table 1, are more likely to have their students take the PSU. By including this by-school measure of the tendency to take the test, we control for school-specific heterogeneity that affects students' likelihood of self-selecting into taking the PSU. The coefficients for teacher characteristics decrease in size after including SIMCE scores and lagged PSU take-up rates, but they remain statistically significant, albeit at around a third of their size in Column (3).

We find similar results when we compare the Spanish PSU performance in Table 3. In Column (1), there is an expected conditional voucher gap of 28.3 points, which reduces to 25.6 points in Column (3) after controlling for students' gender, socioeconomic characteristics, and teacher characteristics. The results closely mirror those of math PSU. Average Spanish PSU performance of teachers and the fraction of teachers with an education degree strongly correlate with the Spanish PSU performance of students. Column (4) reveals a considerable improvement in the model's goodness of fit, indicating a decrease of 7 points in the relevance of school type when including students' eighth-grade Spanish SIMCE scores. Finally, Column (5) shows that the school gap decreases an additional 2.5 points with the inclusion of the school PSU take-up proxy. The estimates for teacher characteristics decrease to about half the size observed in Column (3) but remain statistically significant.

The above specifications assume that the coefficients for each explanatory variable must be the same across both voucher and public schools. However, this might not be the case if there are productivity differences in using any of those variables. Guided by the results in Tables 2 and 3, we apply the methodology developed by Firpo, Fortin, and Lemieux (2018) and Rios-Avila (2019) to analyze whether teacher quality can explain the performance gap observed by different types of schools. In the next section, we estimate the decomposition of the school type gap in the average PSU performance by the contribution of socioeconomic characteristics, teachers, own past performance, and propensity to take the PSU test, allowing more flexibility to explore the isolated effects coming from the different elements of the model.

6. Bridging The School-type Gap: O-B Decompositions

The regression analysis in the previous section identifies many influential factors that explain the gap in PSU performance, measured as the difference in the means of student scores in the two types of schools. We implement a classical Oaxaca-Blinder decomposition to separately estimate how much of the difference comes from the composition effect, i.e., the differences in covariates between the two groups, and how much comes from the structure effect, i.e., the estimated coefficients, which in this educational setting is akin to the productivity of the covariates. Then, we take the analysis one step further by implementing a Recentered Influence Functions (RIF) Oaxaca-Blinder Decomposition, which allows us to go beyond simple mean comparisons to consider gaps in other statistics independent of the decomposition's sequential order. We follow Firpo, Fortin, and Lemieux (2018) to perform the RIF Oaxaca-Blinder decomposition analysis to explain the differences in the PSU performance of students between schools for both mean and quantiles, separating the differences in the distributions into composition and structure effects, decomposing each effect by the contribution of each covariate, combining the RIF Oaxaca-Blinder analysis and the reweight strategy proposed by DiNardo, Fortin, and Lemieux (1996).

Classical Oaxaca-Blinder Decomposition

We first implement a conventional Oaxaca-Blinder decomposition of the form:

$$(2)\; E\left[PSU|X,\text{Voucher}\right]-E\left[PSU|X,\text{Public}\right]=\underbrace{\bar{X}^{V}\left(\hat{\beta}_V-\hat{\beta}_P\right)}_{\text{Unexplained}}+\underbrace{\left(\bar{X}^{V}-\bar{X}^{P}\right)\hat{\beta}_P}_{\text{Explained}},$$

where $\bar{X}^k$ denotes a vector containing the averages of the independent variables for students enrolled in type k's schools, and $\hat{\beta}_k$ is the associated vector of point estimates obtained from a linear regression model (k $\in$ {Public,Voucher}). As is standard in the literature, the school gap attributed to the differences in means is denoted by the "explained" gap, while the part attributed to the coefficient discrepancies is the "unexplained" gap. Taking into account the evidence presented in Tables 2 and 3, we exclude from the characteristics of the teachers the nonsignificant variables (selective education dummy, education as top choice dummy, and teacher's gender) to minimize the noise in the estimations.

RIF Oaxaca-Blinder Decomposition

We then implement the RIF Oaxaca-Blinder decomposition in the following manner, following the terminology laid out in Rios-Avila (2019). Assume that there is a joint distribution that describes all relationships between PSU scores, Y, exogenous characteristics, X, and the categorical variable indicating the types of schools to be compared, T. Then, we can rewrite the PSU distribution conditional on school type as:

$$(3)\qquad f^k_{Y|X}\left(y,x\right)=f^k_{Y|X}\left(Y|X\right)f^k_X\left(X\right),$$

$$(4)\qquad F^k_Y\left(y\right)=\int F^k_{Y|X}\left(Y|X\right)dF^k_X\left(X\right),$$

where k indicates whether the density is conditional on the type of school, T = k with k $\in$ {0,1}.

Then, differences in any distributional statistic v can be calculated as:

$$
\begin{aligned}
\Delta v &= v_1 - v_0 \\
&= v\left(F_Y^1\right) - v\left(F_Y^0\right) \\
&= v\left(F_{Y|X}^1\left(Y|X\right) dF_X^1\left(X\right)\right) - v\left(F_{Y|X}^0\left(Y|X\right) dF_X^0\left(X\right)\right).
\end{aligned} \tag{5}
$$

From equation (5) it follows that the differences in statistics v can arise from differences in average characteristics $\left(dF_X^1\left(X\right) \neq dF_X^0\left(X\right)\right)$, or differences in coefficients $\left(F_{Y|X}^1\left(Y|X\right) \neq F_{Y|X}^0\left(Y|X\right)\right)$. To separately estimate how relevant the composition and structure effects are in separately explaining the school-type gap, it is needed a third statistic, a counterfactual one, that permits the consideration of step-wise variations:

$$v_c = v\left(F_Y^c\right) = v\left(F_{Y|X}^0\left(Y|X\right) dF_X^1\left(X\right)\right)$$

With this counterfactual statistic, we can decompose Δv in equation (5) as:

$$\Delta v = \underbrace{v_1 - v_c}_{\Delta v_s} + \underbrace{v_c - v_0}_{\Delta v_x},$$

where Δv_s denotes the structure effect and Δv_x represents the composition effect. However, v_c is, by definition, a counterfactual statistic and, therefore, not observable in the data. This unobservability represents an empirical challenge that the methodology sorts out by approximating the relevant distribution as follows.

$$F_Y^c\left(y\right) = F_{Y|X}^0\left(Y|X\right) dF_X^1\left(X\right) \approx F_{Y|X}^0\left(Y|X\right) dF_X^0\left(X\right) \omega\left(X\right),$$

where the weights, $\omega\left(X\right)$, can be obtained applying Bayes rule:

$$\omega\left(X\right) = \left[\frac{1-P}{P}\right] \times \left[\frac{P(T=1 \mid X)}{1-P(T=1 \mid X)}\right],$$

where P is the proportion of students in school type T = 1, and P(T = 1|X) is the conditional probability that someone with characteristics X belongs to a school type T = 1. Thus, by reweighting $dF_X^0\left(X\right)$, we can proxy for v_c.

We estimate P(T = 1|X) using a logit model, includings as the main explanatory variables the percentage of voucher schools in the municipality of residence of students, the total number of voucher schools in the municipality of residence of students, mother's education (less than high school, technical, professional or graduate degree), eighth-grade student-specific SIMCE scores on both subjects, gender, the average experience of teachers in the municipality of residence, and average PSU scores of teachers in the municipality of residence. We also include year fixed effects and interactions between the proportion of voucher schools, the total number of voucher schools, SIMCE scores, and the average characteristics of teachers with the SIMCE scores of students and the level of mother's education.[7] Thus, we have:

$$v_k = E\left(RIF\left(y_k; v\left(F_Y^k\right)\right)\right) = \bar{X}^{k\prime}\beta_k \qquad \text{for } k \in \{0,1,c\}.$$

We can then decompose the gaps in the $\hat{\text{P}}$SU scores between the two types of schools, public and voucher, as follows:

$$(6) \qquad \Delta v = \underbrace{\bar{X}^{1\prime}\left(\hat{\beta}_1 - \hat{\beta}_c\right)}_{\Delta v_s^p} + \underbrace{\left(\bar{X}^1 - \bar{X}^C\right)\hat{\beta}_c}_{\Delta v_s^e} + \underbrace{\left(\bar{X}^c - \bar{X}^0\right)\hat{\beta}_0}_{\Delta v_x^p} + \underbrace{\bar{X}^{c\prime}\left(\hat{\beta}_c - \hat{\beta}_0\right)}_{\Delta v_x^e},$$

where the structure effect is further divided in pure structure $\left(\Delta v_s^p\right)$ and a reweighting error $\left(\Delta v_s^e\right)$. Likewise, the composition effect is separated into the pure composition effect $\left(\Delta v_x^p\right)$ and a specification error $\left(\Delta v_x^e\right)$.

The idea behind the pure composition effects, Δv_x^p, is to capture differences in PSU performance between groups that can only be explained by the fact that the two groups are different. For example, voucher school students score higher in 8th-grade knowledge exams than public school students. Therefore, we expect them also to have an advantage on subsequent college admission test results over public school students. This kind of difference between groups is isolated in the composition effect. On the other hand, the pure structure effects, Δv_s^p, indicate differences in PSU scores due to factors that are more productive for one type of school than the other, leading to better PSU results under the same levels of factors. If, for example, keeping all student characteristics constant, having a more experienced teacher is more advantageous (productive, as measured in PSU score points) for voucher school students, this would be captured in the structure effect.

The two additional estimates from the RIF OB decomposition are the reweighting and the specification error, Δv_s^e and Δv_x^e. The reweighting error comes from the selection of the variables and interaction terms included to compute the counterfactual statistic by estimating P(T = 1|X). It should go to zero in large samples. Of course, a tension exists between a higher Pseudo–R2, a common support, and a perfect prediction, which is undesirable (Firpo, Fortin, and Lemieux 2018). Lastly, the specification error comes from deviations from linearity in the conditional expectation and the fact that $F_Y^c\left(y\right)$ is an approximation, so we should expect this error to be different from zero.[8]

7 This richer specification with many interaction terms is needed to improve the fit in the reweighting process. See also Lemieux (2002).

8 As Firpo, Fortin, and Lemieux (2018) point out, how large the error should be remains an open empirical question.

In the next section, we estimate the classical and RIF Oaxaca-Blinder decompositions to explain the mean gap in the math and Spanish results. Following Firpo, Fortin, and Lemieux (2018). Additionally, by implementing RIF Oaxaca-Blinder decompositions, we break down the observed gap by quantiles of PSU performance. As before, we exclude non-significant components (selective education dummy, education as a top-choice dummy, and teacher's gender) from teacher characteristics to minimize noise in the estimations.

6.1 Mean Differences

Table 4 presents our results for the conventional Oaxaca-Blinder decomposition. Panel A displays the overall gaps. Consistent with the summary statistics, voucher schools have unconditional average advantages in math (column 1) and Spanish (column 2) PSU scores. However, 69% and 45% of these gaps, respectively, are explained by the average differences in the observed characteristics. Panel B shows that eighth-grade test scores and school-level historic PSU take-up are the most important contributors for both subjects. High school teachers' characteristics, a compound of the different variables in this category, play a relatively minor role.

The analysis of the contributors to the unexplained gaps delivers a different story. Panel C of Table 4 suggests that the coefficients associated with the characteristics of the teacher contribute more than 10.9 points to the math PSU score gap (favoring voucher schools), being the largest contributing factor. This result suggests that public and voucher schools produce different outcomes equipped with the same inputs, indicating differences in math PSU's productivity levels across school types. In the case of Spanish, we observe that the coefficient associated with teachers' characteristics is negative. However, its size is much smaller than that of the intercept, which is by far the largest contributor to the unexplained component. This result suggests that the covariates included in the analysis are not compelling enough to comprehend the performance gap in the Spanish PSU. Therefore, the estimates presented here should be interpreted with caution.

Table 5 presents the results of the RIF Oaxaca-Blinder decomposition for the mean distribution, which includes the reweighting scheme (expression (6)). Columns 1 and 2 display the results for math and Spanish, respectively. Panel A shows that the observed characteristics (composition) explain more of the total gaps than the parameters (structure), similar to the results in Panel A of Table 4. The analysis of the Composition effects (Panel B) indicates that 8th-grade test score is the most important contributor, followed by the School's PSU take-up (lagged). Teachers' characteristics contribute with less than one PSU point to closing the gap, which is only statistically significant for Spanish. Panel B also provides insight into the model's goodness-of-fit, which is captured by the specification error. We observe a close-to-zero coefficient that is nonsignificant at conventional levels for math and a large, highly significant positive coefficient for Spanish. This result indicates caution in interpreting results for Spanish, given that, unlike the case for math, the model cannot completely capture all the nuance in the factors that might explain the performance gap across students in both types of schools. Consistent with Panel C in Table 4, the coefficients associated with teachers' characteristics play an essential role in closing the average gaps for math, contributing almost 10 points. The school PSU take-up rate significantly contributes to widening the gap, confirming the role of selection in the PSU discussed above. SES characteristics and eighth-grade test scores contribute only marginally to this component.

These results confirm that pre-high school test scores and the school's (predetermined) college admission test take-up emerge as the most critical differences in characteristics explaining the average PSU gap between public and voucher schools. This result underlines the limits of how much schools can modify and adjust input (e.g., teacher characteristics) to reduce the gaps in a specific cohort. Now, since the differences in coefficients in Equation (6) can be interpreted as proxies for the differential productivity levels of schools, our findings also suggest that, with equal input, voucher schools are better at producing higher PSU scores. This result represents a central challenge for public policies and is consistent with the long-standing evidence documenting the advantages of voucher schools' unconditional test scores.

6.2 Beyond The Mean: Quantile Differences

Decomposing the mean differences in PSU scores between public and voucher schools is informative of the factors driving these gaps and the effectiveness of public initiatives to close them. However, this approach does not reveal the factors that affect students at different levels of the academic performance distribution. For example, for low-performance students, the drivers of gaps between public and voucher schools could differ from those affecting students in the middle or at the top of the distributions. To examine this, we implement the RIF Oaxaca-Blinder decomposition introduced in section 6, which expresses the differences in any distributional statistic as the sum of the structure and composition effects.

Figures 4 and 5 represent the results for math and Spanish, respectively. Given the similarities in their messages and the better goodness-of-fit of the model, we focus mainly on math and discuss any disparities between the two subjects.

Panel A of Figure 4 presents the overall difference in math PSU between public and voucher schools, decomposing it into composition and structure effects in each quantile using the reweighting procedure described in equation (5). The estimated overall difference (red line) is more or less stable across the distributions of the PSU scores, and it slightly decreases as we move up across the quantiles. The range lies in the 20 to 35 interval, with an average of 30 points. The stability suggests that the distribution of student-level scores of voucher schools is mainly shifted to the right relative to public schools. This pattern is consistent with the evidence in Figure 1, which shows the distributions. The positive and increasing composition effects (blue dotted line) indicate that this component increasingly explains the gaps, with the observed characteristics increasingly favoring voucher schools as one moves up in the distributions. We come back to this point below. Finally, the structure effects, depicted by the dashed green line in Panel A, partially compensate for the composition effects, showing a declining slope toward the highest quantiles.

Panel B of the same figure presents the contribution of the different sets of factors to the overall gaps between school types by quantiles. Although socioeconomic characteristics have almost no role in explaining the gaps, teachers are the main drivers in expanding them, particularly in the upper half of the distribution. This pattern is not the case for Spanish, which we discuss later in this section. Additionally, heterogeneity from the pre-high-school test scores (SIMCE) explains between one-third and two-thirds of the gaps across the whole distribution. Finally, consistent with the findings of Tables 2 and 3, accounting for PSU enrollment reduces the advantage of voucher schools, further increasing the gap as we move up in the distribution.

Panels C to E complement the previous results and provide further insight into the relative magnitude of the different effects. Specifically, Panel C shows that most of the composition effects come from the pure explained component; meanwhile, Panel E shows that this is not the case for structure effects, where pure explained and residual effects mostly net out each other. Panels D and F highlight the importance of pre-high-school test scores comes from the composition instead of structure effects while confirming that the school-type-specific estimated coefficients (structure effect) of teachers' characteristics and predetermined PSU take-up rates are essential drivers of disparities. It is interesting to observe that the contribution of teachers to the structure effect is somewhat different between math and Spanish (see Panel F of Figure and 5). For math, we see that this component is crucial in explaining the gap in the upper half of the distribution, with voucher schools being relatively more productive. For Spanish, teachers are more important in explaining the gap in the lower half of the distribution, with voucher schools being relatively more productive. The pattern is much noisier in the upper part of the distribution.

6.3 Complementarities

Figure 2 shows that students from voucher schools outperform public school students on the SIMCE test. This fact holds for both subjects, although the gap is more prominent for math. In this subsection, we analyze how teachers' contribution to explaining the PSU gap changes for students at different baseline performance levels.

We start by analyzing the point estimates of Equation 1 when introducing two interaction terms into the model. The first is the interaction between students' performance on the eighth-grade SIMCE test and their average teachers' performance on the college admissions test. We also control for the interaction between students' performance on the eighth-grade SIMCE test, their teachers' performance on the college admissions test, and the voucher school indicator variable. Table 6 reports these results.

Columns (1) and (4) present the original regression results, including all explanatory variables, in the estimations explaining the math and Spanish PSU scores, equivalent to the results in column (5) in Tables 2 and 3, respectively. Columns (2) and (5) present results when including the interaction term between the average teacher's PSU and the student's past SIMCE math and Spanish scores, respectively. We only observe positive and significant coefficients associated with the interaction term for math. This result suggests that the positive effect of having a teacher with a higher PSU score is amplified when the students have higher pre-high school test scores in the case of math PSU scores. Lastly, columns (3) and (6) include an additional interaction term, multiplying the interaction term by the voucher indicator variable. We observe that the coefficient associated with the interaction between student and teacher performance and the voucher dummy is negative for both tests, although only statistically significant for math. Thus, the amplification of the teachers' PSU effect is smaller for students attending voucher schools and nearly nonexistent for Spanish.

Lastly, we return to quantile gap analysis to explore what would happen with the contribution of teachers if we abstracted the students' baseline performance. We re-estimate a RIF Oaxaca-Blinder decomposition of a new measure of student PSU performance orthogonal to SIMCE scores. We construct this measure by residualizing the PSU scores by their own SIMCE test scores and using this residualized measure as the new dependent variable. The results are graphically presented for quantiles of the distributions in Figure 6, with Panel A showing the results for math and Panel B for Spanish for both the original PSU score (red line, also shown in Panel F of Figures 4 and 5) and the new residualized version (navy line). In both panels of Figure 6, we re-scale the Y-axis to reflect the fraction of the total effect that is explained by teacher structure effects under each of the performance measures since the gap (in level) between vouchers and public schools might change once we decompose it using the residualized PSU measure.

The idea behind Figure 6 is the following. A positive teacher structure effect implies that teachers with the same characteristics have students with a better PSU performance in voucher schools than in public schools, i.e., they are more productive. Suppose there is a positive complementarity, such as teachers being more productive with more prepared students (i.e., higher SIMCE score). In that case, we should expect that the teacher's structure effect decreases once we take out the impact of the SIMCE test score on the PSU performance. The rationale is that students from voucher schools have higher SIMCE scores than students from public schools, especially in math. Then, once we isolate the fact that teachers in voucher schools work with students who are better equipped in terms of performance, the differences in productivity should be smaller. This pattern is what we observe in Panel A of Figure 6 for both the lowest and highest quantiles of math PSU performance. In Panel B, this pattern holds only for the lowest quantiles of Spanish PSU performance. These findings are consistent with Table 6, in which we show a positive complementarity between teachers' PSU performance and students' SIMCE score, but only statistically significant for math.

Finally, it is important to mention one caveat for the evidence shown in Figure 6. The analysis assumes that for each student, their corresponding quantile using PSU performance remains unchanged when using the residualized measure of performance and that for each of those quantiles, voucher students outperform public school students in terms of their SIMCE score. The correlation between students' ranking using the PSU and their residualized measures is about 0.7. Additionally, in Figure 2, we observe that for math and Spanish, the SIMCE test score distribution is shifted to the right for voucher school students, compared to public school students. This pattern suggests that the assumption above holds on average but is imperfect. Therefore, we should be cautious when interpreting the figure.

7. Conclusion

Our comprehensive analysis of the factors influencing student achievement in Chile's college admission test (PSU) provides insights into the intricate relationships between schools, teachers, and student outcomes. Our unique dataset includes matched teacher-student data, incorporating detailed information about teachers' performance in high-stakes college admission assessments.[9]

The main results, presented in Tables 2 and 3, demonstrate the persistent impact of the type of high school on PSU performance, even after controlling for student socioeconomic characteristics, teacher attributes, and eighth-grade test scores. Although factors such as teacher's subject-specific PSU performance, experience, and holding an education degree are highly relevant to predicting student success, the school-type gap remains substantial, underscoring the complexity of factors contributing to educational disparities. This fact indicates that addressing inequalities in teacher quality alone may not be sufficient to bridge the gap in student achievement across different school types.

The Oaxaca-Blinder decomposition, as outlined in Table 4, provides a nuanced understanding of the components that directly contribute to the performance gap between public and voucher schools. Although observed characteristics and eighth-grade test scores explain most of the average gaps, teachers' characteristics contribute substantially to the unexplained portion, especially in math. This evidence suggests inherent productivity differences between school types.

The reweighted Oaxaca-Blinder decomposition results (Table 5) emphasize the importance of pre-high school test scores and historic PSU take-up rates in understanding the average gaps. Thus, given equal input, voucher schools might exhibit higher productivity levels, representing a challenge for policy interventions seeking to alleviate educational inequalities. The RIF Oaxaca-Blinder approach enables us to look beyond the mean differences (Figures 4 and 5), adding another layer of complexity. While socioeconomic characteristics have minimal impact on the gaps across quantiles, teachers' characteristics become more pronounced in expanding the gaps, particularly at the high-end distribution of scores, emphasizing the influence of teacher characteristics on the performance of high-achieving students. These results highlight the need for targeted interventions that address the diverse needs of students at different achievement levels.

Finally, we explore complementarities between teacher and student baseline performance in predicting PSU scores and explaining the voucher-public

[9] Due to insufficient data, we cannot determine whether there is a difference in attendance to "preuniversitarios" for students attending both types of schools. Additionally, we cannot isolate the benefits of having access to "preuniversitarios" on PSU performance from our results.

school gap. We find that students with high SIMCE scores perceive a boost in their performance when paired with a high PSU-performing teacher and that the increase is twice as large among public school students. We examine complementarities in teacher-student interactions using the RIF Oaxaca-Blinder quantile methodology, considering all teacher characteristics but using a PSU measure orthogonal to the baseline performance level as measured by the SIMCE. We find evidence that teacher contributions to the gap disappear once baseline test scores are accounted for, underscoring the importance of understanding the interplay between prior achievement and teacher effectiveness in formulating effective educational policies.

Our study advances the understanding of educational disparities in Chile by revealing the persistent gap between school types, the influential role of teachers, and the presence of complementarities. The results emphasize the imperative for comprehensive interventions that combine targeted teacher training, early educational investments, and efforts to address existing productivity differences between school types. Policymakers must strategically combine these factors to foster a more equitable and effective educational system. Future research should deepen the exploration of these dimensions, proposing innovative strategies to improve educational outcomes and inform evidence-based policies.

8. TABLE

TABLE 1
PUBLIC VS. VOUCHER SCHOOLS: SUMMARY STATISTICS

	Public				Voucher			
	Math		Spanish		Math		Spanish	
	Mean (1)	**Std. Dev. (2)**	**Mean (3)**	**Std. Dev. (4)**	**Mean (5)**	**Std. Dev. (6)**	**Mean (7)**	**Std. Dev. (8)**
Panel A. Student-level information								
PSU results	484.67	102.84	477.95	103.95	508.03	99.00	506.10	98.76
Simce 8th grade	-0.13	1.03	-0.08	1.01	0.09	0.97	0.04	0.98
Fraction taking PSU (lagged)	0.72	0.20	0.72	0.20	0.78	0.20	0.78	0.21
Female	0.55	0.50	0.57	0.49	0.55	0.50	0.55	0.50
Mothers with a technical degree	0.07	0.26	0.07	0.26	0.10	0.30	0.10	0.31
Mothers with a professional degree	0.30	0.46	0.30	0.46	0.28	0.45	0.28	0.45
Mothers with a postgraduate degree	0.04	0.18	0.03	0.18	0.05	0.22	0.05	0.22
Year Cohort	2,018.75	2.31	2,018.76	2.33	2,018.68	2.41	2,018.68	2.40
Panel B. Teacher's information								
Teacher PSU	-0.03	1.02	-0.10	1.02	0.06	0.98	0.11	0.97
Teacher GPA in PSU scale (NEM)	0.07	0.99	0.06	1.04	0.01	0.98	0.03	0.97
Graduated from PUC or UCH	0.08	0.25	0.06	0.23	0.10	0.28	0.09	0.28
Teacher has education degree	0.87	0.32	0.97	0.15	0.86	0.32	0.95	0.20
Education as top 3 choice in ranking	0.72	0.41	0.82	0.35	0.75	0.39	0.81	0.35
Years of teaching experience	3.55	3.39	3.80	3.35	3.29	2.95	3.28	2.71
Age	31.45	4.00	31.41	4.08	31.22	3.59	30.92	3.38
Female	0.53	0.46	0.75	0.40	0.52	0.45	0.74	0.40
Number of Observations	155,615		140,947		273,358		274,368	

Note: Panel A displays summary statistics of students in the sample, divided by the type of school they attend, public or voucher schools, and the subject of interest, math, and Spanish. Panel B displays similar summary statistics by type of school and subject but for the average characteristics of teachers teaching math or Spanish to students during high school in Panel A. The total number of students considered is 537,119, while for 307,169 of them, we have information on their performance and teachers' characteristics in both subjects.

TABLE 2

PUBLIC VS. VOUCHER SCHOOLS: AVERAGE MATH PSU GAP REGRESSION ANALYSIS

	Math PSU				
	(1)	(2)	(3)	(4)	(5)
Voucher	23.261***	21.951***	22.005***	9.442***	7.469***
	(4.773)	(4.709)	(4.326)	(2.244)	(2.165)
Teacher's Math PSU			9.058***	3.632***	3.390***
			(1.537)	(0.831)	(0.802)
Teacher's GPA			0.465	0.381	0.419
			(1.985)	(1.083)	(1.029)
Teacher has Selective Education			4.899	0.924	-0.098
			(5.317)	(2.980)	(2.889)
Teacher holds Education Degree			31.772***	13.351***	12.524***
			(3.313)	(1.652)	(1.553)
Education as Top 3 choice			-2.773	-1.610	-1.631
			(3.152)	(1.585)	(1.521)
Years of Teaching Experience			2.647***	1.141***	1.079***
			(0.550)	(0.285)	(0.271)
Teacher's Age			-1.726***	-0.826***	-0.810***
			(0.422)	(0.221)	(0.213)
Fraction Female Teachers			-0.662	-0.453	-0.549
			(3.474)	(1.833)	(1.735)
8th grade Simce (Math)				62.190***	61.145***
				(0.816)	(0.737)
School's PSU Takeup (lagged)					41.695***
					(3.039)
Number of Observations	428,973	428,973	428,973	428,973	428,973
R-squared	0.025	0.032	0.054	0.413	0.418
Year FE	✓	✓	✓	✓	✓
SES Controls	✓	✓	✓	✓	✓

Note: The table presents the point estimates obtained from different versions of equation 1 using Spanish PSU as the dependent variable. The sample includes PSU takers covering the period 2013-2021. Year FE includes year-specific fixed effects for test-taking years. SES Controls include indicator variables for student gender and three indicator variables for maternal education categories: technical, undergraduate, and post-graduate degrees, with high school or less being the omitted category. Standard errors in parentheses clustered at the school level. * p < 0.1, ** p < 0.05,*** p < 0.01

TABLE 3

PUBLIC VS. VOUCHER SCHOOLS: AVERAGE SPANISH PSU GAP REGRESSION ANALYSIS

			Spanish PSU		
	(1)	(2)	(3)	(4)	(5)
Voucher	28.305***	26.615***	25.666***	18.753***	16.064***
	(4.544)	(4.462)	(4.385)	(2.613)	(2.495)
Teacher's Spanish PSU			8.062***	4.781***	4.282***
			(1.532)	(0.930)	(0.878)
Teacher's GPA			-0.406	-0.341	-0.548
			(1.751)	(1.092)	(1.023)
Teacher has Selective Education			14.569	10.837**	9.124*
			(9.178)	(5.489)	(5.048)
Teacher holds Education Degree			24.545***	13.936***	12.958***
			(4.354)	(2.613)	(2.366)
Education as Top 3 choice			1.957	0.678	0.416
			(3.892)	(2.363)	(2.203)
Years of Teaching Experience			2.645***	1.267***	1.129***
			(0.489)	(0.295)	(0.282)
Teacher's Age			-1.556***	-0.705***	-0.630***
			(0.459)	(0.252)	(0.232)
Fraction Female Teachers			-2.005	-1.823	-1.300
			(2.887)	(1.791)	(1.701)
8th grade Simce (Spanish)				64.664***	63.753***
				(0.525)	(0.461)
School's PSU Takeup (lagged)					50.849***
					(3.602)
Number of Observations	415,315	415,315	415,315	415,315	415,315
R-squared	0.019	0.029	0.043	0.433	0.441
Year FE	✓	✓	✓	✓	✓
SES Controls	✓	✓		✓	✓

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The table presents the point estimates obtained from different versions of equation 1 using Spanish PSU as the dependent variable. The sample includes PSU takers covering the period 2013-2021. Year FE includes year-specific fixed effects for test-taking years. SES Controls include indicator variables for student gender and three indicator variables for maternal education categories: technical, undergraduate, and post-graduate degrees, with high school or less being the omitted category. Standard errors in parentheses clustered at the school level. * p < 0.1, ** p < 0.05,*** p < 0.01

TABLE 4

MEAN DECOMPOSITION OAXACA-BLINDER WITHOUT REWEIGHTING

	(1)	(2)
	Math	Spanish
A. Overall Gap		
(a) Average PSU in Voucher Schools	508.028***	506.102***
	(0.189)	(0.189)
(b) Average PSU in Public Schools	484.667***	477.950***
	(0.261)	(0.277)
Gap in favor of Voucher Schools ((a)-(b))	23.361***	28.153***
	(0.322)	(0.335)
Total Explained	16.065***	12.686***
	(0.215)	(0.242)
Total Unexplained	7.296***	15.467***
	(0.258)	(0.266)
B. Contributions to the Explained Gap		
Student's SES	0.545***	1.549***
	(0.035)	(0.050)
Teacher	0.168***	0.617***
	(0.031)	(0.062)
Student's Simce	12.815***	7.863***
	(0.194)	(0.215)
Lagged School PSU Takeup	2.537***	2.657***
	(0.063)	(0.069)
C. Contributions to the Unexplained Gap		
Student's SES	-1.764***	-2.526***
	(0.353)	(0.360)
Teacher's characteristics	10.854***	-11.426***
	(2.951)	(3.076)
Student's Simce	0.278***	-0.124***
	(0.021)	(0.012)
Lagged School PSU Takeup	-5.224***	-13.093***
	(0.966)	(0.996)
Intercept	3.152	42.636***
	(3.186)	(3.298)
Number of Observations	428,973	415,315

Note: The table presents the Oaxaca-Blinder decomposition for PSU scores in math and Spanish by type of school (public or voucher). The sample includes PSU takers covering the period 2013-2021. Standard errors in parenthesis clustered at the school level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

TABLE 5

MEAN DECOMPOSITION OAXACA-BLINDER WITH REWEIGHTING

	Math	Spanish
A. Decomposition		
Total gap	23.361***	28.153***
	(0.31)	(0.317)
Composition	15.401***	12.237***
	(0.294)	(0.324)
Structure	8.282***	8.694***
	(0.3)	(0.308)
B. Contributions of Xs (composition)		
Student's SES	0.615***	1.639***
	(0.041)	(0.069)
Teacher's characteristics	-0.059	0.874***
	(0.036)	(0.057)
8th grade test score (Simce)	14.233***	9.101***
	(0.283)	(0.298)
School's PSU takeup (lagged)	0.611***	0.622***
	(0.039)	(0.042)
Specification error	-0.547*	7.476***
	(0.314)	(0.36)
C. Contributions of β s (structure)		
Student's SES	0.145	0.002
	(0.49)	(0.492)
Teacher's characteristics	9.937***	0.321
	(3.36)	(4.077)
8th grade test score (Simce)	0.051	-0.226***
	(0.032)	(0.029)
School's PSU takeup (lagged)	-10.17***	-19.241***
	(1.063)	(1.106)
Intercept	8.32**	27.838***
	(3.698)	(4.245)
Reweighting error	0.225	-0.254
	(0.314)	(0.248)
D. Total (composition + structure)		
Student's SES	0.759	1.64***
	(0.494)	(0.49)
Teacher's characteristics	9.878***	1.195
	(3.362)	(4.075)
8th grade test score (Simce)	14.284***	8.876***
	(0.285)	(0.29)
School's PSU takeup (lagged)	-9.559***	-18.618***
	(1.07)	(1.105)

Note: The table presents the RIF Oaxaca-Blinder decomposition for the mean PSU score (math and Spanish) by type of school (public or voucher). The sample includes PSU takers covering the period 2013-2021. Bootstrapped standard errors over the entire procedure (100 replications) were used to compute the p-values and are presented in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01.

TABLE 6

PUBLIC VS. VOUCHER SCHOOLS: STUDENT-TEACHER INTERACTIONS AS A MECHANISMS REGRESSION ANALYSIS INTERACTION

		Math PSU			Spanish PSU	
	(1)	(2)	(3)	(4)	(5)	(6)
Voucher	7.469***	7.647***	7.873***	16.064***	16.092***	16.200***
	(2.165)	(2.150)	(2.153)	(2.495)	(2.501)	(2.519)
Teacher's PSU	3.390***	3.442***	3.551***	4.282***	4.266***	4.299***
	(0.802)	(0.800)	(0.809)	(0.878)	(0.871)	(0.883)
Teacher's GPA	0.419	0.456	0.465	-0.548	-0.547	-0.546
	(1.029)	(1.033)	(1.039)	(1.023)	(1.023)	(1.026)
Teacher has Selective Education	-0.098	-0.511	-0.637	9.124*	9.099*	9.051*
	(2.889)	(2.819)	(2.805)	(5.048)	(5.060)	(5.088)
Education Degree	12.524***	12.337***	12.360***	12.958***	12.945***	12.935***
	(1.553)	(1.539)	(1.539)	(2.366)	(2.362)	(2.364)
Education as Top 3 choice	-1.631	-1.624	-1.611	0.416	0.421	0.446
	(1.521)	(1.512)	(1.511)	(2.203)	(2.204)	(2.201)
Years of Teaching Experience	1.079***	1.072***	1.074***	1.129***	1.131***	1.133***
	(0.271)	(0.273)	(0.272)	(0.282)	(0.281)	(0.281)
Teacher's Age	-0.810***	-0.797***	-0.800***	-0.630***	-0.632***	-0.634***
	(0.213)	(0.212)	(0.212)	(0.232)	(0.231)	(0.230)

Fraction Female Teachers	-0.549	-0.620	-0.690	-1.300	-1.300	-1.308
	(1.735)	(1.755)	(1.758)	(1.701)	(1.701)	(1.702)
Student's Simce	61.145***	61.106***	61.127***	63.753***	63.753***	63.812***
	(0.737)	(0.725)	(0.722)	(0.461)	(0.461)	(0.455)
School's PSU Takeup (lagged)	41.695***	41.723***	41.574***	50.849***	50.845***	50.807***
	(3.039)	(3.026)	(3.020)	(3.602)	(3.603)	(3.607)
Teacher PSU × Student SIMCE		2.780*** (0.415)	4.070*** (0.719)		0.373 (0.365)	1.264 (0.795)
Teacher PSU × Student SIMCE × Voucher			-2.169** (0.860)			-1.454 (0.889)
Number of Observations	428973	428973	428973	415315	415315	415315
R-squared	0.418	0.419	0.419	0.441	0.441	0.441
Year FE	✓	✓	✓	✓	✓	✓
SES Controls	✓	✓	✓	✓	✓	✓

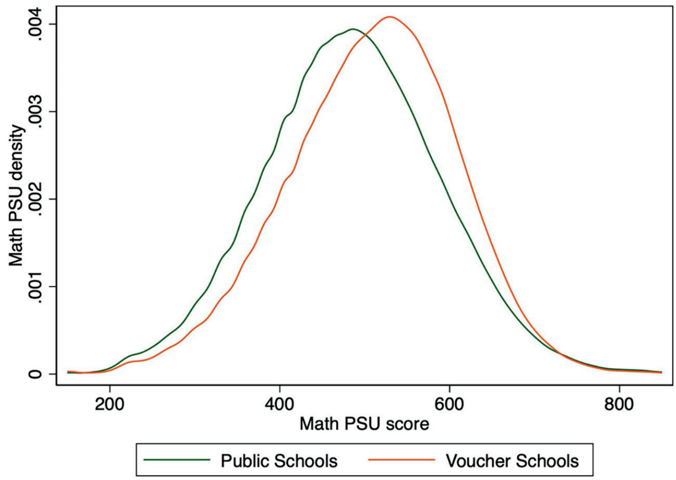
Note: The table presents the point estimates obtained from different versions of equation 1 using Spanish PSU as the dependent variable. The sample includes PSU takers covering the period 2013-2021. Year FE includes year-specific fixed effects for test-taking years. SES Controls include indicator variables for student gender and three indicator variables for maternal education categories: technical, undergraduate, and post-graduate degrees, with high school or less being the omitted category. Standard errors in parentheses clustered at the school level. * $p < 0.1$, ** $p < 0.05$,*** $p < 0.01$

9. Figures

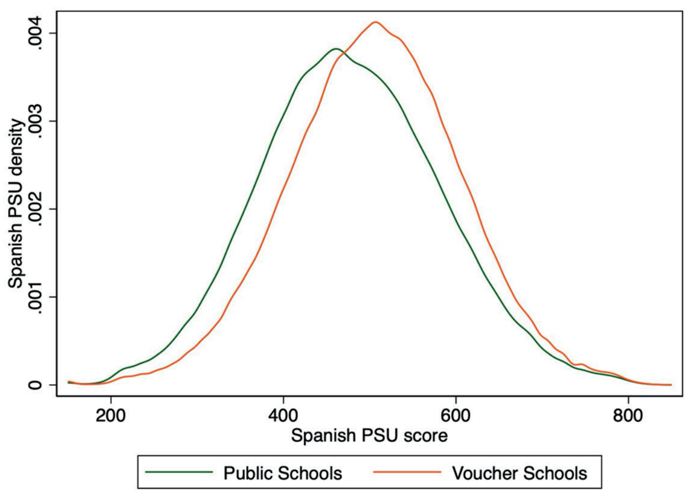
FIGURE 1

DISTRIBUTION OF STUDENT-LEVEL PSU SCORES BY SCHOOL TYPE

A. MATH PSU



B. SPANISH PSU

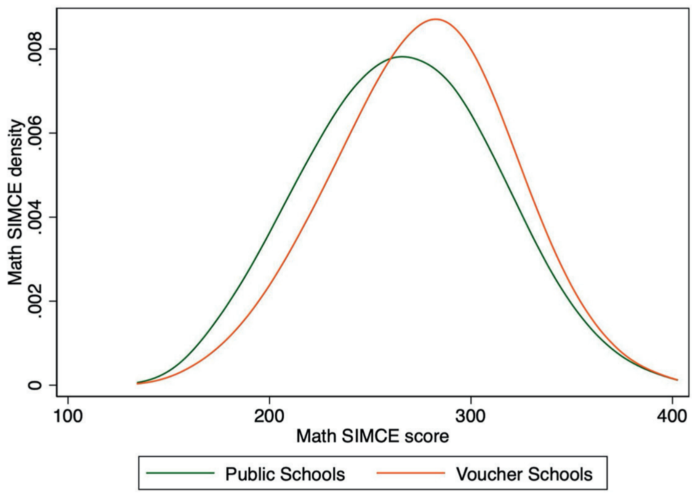


Note: Panel A (B) displays the distribution of math (Spanish) PSU scores computed from our sample of 428,973 (415,315) test takers between the years 2013 and 2021.

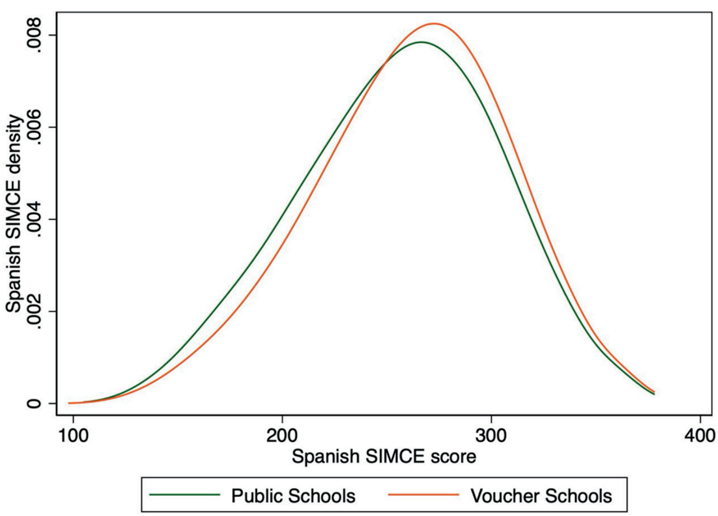
FIGURE 2

DISTRIBUTION OF STUDENT-LEVEL SIMCE SCORES BY SCHOOL TYPE

A. MATH SIMCE



B. SPANISH SIMCE

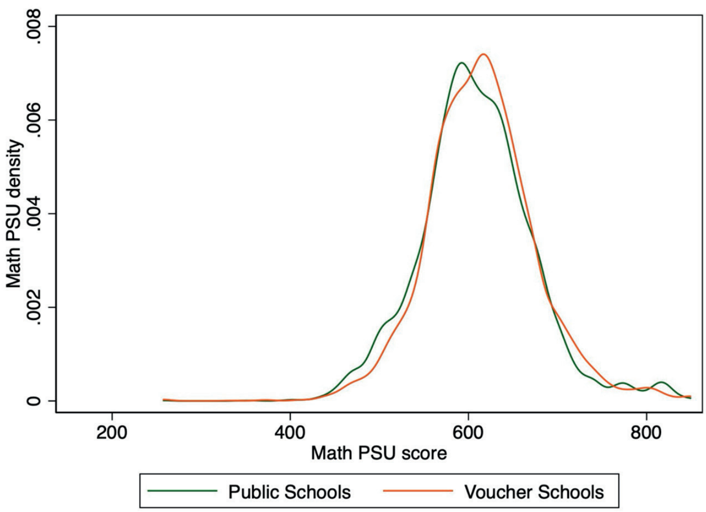


Note: Subfigure a (b) displays the distribution of PSU scores at the student level for math (Spanish) computed from our sample of 428,973 (415,315) test takers between the years 2013 and 2021.

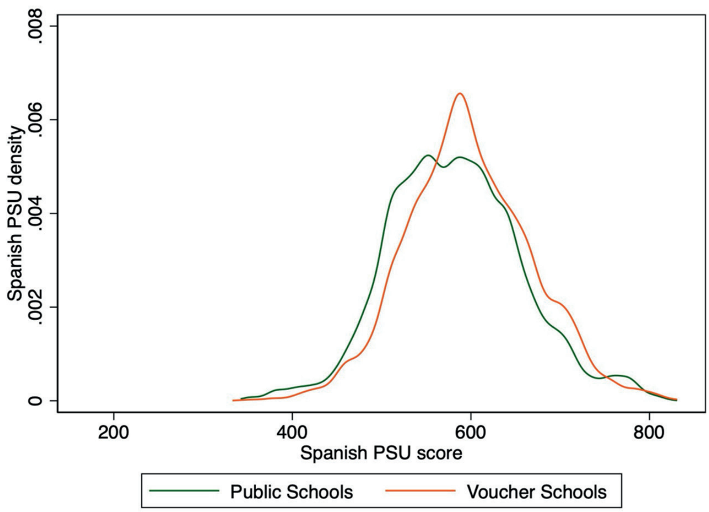
FIGURE 3

DISTRIBUTION OF AVERAGE TEACHERS' PSU SCORES BY SCHOOL TYPE

A. MATH PSU



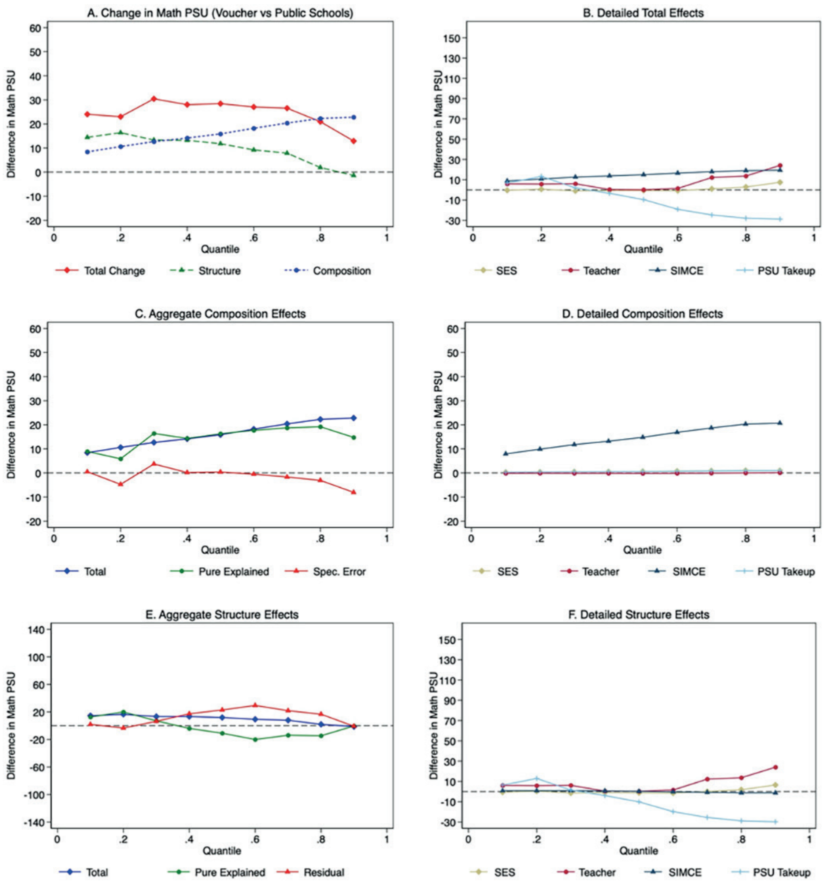
B. SPANISH PSU



Note: Subfigure a (b) displays the distribution of average teacher math (Spanish) PSU scores computed from our sample teaching 9,938 (9,574) school cohorts of student test takers between the years 2013 and 2021.

FIGURE 4

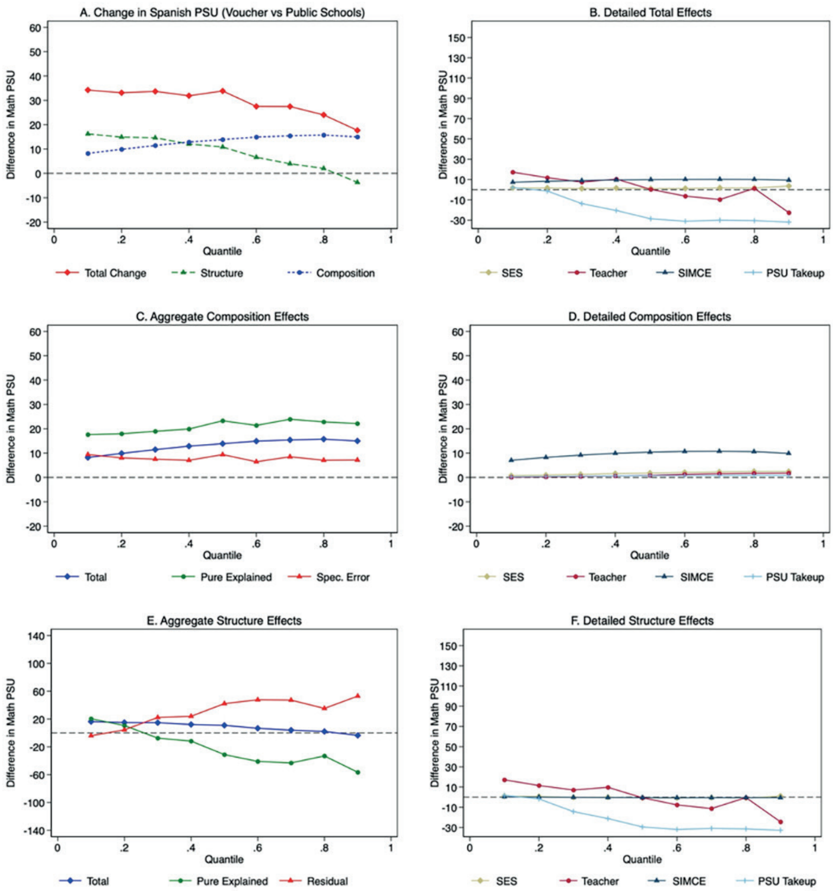
GAPS ACROSS THE MATH PSU DISTRIBUTION: TOTAL, COMPOSITION, AND STRUCTURE EFFECTS



Note: The figure presents the RIF Oaxaca-Blinder decomposition for quantiles of PSU score in math by type of school (public or voucher). Panel A displays the total gap and the portion of it that is explained by the composition and structure effect. Panel B decomposes the total gap by the contribution of each group of variables included in the analysis. Panel C displays the total composition effect, the portion of it that is purely explained, and the specification error. Panel D decomposes the purely explained composition effect by the contribution of each group of variables included in the analysis. Panel E displays the total structure effect and the portion of it that is purely explained and residual. Panel F displays decomposes the purely explained structure effect by the contribution of each group of variables included in the analysis. The sample includes 428,973 students covering the period between 2013 and 2021. See Sections 4 and 5 for a formal discussion.

FIGURE 5

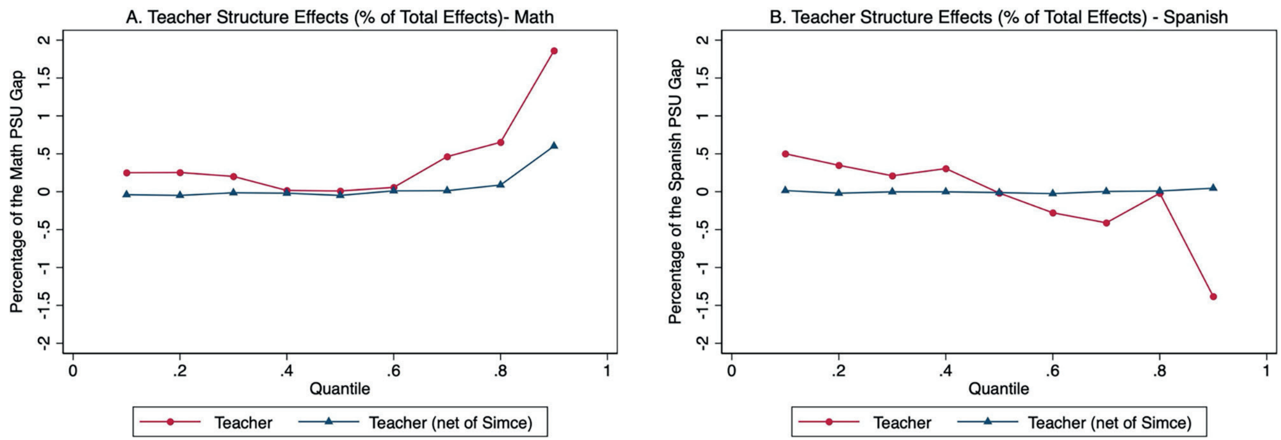
GAPS ACROSS THE SPANISH PSU DISTRIBUTION: TOTAL, COMPOSITION AND STRUCTURE EFFECTS



Note: The figure presents the RIF Oaxaca-Blinder decomposition for quantiles of PSU score in Spanish by type of school (public or voucher). Panel A displays the total gap and the portion of it that is explained by the composition and structure effect. Panel B decomposes the total gap by the contribution of each group of variables included in the analysis. Panel C displays the total composition effect, the purely explained portion, and the specification error. Panel D decomposes the purely explained composition effect by the contribution of each group of variables included in the analysis. Panel E displays the total structure effect and the portion of it that is purely explained and residual. Panel F displays the decomposition of the purely explained structure effect by the contribution of each group of variables included in the analysis. The sample includes 415,315 students covering the period between 2013 and 2021. See Sections 4 and 5 for a formal discussion.

FIGURE 6

TEACHERS CONTRIBUTION TO STRUCTURE EFFECT: TOTAL AND RESIDUALIZED OF PREVIOUS TEST SCORE



Note: The figure presents the contribution of teachers' characteristics to the purely explained structure effect on the PSU score gap and a residualized measure of the PSU score gap. This residualized measure corresponds to the PSU score minus the effect of the SIMCE test score in the eighth grade. Panel A displays the results for math. Panel B displays the results for Spanish. In both panels, the red line (Teacher) corresponds to the contribution of teachers' variables to the explained structure effect on the PSU gap by quantiles. In contrast, the blue line (Teacher res.) corresponds to the contribution of teachers' variables to the explained structure effect on the residualized PSU gap by quantiles. The sample includes 428,973 individuals for math and 415,315 for Spanish, covering 2013 to 2021. See Section 5.2 for a formal discussion.

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Risky Behavior among Chilean Youths*

Conductas de riesgo entre los jóvenes en Chile

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Abstract

This paper examines the connection between risky behaviors and various socioeconomic factors, including skills, preferences, aspirations, expectations, and exposure to shocks. Using a representative sample of Chilean youths aged 15 to 19 years old, our analysis identifies self-esteem, risk aversion, and educational aspirations as relevant factors associated with participation in risky activities. Remarkably, even after accounting for socio-demographic factors, skills, expectations, aspirations, and preferences, we uncover a significant correlation between exposure to shocks at both individual and family levels and engagement in risky behavior. Particularly striking is the association between experiencing job loss and family illness and the prevalence of risky behaviors. Additionally, we observe positive correlations among the unexplained variability of these behaviors, suggesting a complementary relationship between these activities. While these patterns are correlational rather than causal, they offer valuable insights into the determinants of risky decision-making among youths.

Key words: *Smoking, alcohol, violence, unemployment, health, self-esteem*

JEL Classification: *D91, I12, I31*

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Resumen

Este trabajo examina la relación entre conductas de riesgo y diversos factores socioeconómicos, incluyendo habilidades, preferencias, aspiraciones, expectativas y exposición a shocks. Utilizando una muestra representativa de jóvenes chilenos entre los 15 y 19 años de edad, nuestro análisis identifica la autoestima, la aversión al riesgo y las aspiraciones educativas como factores relevantes asociados a la participación en actividades riesgosas. Es interesante notar que, incluso después de controlar por factores sociodemográficos, habilidades, expectativas, aspiraciones y preferencias, observamos una correlación significativa entre la exposición a shocks tanto a nivel individual como familiar y la participación en conductas de riesgo. Resulta especialmente llamativa la relación entre la pérdida de empleo y las enfermedades familiares y la prevalencia de conductas de riesgo. Asimismo, observamos correlaciones positivas entre la variabilidad no explicada de los distintos comportamientos, lo que sugiere una relación complementaria entre estas actividades. Aunque los patrones descritos son correlacionales y no causales, ofrecen una pespectiva valiosa sobre los determinantes de las decisiones de riesgo de los jóvenes.

Palabras clave: *Tabaquismo, alcohol, violencia, desempleo, salud, autoestima*

Clasificación JEL: *D91, I12, I31*

1. Introduction

Adolescence is a critical phase in life characterized by physiological, psychological, and social changes that have lifelong impacts. Many risky behaviors, such as smoking, consuming alcohol, engaging in sex, and committing crimes, occur for the first time during this period. These behaviors may have consequences for youths' well-being, as they are associated with health, education, productivity, and labor market outcomes. Furthermore, these behaviors can also impact others through their relationship with crime, accidents, the cost of insurance, and potential dependence on public resources.

The economics literature on risky behaviors describes individuals as trading off present and future costs and benefits. Individuals compare the expected present satisfaction associated with smoking or drinking alcohol to the expected (discounted) cost of future health problems or low productivity (Becker & Murphy, 1988). This approach has been complemented by behavioral economics literature, which describes circumstances where individuals do not necessarily act in their own best interests, such as engagement in risky activities

(O'Donoghue & Rabin, 2001). When it comes to teenagers and risky behaviors, developmental psychologists also concern themselves with how cognitive, affective, and social development affect decision-making (Fischhoff, 1992).

The aim of this study is to analyze risky behaviors among teenagers in Chile. Our analysis has three goals. First, we aim to document the prevalence of specific risky behaviors among adolescents in the country and the patterns of association between these activities. Second, we seek to describe the correlations between risky behaviors and economic variables, including preferences, expectations, aspirations, and skills. Finally, we intend to describe the relationship between participation in risky behaviors and shocks, including unemployment and illness.

Using a representative sample of Chilean youths aged 15-19, we find correlations between engaging in risky behavior and socioemotional skills, risk aversion, and educational aspirations. Interestingly, we find a significant correlation between exposure to shocks at both individual and family levels. Notably, experiencing job loss and health problems in the family are associated with a higher prevalence of risky behaviors. Furthermore, we document positive correlations between the unexplained variation of these behaviors, with the strongest associations observed among drugs and alcohol use. While these patterns are correlational rather than causal, we believe they offer valuable insights into the determinants of risky decision-making among youths.

Figures 1, 2, and 3 reveal a decline in participation in several risky behaviors among adolescents in Chile, although some rates remain higher than in advanced countries. Figure 1 illustrates the prevalence of alcohol, tobacco, marijuana, and cocaine consumption among students in grades 8 to 12. Remarkably, the rate of alcohol and tobacco use dropped by 38% and 71% in the past two decades, respectively. However, according to PAHO statistics, the rates of tobacco use are still much higher than those in Canada (1%) and the United States (4.6%), and even higher than in other Latin American and Caribbean (LAC) countries, such as Brazil (6.9%), Peru (7.2%), and Uruguay (11.5%). Cocaine use also fell, from a prevalence of 1.5% in 2003 to 1% in 2021. However, the prevalence of marijuana use shows a different dynamic: it grew from 6.8% in 2003 to 20.1% in 2015, and then declined steadily to 11.2% in 2021.

Figure 2 demonstrates that, after experiencing a plateau in the early 1990s, teen fertility in Chile steadily declined throughout the following decade. It rose again in the mid-2000s, then declined in the early 2010s. The downward trend is also observed in other regions, although it is less pronounced in LAC. Currently, Chile's teenage fertility rate is about half of LAC's rate but almost twice the rate observed in Europe and North America.

Furthermore, there has been a decrease in the number of adolescent offenders entering the justice system. Figure 3 indicates that the rate of adolescents in conflict with the law has steadily decreased, and at a much faster rate than that of adults. Although not strictly comparable, juvenile crime statistics in the United States also show a decreasing trend over time (Hockenberry and Puzzanchera, 2023).[1]

This study aims to make contributions to at least three distinct bodies of literature. The first relates to protective factors that mitigate the prevalence of risky behaviors among the youth population. These factors encompass socio-emotional skills and educational aspirations (Donnellan et al., 2005; Chiteji, 2010; Favara and Sánchez, 2017), as well as peer and friend behaviors (Clark and Lohéac, 2006; Card and Giuliano, 2013; Einsberg et al., 2014). Moreover, the literature has evidenced that youth do respond to economic incentives such as tobacco and alcohol prices and taxes (Cook and Moore, 2001; Carpenter and Cook, 2008; Paraje et al., 2021; Assael, 2023), along with access restrictions (Cook and Moore, 2001; DiNardo and Lemieux, 2001; Wagenaar and Toomey, 2002). Similarly, contextual factors like the length of the school day and the type of educational institution attended can also influence the prevalence of certain behaviors (Berthelon and Kruger, 2011; Figlio and Ludwig, 2012).

The second literature refers to the consequences of risky behavior among youths, encompassing effects on educational outcomes (Renna, 2007; Fletcher and Lehrer, 2009; Parkes et al., 2010; Lye and Hirschberg, 2010; Carrell et al., 2011), health (Patton et al., 2016), fertility (Kearny and Levine, 2012), and incarceration (Levitt and Lochner, 2001).

Finally, our study contributes to the literature on the social consequences of economic shocks. Beyond the existing evidence on persistent earnings losses (Jacobson et al., 1993; von Wachter et al., 2009: Albagli et al., 2020), the literature has highlighted a connection with stress-related health issues and reduced life expectancy (Burgard et al., 2007; Sullivan and von Wachter, 2009; Eliason and Storrie, 2009), decreased school performance of children (Oreopoulos et al., 2008; Stevens and Schaller, 2011), and a higher incidence of divorce (Charles and Stephens, 2004). Furthermore, economic shocks are linked to lower happiness and life satisfaction (Frey and Stutzer, 2002).

The remainder of the paper proceeds as follows. Section 2 presents the survey design and data, while Section 3 describes and discusses the results. Section 4 concludes.

1 In the United States, the overall delinquency rate among youths aged 10-16 in 2020 was 65%, below the 2005 rate.

2. Survey Design And Data

2.1 The Millennials in Latin America and the Caribbean Survey

Our analysis is based on the Millennials in LAC survey, a cross-sectional survey conducted in Chile and six other countries in Latin America and the Caribbean.[2] The survey was designed to study the schooling and labor market decisions of youths. The Chilean survey was administered between July and October 2017 and included information on 3,560 individuals aged 15 to 24 years living in the urban areas of the Metropolitan, Biobío, and Valparaíso regions. Households were selected based on previous censuses using a stratified multistage sampling method. The final stage of the sampling method consisted of randomly choosing a young person within the household.

The survey consists of two questionnaires. The first contains standard demographic and socioeconomic questions. It also gathers information on cognitive and socioemotional skills, expectations, and aspirations, among other variables. The second questionnaire collected information about risky behaviors and was self-administered to improve the data's response rate and quality (Tourangeau et al., 1997; Krumpal, 2013). Written consent was obtained from the participants if they were 18 or older or their parents otherwise.

2.2 Study Measures[3]

The survey gathers information on several measures of risky behavior. First, we measure whether the individual engaged in unprotected sex during the last sexual intercourse. Second, we measure violent behavior: whether the respondent or someone in his/her group of friends carried a weapon in the previous thirty days or committed a robbery in the last 12 months. Finally, we measure the consumption of alcohol and drugs: tobacco smoking, binge drinking, and marijuana and other drugs consumption in the last 12 months. We created dummy variables indicating whether the individual has engaged in each of these seven behaviors and a summary variable adding up the dummies.

The survey also gathers information on risk and intertemporal preferences. To measure risk tolerance, subjects were asked about their willingness to pay 5% of a monthly minimum wage to participate in hypothetical lotteries with

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2 The data used in this paper were collected as part of the "Millennials in Latin America and the Caribbean: to work or study?" project. The project, including the data collection, was funded by the International Development Research Centre (IDRC-Canada) and the Inter-American Development Bank (IDB). The countries in the study are Brazil, Chile, Colombia, El Salvador, Haiti, Mexico, and Paraguay. See Novella et al. (2018) and Alvarado et al. (2020) for more information.

3 This section is based on Alvarado et al. (2020) and Gantier et al. (2023).

prizes between 1% and 5% of the same minimum wage. We created a risk averse dummy variable equal to 1 when the individual is unwilling to participate in any of these lotteries and 0 otherwise. We expect a lower likelihood of risky behaviors among risk averse individuals.

We include traditional sociodemographic control variables such as age and gender. Education is measured by the number of years of schooling achieved. We also include a teenage parenthood dummy that equals one if the youth had a child when younger than 20 years old or is pregnant and younger than 20, and zero otherwise. Finally, we include measures of dependency in the family, that is, the number of household members below five and above 65 years of age.

We also include the household's monthly income per capita. In addition, we include measures of economic shocks experienced by the youth (job loss and illness) and the family (divorce, illness or death, and crime) in the last 12 months to capture sources of unexpected variation in household resources. We created a set of dummy variables indicating separately the experience of each shock and an aggregated variable that adds up these variables.

The survey considers a basic numeracy test that poses simple problems in which respondents must divide and multiply to obtain the correct answers. To evaluate cognitive achievement, we use the standardized percentage of correct answers such that the measure has a zero mean and unit variance (z-scores).

The survey also measures socioemotional skills. In particular, it includes the Rosenberg self-esteem test that measures people's image of themselves (Rosenberg, 1965). We normalize this measure to have a mean of zero and a standard deviation of one. A higher score reflects higher self-esteem. Therefore, we expect socioemotional skills to be negatively correlated with risky behavior.

The questionnaire also gathers perceptions about wages. To measure the perceived returns to schooling, we include the difference between the monthly salary youths believe college graduates earn in their local area in logs, and the earnings of local secondary education graduates (also in logs); i.e., the expected return to a college education. We hypothesize that individuals who expect higher returns are less likely to engage in risky behavior.

Finally, to measure educational aspirations, the survey asks individuals about the highest academic degree they would like to complete assuming no constraints. Our aspirational measure is the number of additional years of education the respondents would like to meet beyond what they have achieved. We hypothesize a negative correlation between aspirations and risky behavior.

2.3 Sample

Our sample consists of teenage youths (i.e., those aged between 15 and 19) with complete information on the relevant variables. The full sample contains 1,916 individuals in the relevant age group. We lose 489 observations due to missing relevant data. Appendix Table 1 compares our sample and the sample of individuals missing information.

Table 1 contains the main statistics of our sample and according to the youth's engagement in at least one of our risky behavior measures. On average, youths in the sample are 17 years old and have completed almost ten years of education. The sample is evenly distributed by gender. Six percent have already had a child or were expecting one at the time of the interview.[4]

3. Risky Behavior Among Youths

3.1 Correlates of Risky Behavior

In Table 1 we present the main statistics of the final sample, categorized by youths' engagement in at least one of our risky behavior measures. On average, individuals in the sample have participated in 1.4 risky behaviors out of a potential of 7 over the last 12 months. The most prevalent activities are binge drinking and marijuana consumption, reported by 42% and 34% of the sample, respectively. Among those who have engaged in at least one risky behavior, the mean number of risky activities rises to 2.4.

Figures 4 and 5 illustrate simple correlations between engagement in each risky activity and various characteristics and environmental factors of youths. The statistical significance of difference-in-means tests for aggregate risky behavior is reported in the final columns of Table 1. The figures and tests reveal differences between individuals who engage in risky behaviors and those who do not across relevant aspects.

Figure 4 demonstrates that men (Panel a) and older individuals (Panel b) are more likely to engage in risky behavior. Panels c and d also indicate differences based on numerical and socioemotional skills, with a lower prevalence

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4 To explore the external validity of our results, we compared our final sample to the nationally representative 2017 CASEN survey sample. We find many demographic similarities when limiting the analysis to youths aged 15 to 19 living in the urban areas of Santiago, Biobío, and Valparaíso. In the CASEN sample, 50% of individuals are men, the average age is 17, and the average years of education is 10.7. However, we find a significant difference in income per capita: including subsidies, households' income in CASEN is twice that in our sample. Possibly, youths are unaware of the monetary resources available in their households, as in CASEN, the primary respondent is an adult.

of risky activities among individuals with higher skills.[5] Furthermore, Panels e and f suggest that individuals who engage in risky behaviors have lower educational aspirations and expect lower returns from a college education, respectively. Panel g shows that they are also less likely to be risk averse.

Notably, youths who engage in risky behaviors have experienced a larger number of shocks and a higher prevalence of all types of shocks except for parental separation. Particularly, they are more likely to have lost their jobs, experienced an illness of death in the family, or had someone in the household become a crime victim. These differences are statistically significant, as shown in Table 1.

Figure 5 depicts the prevalence of each risky activity by shock experience, highlighting the noteworthy differences. For instance, those who experienced a shock are 62% more likely to consume marijuana and to smoke tobacco than those who have not.

3.2 Co-Occurrence of Risky Behaviors

In this section, we investigate the relationships between different risky behaviors, exploring whether individuals who engage in one behavior are also likely to engage in others. To mitigate the risk of spurious correlations stemming from youth characteristics and environmental factors, we initially regress each risky behavior dummy variable on the observable covariates presented in Table 1. Subsequently, we estimate pairwise correlations between the residuals.

Specifically, we estimate seven linear probability models, each corresponding to a relevant behavior (unprotected sex, smoking, etc.). Our models control for various sociodemographic variables (including gender, age, years of education, household's monthly income per capita, teenage parenthood status, and the number of household members younger than five and older than 65), measures of cognitive and non cognitive skills (numeracy and self-esteem), as well as variables capturing expected returns, educational aspirations, risk averse, and indicator variables for shocks. Additionally, we incorporate dummy variables to account for regional differences that may influence youths' decisions, encompassing factors like labor market conditions, the educational environment, and social preferences. Appendix Table 2 presents the estimation results, while Table 2 summarizes the residuals correlations.

Our findings reveal relevant correlation among risky activities. Particularly noteworthy is the close connection observed among binge drinking, tobacco use, and consumption of marijuana and other drugs. These results may reflect

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5 We divide the sample into halves when we plot behavior by numeracy skills, self-esteem, aspirations, and expectations.

unobserved characteristics of youths predisposing them towards risky behavior, which remain unaccounted for in the regression models. Alternatively, they may signify complementarity between these activities.

3.3 Risky Behaviors and Socioeconomic Shocks

In this section, we emphasize the correlation between risky behavior and socioeconomic shocks. Figure 6 presents the associated estimated coefficients of the linear probability models detailed in the previous section, along with their confidence intervals. The complete results are available in Appendix Table 2.

Two shocks demonstrate particularly notable correlations with risky behaviors: experiencing job loss and encountering a significant illness or death within the family. For instance, losing a job is linked with a 16.4 percentage point (pp) higher likelihood of smoking tobacco, a 13.6 higher pp likelihood of binge drinking, and 22.2 pp higher probability of consuming marijuana. Similarly, a health-related shock or familial loss is associated with a 5.2 pp higher probability of engaging in unprotected sex, an 11.4 pp higher likelihood of binge drinking, and an 11.2 pp higher chance of consuming marijuana.

Of particular interest, we observe that youths from families recently affected by crime are 12.6 pp more likely to consume marijuana.

3.4 Discussion

Our findings align with previous literature, demonstrating correlations between engaging in risky behavior and factors such as age, skills, and risk aversion (Donnellan et al., 2005; Chiteji, 2010; Favara and Sánchez, 2017). Furthermore, this study introduces novel evidence highlighting a correlation between risky behaviors and educational aspirations. Additionally, we elucidate relevant links between various risky behaviors even after accounting for observables. This finding suggests that some individuals might be more prone to risky behaviors than others due to unobserved factors, emphasizing the importance of analyzing these activities jointly rather than in isolation.

Morevover, we find a noteworthy correlation between exposure to shocks at both individual and family levels. Particularly, experiencing job loss is associated with a higher prevalence of risky behaviors. Although the impact of job loss on adolescents may seem surprising, it is crucial to note that a significant proportion of subjects were employed during the survey period (20.2%), with many working part-time while studying. Therefore, job loss could indeed influence young workers' engagement in the risky behaviors analyzed in this paper. Similarly, we observe analogous outcomes concerning health issues and family deaths.

As previously indicated, our results only reflect correlations in the data. However, if causality is established, our findings may have implications for the design of policies aiming to address concerns about the prevalence of risky behaviors among youths. Interventions targeting cognitive and non-cognitive skills, particularly self-esteem, may hold promise in mitigating rates of risky behaviors, as they are amenable to change at this life cycle stage (Almlund et al., 2011). Interventions that have demonstrated efficacy in altering youths' educational trajectories by enhancing their socioemotional skills may hold the potential to mitigate rates of risky behaviors. Some of these interventions can be implemented at minimal cost. An encouraging body of experimental evidence underscores the potential of motivation, self-esteem, and student achievement enhancement through interventions providing words of encouragement and values affirmation, along with similar "light touch" approaches (Martins, 2010; Behncke, 2012; Bancroft et al., 2017; Bettinger et al., 2018; Broda et al., 2018; Baker et al., 2020).

Furthermore, policy initiatives could focus on averting costly earnings losses resulting from youth unemployment. Specifically, the unemployment insurance system in Chile, which currently offers limited coverage for young workers due to its design, could be strengthened.[6] Also policies could aim at reducing the impact of health shocks through improvements in healthcare access and efficiency. Enhancing efficiency in primary healthcare services and surgical wards are critical components of this aim (CNEP, 2020).[7]

Nonetheless, our study has limitations, particularly due to the cross-sectional nature of our dataset, which complicates establishing causal relationships between variables and the likelihood of engaging in risky behaviors. Many economic shock measures included in the analysis, such as job loss, might serve as either determinants or consequences of risky behaviors. Future analyses should attempt to disentangle the causal effects of shocks on the likelihood of engaging in risky behavior.

6 Coverage statistics by age can be found in https://www.spensiones.cl/apps/centroEstadisticas/paginaCuadrosCCEEsces.php?menu=sces&menuN1=afiliados&menuN2=NOID

7 Official waiting time statistics can be found in https://public.tableau.com/app/profile/tableau.minsal/viz/PortadaLE/PortadaLE

4. Conclusion

A substantial body of literature demonstrates that economic shocks affect various outcomes, including labor market and health outcomes, educational attainment, and subjective well-being. This study contributes to understanding a crucial aspect of the impact of economic shocks on young individuals—their engagement in risky behaviors. The findings highlight the connection of economic circumstances, adolescent behaviors, and future life trajectories, suggesting that economic shocks can shape not only traditional outcomes but also behaviors with profound implications for long-term well-being.

The correlation between economic shocks and youths' participation in risky behaviors raises important concerns about their future trajectories. Engaging in risky behaviors during adolescence may lead to detrimental outcomes in adulthood, affecting individual's socio-economic standing and overall quality of life.

While this study establishes associations between economic shocks and risky behaviors among youths, disentangling the causal relationship requires further investigation. Future work should leverage longitudinal data and experimental designs to delineate the mechanisms through which economic shocks lead to engagement in risky behaviors, enabling the design of informed policies and interventions to safeguard the well-being and future prospects of young individuals in the face of economic uncertainty. Future work should also examine risky behaviors concurrently rather than in isolation.

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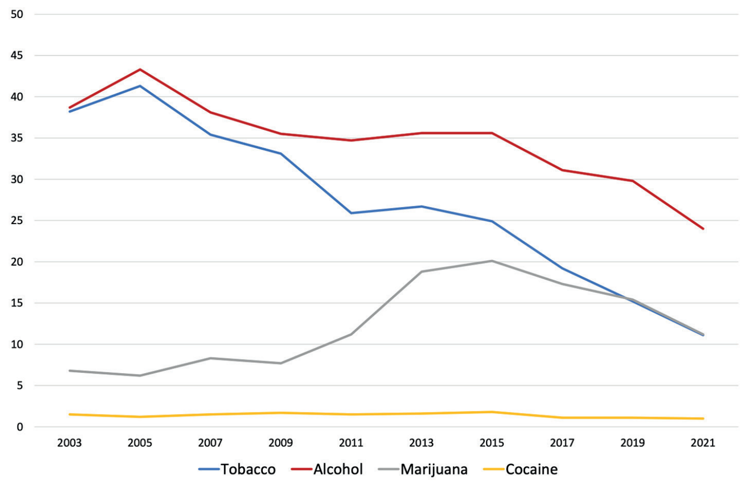
FIGURE 1

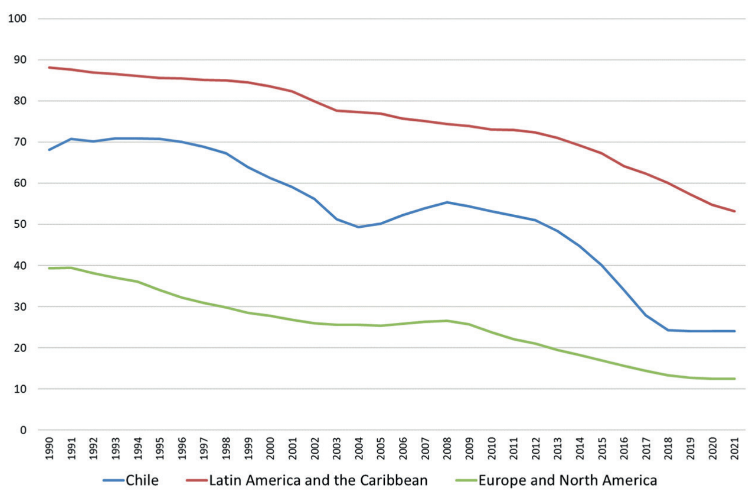
PREVALENCE OF TOBACCO,ALCOHOL, MARIJUANA, AND COCAINE USE, 8TH-12TH GRADE (% USE IN PREVIOUS MONTH)



Note: SENDA (2023).

FIGURE 2

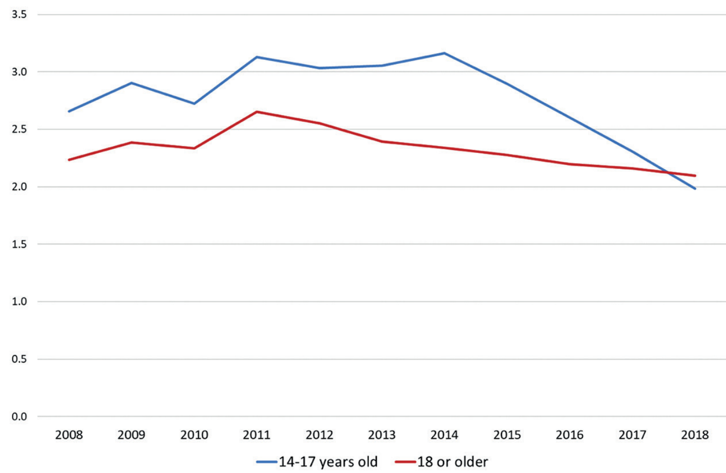
FERTILITY RATES, WOMEN AGED 15-19 (BIRTHS PER 1000 WOMEN)



Note: United Nations, World Population Prospects 2022.

FIGURE 3

ADMISSIONS OF CRIMINAL CASES BY AGE OF DEFENDANT
(PER 100.000 INHABITANTS IN THE RESPECTIVE AGE GROUP)

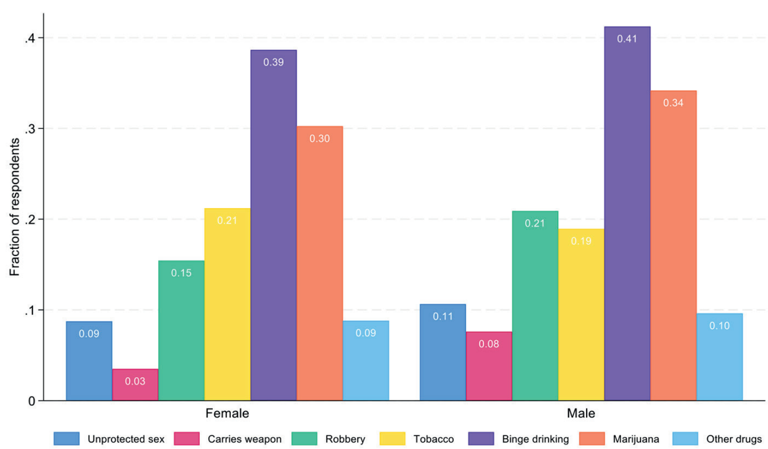


Note: UNICEF and Defensoría Penal Pública (2020).

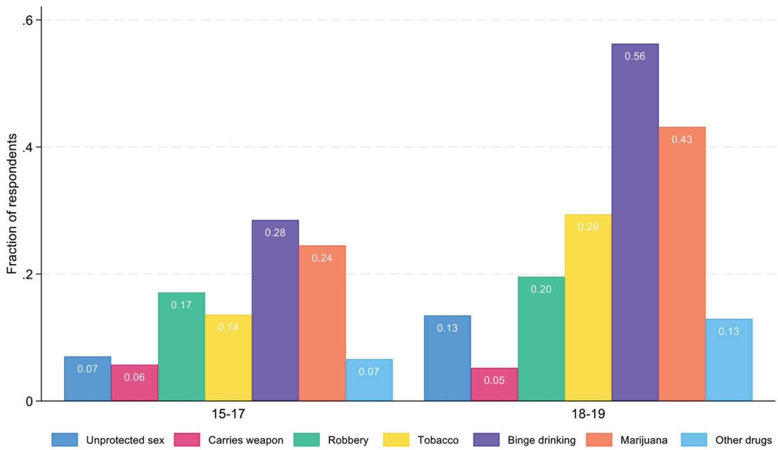
FIGURE 4

PREVALENCE OF RISKY BEHAVIORS BY INDIVIDUAL CHARACTERISTICS

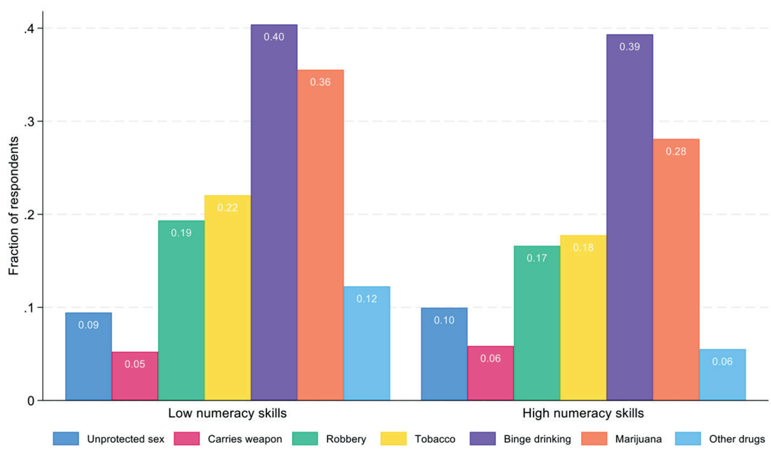
A. GENDER



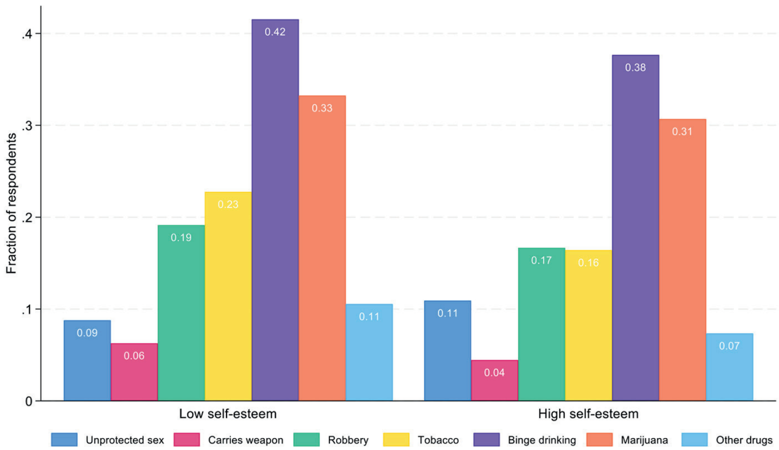
B. AGE



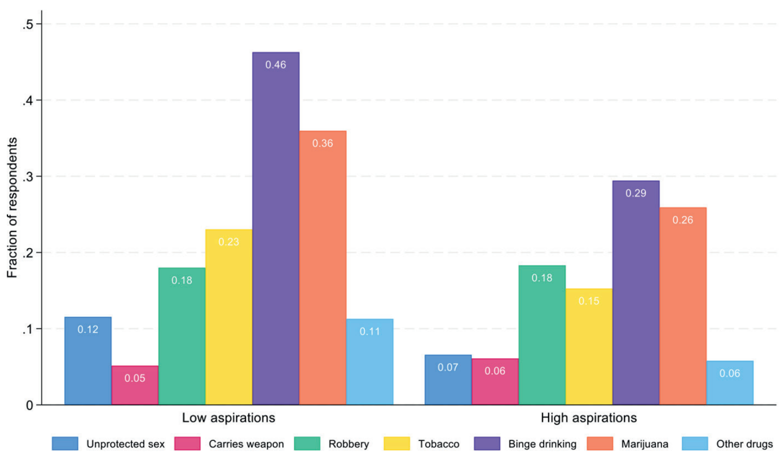
C. NUMERACY SKILLS



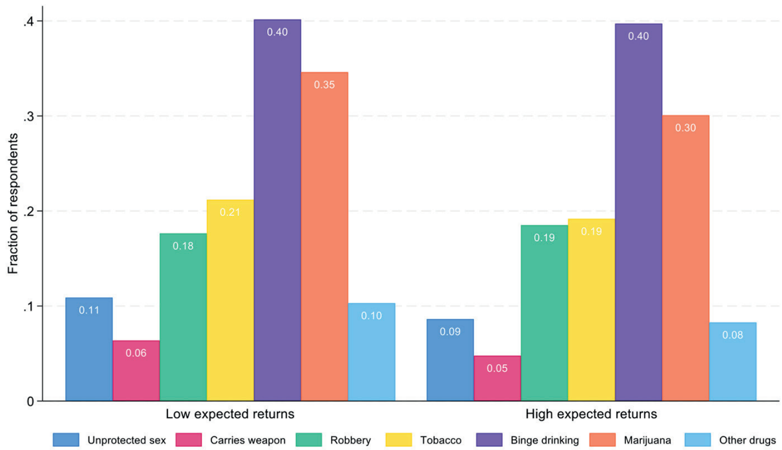
D. SELF-ESTEEM



E. EDUCATIONAL ASPIRATIONS



F. EXPECTED RETURNS TO COLLEGE



G. RISK AVERSION

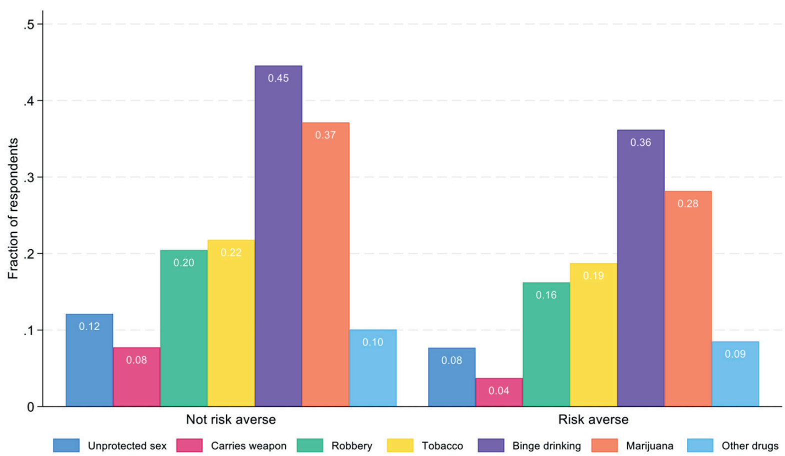


FIGURE 5

PREVALENCE OF RISKY BEHAVIORS BY EXPERIENCE OF SHOCKS

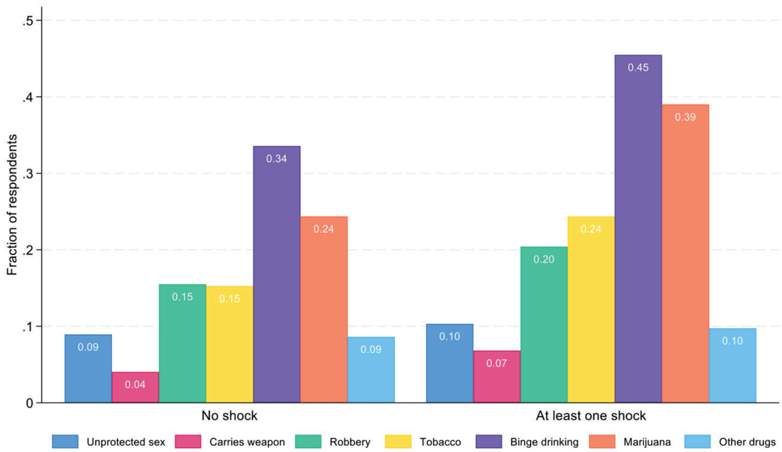


FIGURE 6

CONDITIONAL CORRELATION BETWEEN RISKY BEHAVIORS AND INDIVIDUAL SHOCKS

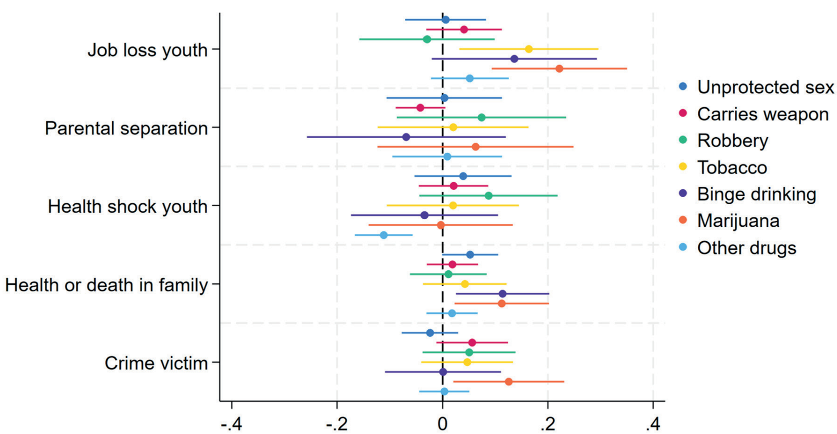


TABLE 1
DESCRIPTIVE STATISTICS

	All		No risky behavior		At least one risky behavior		Means test	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Difference	p-value
Any risky behavior	0.60	0.49	0.00	0.00	1.00	0.00		
Number of risky behaviors	1.43	1.55	0.00	0.00	2.40	1.31		
Unprotected sex	0.09	0.29	0.00	0.00	0.16	0.37		
Carries a weapon	0.07	0.25	0.00	0.00	0.11	0.32		
Robbery	0.19	0.39	0.00	0.00	0.31	0.46		
Tobacco	0.22	0.41	0.00	0.00	0.36	0.48		
Binge drinking	0.42	0.49	0.00	0.00	0.70	0.46		
Marijuana	0.34	0.48	0.00	0.00	0.58	0.50		
Other drugs	0.11	0.31	0.00	0.00	0.18	0.39		
Age	17.03	1.39	16.61	1.37	17.31	1.33	-0.70	0.27
Male	0.51	0.50	0.49	0.50	0.52	0.50	-0.03	0.00
Years of education	9.95	1.86	9.57	1.94	10.21	1.76	-0.64	0.06
Teenage parenthood	0.06	0.24	0.05	0.21	0.07	0.25	-0.02	0.34
Household members under 5 years	0.25	0.53	0.24	0.55	0.26	0.52	-0.03	0.60
Household members over 65 years	0.22	0.50	0.23	0.50	0.21	0.50	0.01	0.47

Income per capita (thousand pesos)	121.20	87.50	118.75	86.69	122.93	88.04	-4.17	0.60
Numeracy skills	0.03	1.00	0.05	0.99	0.02	1.01	0.03	0.38
Rosenberg score	0.01	1.00	0.08	0.99	-0.04	1.00	0.12	0.03
Expected return to a college education	0.63	0.50	0.63	0.49	0.63	0.51	0.01	0.75
Educational aspirations	6.38	2.65	6.78	2.66	6.11	2.61	0.67	0.00
Risk averse	0.54	0.50	0.61	0.49	0.49	0.50	0.12	0.00
Number of economic shocks (0-5)	0.70	0.87	0.56	0.77	0.80	0.92	-0.24	0.00
Job loss youth	0.09	0.28	0.04	0.20	0.12	0.32	-0.07	0.00
Parental separation	0.06	0.23	0.05	0.22	0.06	0.24	-0.01	0.34
Health shock youth	0.11	0.33	0.09	0.28	0.12	0.33	-0.04	0.02
Health or death in family	0.27	0.44	0.24	0.43	0.29	0.45	-0.05	0.05
Crime victim	0.18	0.39	0.14	0.34	0.21	0.41	-0.08	0.00
Number of observations	1427	1427	577	577	850	850	1427	1427

Note: This table presents averages for the complete sample, and according to youths' engagement in risky behavior. The table also presents the p-value for the test of differences of means between youths engaging and those not engaging in risky behavior. Any risky behavior is a dummy variable indicating whether the youth engaged in at least one of the behaviors listed below. Unprotected sex, carries a weapon, robbery, tobacco, binge drinking, marijuana, other drugs, teenage pregnancy, risk averse, and the shock variables are all dummy variables. Numeracy skills and Rosenberg score are normalized variables.

TABLE 2
RESIDUAL CORRELATIONS

	Unprotected sex	Carries a weapon	Robbery	Tobaco	Binge drinking	Marijuana	Other drugs
Unprotected sex	1.000						
	0.000						
Carries a weapon	0.030	1.000					
	0.260	0.000					
Robbery	0.075	0.071	1.000				
	0.004	0.008	0.000				
Tobaco	0.037	0.056	0.096	1.000			
	0.168	0.034	0.000	0.000			
Binge drinking	0.102	0.064	0.239	0.338	1.000		
	0.000	0.015	0.000	0.000	0.000		
Marijuana	0.121	0.177	0.176	0.435	0.484	1.000	
	0.000	0.000	0.000	0.000	0.000	0.000	
Other drugs	0.046	0.071	0.140	0.194	0.251	0.405	1.000
	0.084	0.008	0.000	0.000	0.000	0.000	0.000

Note: This table presents the correlations between the residuals of linear probability regression models of each risky behavior dummy variable on the set of observable covariates in Table 1. The first entry is the correlation, while the second entry is its significance.

APPENDIX TABLE 1

SAMPLE COMPARISON: INCLUDED AND EXCLUDED OBSERVATIONS

	Sample		Excluded observations		Means test	
	Mean	Std. Dev.	Mean	Std. Dev.	Difference	p-value
Age	17.04	1.38	16.88	1.42	0.16	0.02
Male	0.52	0.50	0.48	0.50	0.03	0.19
Years of education	9.97	1.87	9.76	1.89	0.21	0.02
Teenage parenthood	0.06	0.24	0.07	0.25	-0.01	0.57
Household members under 5 years	0.25	0.53	0.24	0.52	0.01	0.73
Household members under 65 years	0.23	0.51	0.20	0.47	0.03	0.22
Income per capita (thousand pesos)	121.2	87.5	108.3	75.9	13.0	0.00
Numeracy skills	0.05	0.99	-0.10	1.01	0.15	0.00
Locus of control score	0.07	0.99	-0.13	1.00	0.21	0.00
Rosenberg score	0.03	1.01	-0.06	0.98	0.09	0.05
Expected return to a college education	0.63	0.50	0.68	0.61	-0.05	0.13
Educational aspirations	6.44	2.60	6.18	2.71	0.27	0.04
Risk averse	0.53	0.50	0.55	0.50	-0.03	0.23
Short term discount rate	4.70	2.71	4.58	2.72	0.12	0.44
Discount difference	2.75	2.12	2.46	1.77	0.29	0.01
Number of economic shocks (0-5)	0.70	0.86	0.59	0.82	0.11	0.01
Job loss youth	0.09	0.29	0.05	0.22	0.04	0.00
Parental separation	0.05	0.22	0.05	0.22	0.00	0.84
Health shock youth	0.11	0.31	0.09	0.29	0.02	0.22
Health or death in family	0.27	0.44	0.24	0.43	0.02	0.29
Crime victim	0.18	0.38	0.16	0.36	0.02	0.22
Number of observations	1427	1427	489	489	1916	1916

APPENDIX TABLE 2
LINEAR PROBABILITY REGRESSION RESULTS

	Unprotected sex	Carries weapon	Committed robbery	Smokes tobacco	Binge drinking	Consumers marijuana	Consumers other drugs
	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Demographic							
Age	0.010	0.008	0.015	0.057***	0.069***	0.050***	0.030***
	(0.013)	(0.008)	(0.016)	(0.014)	(0.018)	(0.017)	(0.010)
Male	0.025	0.031	0.062*	-0.027	0.026	0.027	0.006
	(0.024)	(0.021)	(0.034)	(0.036)	(0.043)	(0.041)	(0.024)
Years of education	0.005	-0.018*	0.01	-0.033**	0.025	0.001	-0.009
	(0.011)	(0.011)	(0.012)	(0.013)	(0.015)	(0.015)	(0.008)
Teenage parenthood	0263***	0.006	-0.053	0.141	0.009	-0.116	-0.036
	(0.094)	(0.034)	(0.064)	(0.089)	(0.089)	(0.080)	(0.051)
Household members under 5 years	-0.019	-0.002	-0.008	0.013	-0.008	0.011	0.035
	(0.021)	(0.015)	(0.025)	(0.030)	(0.039)	(0.038)	(0.023)
Household members over 65 years	-0.029	0.028	0.007	0.022	0.014	0.003	-0.009
	(0.021)	(0.023)	(0.032)	(0.037)	(0.038)	(0.039)	(0.019)
Income per capita (thousand pesos)	0.000*	0.000	0.000	0.001***	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Skills							
Numeracy skills	-0.001	0.009	-0.02	0.030*	-0.014	-0.033*	-0.030***
	(0.011)	(0.011)	(0.017)	(0.017)	(0.021)	(0.020)	(0.011)

Rosenberg score	0.004	-0.008	-0.019	-0.034**	-0.053***	-0.027	-0.018
	(0.012)	(0.008)	(0.016)	(0.015)	(0.018)	(0.018)	(0.012)
Expectations and aspirations							
Expected return to a college education	-0.048*	0.004	0.013	0.005	0.048	-0.014	-0.024
	(0.026)	(0.013)	(0.032)	(0.030)	(0.039)	(0.035)	(0.028)
Educational aspirations	0.000	-0.005	0.009	-0.017*	-0.012	-0.013	-0.011*
	(0.005)	(0.004)	(0.006)	(0.010)	(0.010)	(0.010)	(0.006)
Preferences							
Risk averse	-0.037	-0.038*	-0.039	-0.002	-0.084*	-0.078**	0.002
	(0.024)	(0.022)	(0.033)	(0.033)	(0.043)	(0.039)	(0.022)
Exposure to shocks							
Job loss youth	0.006	0.041	-0.029	0.164**	0.136*	0.222***	0.052
	(0.039)	(0.037)	(0.065)	(0.067)	(0.080)	(0.066)	(0.038)
Parental separation	0.004	-0.042*	0.074	0.02	-0.069	0.063	0.009
	(0.056)	(0.024)	(0.082)	(0.073)	(0.096)	(0.095)	(0.053)
Health shock youth	0.039	0.021	0.087	0.02	0.034	-0.003	-0.111***
	(0.047)	(0.033)	(0.067)	(0.064)	(0.071)	(0.070)	(0.028)
Health or death in family	0.052*	0.019	0.011	0.042	0.114**	0.112**	0.018
	(0.027)	(0.025)	(0.037)	(0.040)	(0.045)	(0.046)	(0.025)
Crime victim	-0.024	0.056	0.051	0.047	0.001	0.126**	0.003
	(0.027)	(0.035)	(0.045)	(0.044)	(0.056)	(0.054)	(0.024)
Region							

Biobio	-0.039	-0.028	-0.041	-0.019	-0.004	-0.073	-0.015
	(0.034)	(0.027)	(0.040)	(0.043)	(0.048)	(0.047)	(0.033)
Metropolitan Santiago	-0.015	-0.02	-0.014	-0.06	-0.047	-0.074*	-0.061**
	(0.033)	(0.026)	(0.038)	(0.041)	(0.046)	(0.043)	(0.027)
Constant	-0.065	0.115	-0.264	-0.414	-0.970***	-0.476	-0.206
	(0.203)	(0.108)	(0.262)	(0.277)	(0.307)	(0.296)	(0.174)
Observations	1.427	1.427	1.427	1.427	1.427	1.427	1.427
R-squared	0.073	0.053	0.032	0.112	0.136	0.117	0.063

Note: p-values *0.10 **0.05 ***0.001
Standar errors in perenthesis

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- Equations should be numbered in consecutive order. When the derivation of a formula has been condensed, an additional page should be included with a full derivation.
- Tables and graphs must be included in a different page. They should be numbered and should include all the information needed for interpretation as well as the data sources.
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