Innovation and Entrepreneurship in Latin America: Recent Evidence and Challenges

Innovación y Emprendimiento de América Latina: Evidencia Reciente y Desafíos

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Abstract

In this paper, we discuss several aspects related to innovation and entrepreneurship in Latin America (LATAM). First, we document how LATAM lags behing high-income economies using various innovation indicators and how heterogeneity is a relevant issue for the region. Then, we review the main research topics related to innovation and entrepreneurship covered by economic academic research focused on the region. Within this context, we summarize the main results and contribution of the selected papers for this special issue.

Key words: *Innovation, entrepreneurship, research, Latin America.*

JEL Classification: *L26, M13, O31.*

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Resumen

En este documento, se discuten varios aspectos relacionados con la innovación y el emprendimiento en América Latina (AL). En primer lugar, se documenta cómo AL está rezagada respecto a las economias de altos ingresos usando varios indicadores de innovación y cómo la heterogenidad es un tema relevante para la región. Luego, se revisan los principales temas de investigación en las areas de innovación y emprendimiento abordados por la investigación economica centrada en la región. Dentro de este contexto, se resumen los principales resultados y la contribución de los trabajos seleccionados para este numero especial.

Palabras clave: *Innovación, emprendimiento, investigación, América Latina.*

Clasificación JEL: *L26, M13, O31*

1. Introduction

Assessing innovation performance, whether at the firm, sector, country, or global level, is a complex challenge. This requires considering a broad range of aspects, including economic, social, technological, and institutional dimensions. Thus, it is crucial to examine a comprehensive array of indicators that capture different innovation facets to fully understand innovation capabilities.[1]

As a general context, it is interesting to notice that even before the pandemic there were indications that the technological efforts were diverging across countries by level of development. Between 2015 and 2020, the change in R&D investments was positively correlated with GDP per capita (Figure 1). Thus, more advanced economies tended to increase R&D investments more intensively than less developed economies. The decline of trade as a growth engine observed in the last decade, coupled with the ongoing fragmentation of the global economy and its effects on foreign direct investment, raises significant concerns about the future of technological asymmetries across economies, even within developing economies.

There are relevant challenges for Latin American countries to catch-up the productivity and technology of the developed world. This requires private ef-

[1] As such, innovation indexes summarize and combine various innovation aspects, for example human capital, research, infrastructure, technology outputs and institutional capacities, among others. This approach, however, lacks theoretical foundations and could suffer from biases, depending on the relative importance of each aspect into the overall index.

forts and public incentives. The academic research on these issues should be relevant for implementing the right initiatives. This has been the main objective of the Latin American Network on Economics of Innovation and Entrepreneurship since the first conference held in Washington D.C. in July 2017. The papers in this special issue were presented at the last conferences held in Santiago, Chile in 2022 and in Guayaquil, Ecuador in 2023.

This paper is structured as follows. The second section reviews the Latin American comparative performance using several innovation indicators. The third section discusses about firm's heterogeneity. Section fourth presents some facts about recent empirical evidence. The fifth section summarizes the papers in this issue.

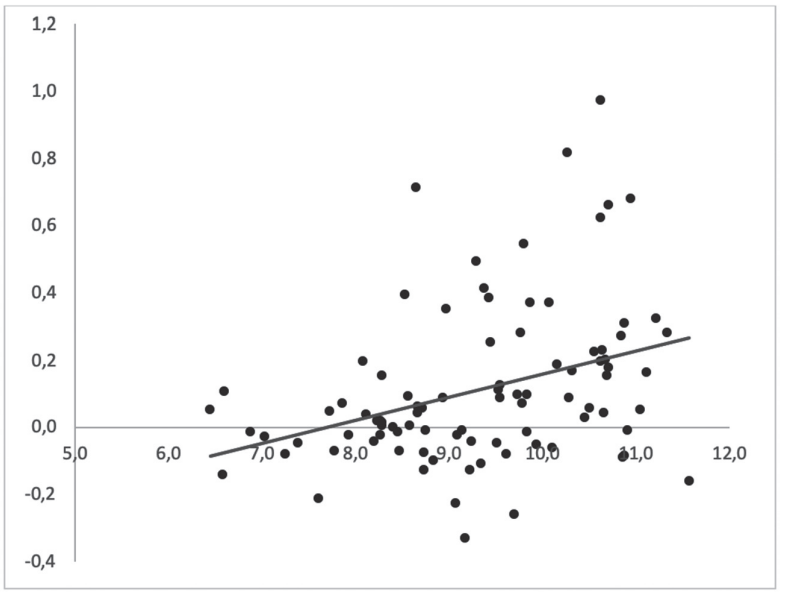
2. Latam Innovation Performance

A traditional starting point is R&D investments, which mirror the technological efforts to generate, absorb, and utilize knowledge. As such, R&D investments are crucial inputs for introducing product and process innovations (Lööf, et al., 2017). In recent decades, R&D investments in Latin America showed a modest increase (see Table 1). Between 2000 and 2015, R&D investments as a share of GDP climbed from 0.51% to 0.72%. However, it then declined to 0.59% by 2020, following the end of the commodity boom in 2014/15. By contrast, developed economies and East Asian economies show a more substantial expansion of R&D investments. R&D investments as a share of GDP in developed economies increased from 2.23% in 2000 to 2.99% in 2020. Thus, the R&D gap between Latin America and developed economies expanded from 1.72 to 2.40 percentage points. In East Asia, R&D investments as a share of GDP expanded from 0.67% in 2000 to above 2.0% of GDP in 2020.

FIGURE 1

CHANGE IN R&D INVESTMENTS OVER GDP BETWEEN 2020 AND 2015 AND GDP PER CAPITA 2015

PERCENTAGE POINTS AND NATURAL LOG



Source: Authors' elaboration based on data from UNESCO and IMF.

Since 2020, the R&D gap between Latin America and developed economies has likely expanded further. For developed economies, the pandemic crisis and the war in Ukraine uncovered critical supply chain weaknesses and productive vulnerabilities, underscoring domestic resilience and national security issues over efficiency considerations. Also, the growing geopolitical rivalries, together with the green energy transition, are prompting United States, China, and the European Union to expand their policies to retain or enhance competitive advantage (OECD, 2023). Therefore, developed economies are increasingly supporting R&D investments, particularly in high-tech sectors, as well as supporting low-carbon innovations. In contrast, innovation policy efforts in developing economies remain much smaller in scale and scope, and public budgets towards science, innovation and technology are only gradually recovering from substantial cuts in the pandemic crisis.

TABLE 1
INNOVATION INDICATORS, 2000-2020
WEIGHTED AVERAGES

Region	Indicator	2000	2005	2010	2015	2020
Developed economies	R&D	2.23	2.24	2.38	2.56	2.99
	Researchers	3,260.60	3,549.34	3,807.15	4,166.83	4,448.50
	Patents	797.16	829.57	813.62	856.21	799.84
	Publications	973.52	1,175.54	1,277.50	1,341.03	1,403.17
Latin America	R&D	0.51	0.53	0.65	0.72	0.59
	Researchers	253.17	382.12	496.79	569.56	586.2
	Patents	11.95	13.84	12.74	13.63	14.93
	Publications	61.94	89.68	140.55	166.96	226.02
East Asia	R&D	0.67	1.00	1.37	1.70	2.03
	Researchers	562.91	845.53	946.45	1,208.43	1,563.88
	Patents	17.71	54.97	168.16	545.72	760.75
	Publications	67.67	141.65	227.45	283.41	434.67

Source: Authors' elaboration based on data from UNESCO and WIPO.
Note: R&D corresponds to R&D as a share of GDP; researchers are the number of full-time equivalent researchers per million inhabitants; patents are patents applications per million inhabitants; publications are the number of scientific publications per million inhabitants. For Brazil, the data for researchers in 2020 is not available. For the regional calculation, we used the same number of researchers that Brazil reported in 2015.

Another indicator of innovation refers to the number of scientific researchers, which is also a key input for innovation. In the last two decades, the number of full time-researchers per million inhabitants in Latin America has more than doubled. As such, the region was able to reduce the gap with respect to developed economies, which have already accumulated a critical mass of researchers. East Asian countries have nearly tripled their scientific research base, showcasing an even more impressive expansion.

Regarding patents applications –usually considered as an outcome of innovation efforts–, Latin American economies have not been able to catch-up with the performance of developed economies (Table 1). The average number of patents applications per million inhabitants has only increased marginally. This poor performance is explained mainly by the low levels of R&D investments and skills of the labour force, weak legal and regulatory frameworks and lack of technological infrastructure. By contrast, the performance of East Asia in the last two decades was remarkable, driven by China. Meanwhile, the scientific publications exhibit a relatively strong expansion in Latin America. The number of scientific publications per million inhabitants in the region in-

creased nearly fourfold in the past two decades.

This confirms that Latin America performed poorly regarding innovation indicators and did not substantially close innovation gaps in the recent decades.[2] There is no single factor to explain the poor innovation performance in the region, and crucial aspects are a largely limited scientific community and low levels of labour force skills, usually including mismatches between educational outcomes and industry requirements (Navarro et al., 2016). In addition, the productive structure is biased towards low-tech sector, which leads a poor innovative dynamic with also low levels of technological spillovers. Manufacturing innovation is highly informal. Thus, R&D investments are low and with a relatively low participation of the private sector.

Also, there is a lack of interactions and cooperation between private sector and universities, and innovative firms tend to operate isolated, without creating downward and upstream linkages. Finally, countries have decided not to embark in transformative innovation policies, amid major structural constrains, including fragile institutional frameworks and lack of financing resources (Peres and Primi, 2019; ECLAC, 2022). In addition, in recent years many countries in the region are facing increasing fiscal constrains to implement innovation policies due to elevated levels of debt, rising debt servicing costs and large output losses from the pandemic crisis (United Nations, 2023).

3. Firms' Heterogeneity, Productivity and Innovation

Most of the economic literature on innovation and productivity assumes firms as homogeneous. However, worldwide empirical evidence indicates that there is significant heterogeneity not only across countries and sectors, but also among firms operating in the same markets (see Table 2). In the United States, Syverson (2004 and 2011) found that -within the same four-digit Standard Industrial Classification (SIC) code in the manufacturing sector- the plant in the 90th percentile of the productivity distribution has almost twice as much output than the plant in the 10th percentile with the same measured inputs. Even when homogenous products industries are considered - such as solid fiber boxes or ready-mixed concrete - large differences persist (Foster et al., 2008). The existence of high productivity dispersion has been confirmed by several other country-specific studies (see, for example Disney et al., 2003 for results on the United Kingdon, Ito and Lechevalier 2009 for Japan and Crespi and Zuñiga, 2012, Fiorentin et al. 2021, and Molina-Domene y Pietrobelli, 2012 for Latin America).

[2] This analysis uses weighted averages (according to GDP) for calculating regional indicators. However, using simple averages and the median across countries for regional indicators does not alter the main messages.

In developing regions, where economic dualism is a common phenomenon, firms' heterogeneity is usually even more pronounced. For example, in China and India, the average 90–10 TFP ratios was found around 5:1 (Hsieh and Klenow 2009). LAC is no exception. Overall, the region is characterized by large disparities in productivity (Busso et al., 2013; Pagés, 2010), where many low-productivity firms coexist with few firms with high productivity. Using data from the World Bank Enterprise Survey, Grazzi and Pietrobelli (2016) found that the variance between the 90th and 10th percentiles of the labor productivity distribution in the LAC manufacturing sector was approximately 10:1, with most firms clustered at very low levels of productivity, although some highly productive firms also appear in the scenario.

TABLE 2
EMPIRICAL EVIDENCE ON FIRM PRODUCTIVITY DISPERSION

Country	**90-10 percentile average difference in logged TFP**	**90-10 percentile TFP ratio**	**Author**
Japan	0.25	1.28*	Ito and Lechevalier (2009)
United States	0.65	1.91	Syverson (2004, 2011)
United Kingdom	0.91	2.47*	Disney et al. (2003)
Chile	1.31	3.70	Figal Garone et al. (2020)
China	1.59	4.90*	Hsieh and Klenow (2009)
India	1.60	4.95*	Hsieh and Klenow (2009)
Latin America and the Caribbean	1.91	6.72	Figal Garone et al. (2020)

Note: In the cases marked with *, the value was not included in the original papers, but it has been calculated on the basis of the original data in Figal Garone et al. (2020).

Source: Authors´ elaboration.

In a more recent research effort, Figal Garone et al. (2020) confirmed the persistence of high firm productivity dispersion in the region by finding an average TFP ratio between an industry's 90th and 10th percentile firm of 6.72.

It means that the firm at the 90th percentile of the productivity distribution is found to generate almost seven times more output with the same inputs than the 10th percentile firm operating in the same industry. The authors also replicated this analysis in Chile, finding a 90-10 TFP ratio of 3.70. Interestingly, they found similar figures using different levels of industry disaggregation (two-digit industries vs. four-digit industries), concluding that their results do not depend on data structure.

From a theoretical point of view, this situation has been explained in various forms by scholars from different schools of thought. On the one hand, the neoclassical approach stresses the role of market imperfections and particularly of lack of competition, which prevents the correct functioning of the entry-exit mechanism. Without competitive pressures, incumbent firms may face fewer incentives to innovate or improve their products and services. Therefore, poorly performing firms may persist in the market without facing pressure to exit. At the same time, incumbent firms may engage in practices that deter potential entrants. This could include predatory pricing strategies that make it difficult for new firms to establish themselves or compete effectively. This can result in the inefficient allocation of resources, as they continue to be allocated to firms that are not productive or competitive.

On the other hand, evolutionary and managerial approaches refer to the intrinsic characteristics of firms: their internal organization, routines and practices, specific strategies to accumulate technological capabilities, learning, and innovation (See e.g. Dosi, 1988; Lundvall, 1992; Nelson, 1991). In other words, firm performance depends on the unique characteristics embedded within firm-specific decision making, organization, and processes.

Heterogeneity in productivity highlights the fact that not all the firms innovate in the same way or to the same extent, and that their returns to innovation effort largely vary, depending not only on the sector where they operate but also on their characteristics, capabilities, technological orientation, and market positioning.

Related empirical evidence in the region seems to confirm this hypothesis. Morris (2018) found that explicitly accounting for unobserved firm heterogeneity significantly reduces the size of both the effect of innovation input on innovation output and of innovation output on productivity. Specifically, investment in R&D consistently increases the innovation performance of firms operating in the manufacturing sector but its effect is unstable and substantially for firms in the services sector. Crespi et al. (2015), by employing a quantile regression approach, estimated the impact of innovation on productivity in LAC firms, finding that it is remarkably different across productivity quartiles. In other words, innovation has much larger effects on the firms that are already more productive than others. At the upper end of the distribution (the top 10

percent in terms of productivity), the increase in productivity due to innovation is much higher than in the lower quartiles (an increase of no less than 65 percent versus 29-34 percent in the first three quartiles).

These findings have direct implications for both innovation economics research and innovation policy design and effectiveness. One-size-fits-all policies may not adequately address the diverse needs and challenges faced by different types of firms. Detailed research and impact evaluations should throw further light on what kind of specific tools should be employed in each case.

4. Recent Empirical Evidence

To shed light on the main research topics related to innovation and entrepreneurship in Latin America, we look for articles in the top field journals in this area. We use the Scholar Google classification for the top ten journals. These are the following ones: Research Policy, Small Business Economics, Journal of Business Venturing, Entrepreneurship Theory and Practice, Journal of Small Business Management, International Journal of Entrepreneurial Behavior & Research, International Entrepreneurship and Management Journal, Journal of Open Innovation: Technology, Market, and Complexity, Technovation and The Journal of Technology Transfer. We select articles in top journals for looking at high quality research, even we acknowledge that this can be arguable. In total, we find 23 articles published between 2018 and 2024. We start in 2018 because this was the publication year of the previous literature review carried out for the last special issue of the Network of Innovation and Entrepreneurship Economics (RIE). The articles were selected under the following criteria: (i) the question addressed should be related to innovation and entrepreneurship and (ii) the focus is on some Latin American country or whether the region as a whole is part of the research.[3]

Several patterns emerge from this selection. First, most of the articles (about 70%) have been published in Research Policy, the top one field journal according to the Scholar Google classification. This is evidence that research in these topics can be qualified as high quality. Second, most of the articles have focused on issues related to innovation. Few articles analyze aspects of entrepreneurship in Latin America. Third, according to the main question in the article, the emphasis of the research is about the determinants (drivers or obstacles) of innovation. We find that 15 over 23 papers, about 65%, corresponds to this issue. The rest of the articles analyze the impact of innovation on different aspects of performance (22%) and there are three articles summarizing literature on innovation and entrepreneurship in Latin America. Finally,

[3] The list of selected papers is available upon request.

regarding the location of the authors, we look at whether some of the authors of the articles work for some Latin American institution. We find that most of the papers (78%) have at least one author located in the region.

5. This Issue

The paper titled "Inventions, Public Subsidies, and Market Launch: Opportunities and Limits of Patenting Support in Argentina" by Dario Milesi, Carlos Aggio, and Vladimiro Verre delves into an analysis of the Argentinean program "ANR Patentes," which offers grants for patent applications to innovative firms, entrepreneurs, and researchers. The novelty of this paper lays on its original methodological approach in evaluating the results and impacts of a small-scale program, with a particular focus on the post-patenting phase. The authors raise the question of whether patents met market expectations, ultimately concluding that the program successfully stimulated patenting among Argentinean firms and inventors—a significant feat given the low levels of patenting in Argentina. However, the authors assert that merely promoting patent applications falls short of ensuring that innovative products reach the market. They argue that additional, well-coordinated policies are necessary to bridge this gap effectively.

The paper titled "The Impact of Intangible Capital on Productivity and Wages: Firm-level Evidence from Peru," authored by Rafael Castillo and Gustavo Crespi, investigates the influence of intangible assets on firms' productivity and wages in Peru. Utilizing longitudinal firm-level data, the study offers robust estimations of causal relationships. Additionally, the authors reflect about the roles of intangible and tangible assets within the context of a middle-income country, exploring how wages and total factor productivity compete for appropriability of quasi-rents. Through their analysis of capital investments in both types of assets, the authors found that increases in the proportion of intangible assets correlate with elevated levels of total factor productivity, surpassing the returns on investments in tangible assets. Furthermore, they observe that while higher productivity levels are associated with increased wages, this relationship is not fully translated due to imperfect competition in labor markets. This highlights the potential for policy interventions aimed at improving income distribution.

The paper titled "Diverse Knowledge for Diverse Innovation: Evidence from Chilean Firms," authored by Rodolfo Lauterbach, examines the relationship between institutions from the national system of innovation as sources of external knowledge and the innovation performance of Chilean firms, using firm-level data. The research question focuses on identifying the differential

impacts of various sources of external knowledge on the specificities of firms' innovation outcomes. In pursuit of answers, the author delves into the Chilean innovation survey, which follows the traditional Oslo Manual framework, to investigate whether the source of knowledge—whether from commercial chains (clients and suppliers), S&T institutions, or government agencies—affects firms' innovation outcomes. The findings reveal that while knowledge gathered from clients influences all types of innovations, knowledge from governmental agencies is positively associated with social innovations, and to a lesser extent, with product and process innovations. None specific association is found for the case of knowledge from competitors. These results offer valuable insights for policy design and firm-level decision-making, suggesting which types of linkages should be fostered depending on the desired innovation outcome.

In the paper titled "Quality Management and Labor Productivity of Formal Companies in Peru: A Non-Experimental Design and Causal Machine Learning Techniques," Mario Tello and Daniel Tello-Trillo examine the effects of quality management tools on the labor productivity of Peruvian firms using firm-level data. Apart from employing non-experimental methodologies and cutting-edge techniques, such as machine learning, the novelty of this paper lies in its assessment of causal relationships between quality management and labor productivity. The authors establish that quality assurance techniques have a positive impact on productivity, particularly among large and medium-sized firms in the manufacturing sector. These findings are consistent across various estimations, affirming not only the positive association between the variables under study but also the methodological contribution of the paper for future applications of the proposed modeling technique.

The paper "Beyond Formal R&D: Firms' Capabilities and Its Innovation Profile. The Case of Argentinean Manufacturing Firms (2014-2016)," authored by Florencia Barletta, Diana Suarez, Gabriel Yoguel, and Florencia Fiorentin, explores the relationship between different innovative strategies and firms' innovation outcomes. Departing from the low levels of R&D investments among Argentinean firms, they investigate different innovative profiles based on different forms of R&D investments (formal and informal, and other innovation efforts). They found that the more significant the role of R&D, the higher the likelihood of achieving product and process innovations. Additionally, the more complex the R&D strategy, the higher the probability of patenting. However, they observed that R&D-based strategies require higher levels and types of capabilities - productive, organizational, connectivity, and absorptive. The novelty of their contribution lays on the methodological approach that considers the presence of micro-heterogeneity, not only in terms of productivity levels but also derived from discretionary choices of firms. Their results con-

tribute to public policy design by shedding light on the relationship between innovation investments and capabilities, and the necessity of articulating different types of innovation public policies.

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