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Leader-Follower vs. Neck-to-Neck: Competition and Technological Status Across Bolivian Industries

Líder-seguidor vs. codo a codo: competencia y estado tecnológico en las industrias bolivianas

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Abstract****

How does competition shape technological dispersion in developing economies with persistent structural rigidities? Drawing on the Schumpeterian step-by-step framework, this paper studies whether competitive pressure is associated with convergence toward the technological frontier or with the persistence of leader-follower structures. Using firm-level data from Bolivia's 2017 Survey of Medium and Large Enterprises, we relate industry-level competition to firms' Total Factor Productivity gaps within two-digit industries. Greater competition is systematically associated with smaller gaps, consistent with catch-up

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incentives. Yet the distribution of technological positions reveals that most markets operate under leader-follower configurations. Heterogeneity across firm size and sectors further indicates that technological dispersion is unevenly distributed across the industrial landscape. These findings provide a structural characterization of how competition interacts with technological asymmetries in a commodity-dependent economy, highlighting the role of market configuration in shaping innovation incentives.

Keywords: Market Structure; Schumpeterian Effect; Unbalanced industry status.

Resumen

Este artículo analiza cómo el grado de competencia en un mercado influye en la dispersión tecnológica en economías en desarrollo caracterizadas por rigideces estructurales persistentes. A partir del enfoque schumpeteriano "step-by-step", se examina si una mayor presión competitiva se vincula con una convergencia hacia la frontera tecnológica o, por el contrario, con la persistencia de estructuras de líder y seguidor. Utilizando datos de la Encuesta de Medianas y Grandes Empresas de Bolivia de 2017, se analiza la relación de la competencia a nivel de industria con la brecha de productividad total de los factores entre firmas dentro de industrias a una clasificación de dos dígitos. Los resultados muestran que una mayor competencia se asocia sistemáticamente con brechas más pequeñas, en línea con incentivos al "catch-up". Sin embargo, la distribución de las posiciones tecnológicas revela que la gran mayoría de los mercados opera bajo configuraciones de líder-seguidor. Además, la heterogeneidad por tamaño de empresa y sector indica que la dispersión tecnológica se distribuye de manera desigual dentro del tejido industrial. En conjunto, estos hallazgos ofrecen una caracterización estructural de cómo la competencia interactúa con las asimetrías tecnológicas en una economía dependiente de *commodities,* destacando el papel de la estructura de mercado en la configuración de los incentivos a la innovación.

Palabras clave: Estructura de mercado; efecto schumpeteriano; Estado industrial desbalanceado.

Classification/Clasificación JEL: D40, L16, O30.

1. Introduction

For more than four decades, Bolivia's productive structure has remained remarkably static. Despite episodic periods of rapid growth, the economy continues to rely heavily on primary exports and remains highly exposed to fluctuations in international commodity prices. This persistent dependence reflects a limited capacity for structural transformation and a narrow set of domestic industries capable of driving productivity improvements. Yet standard macroeconomic analyses of Bolivia continue to assume that firms operate in competitive environments, overlooking the strategic interactions that shape innovation, entry, and long-run growth.

Traditional growth frameworks such as Solow (1956), Ramsey (1928), Cass (1965), Koopmans (1963), and Romer (1986) highlight the role of physical and human capital accumulation but abstract from market structure and the heterogeneity of firms across sectors. In contrast, Schumpeterian models (Aghion & Howitt, 1992) explicitly incorporate insights from industrial organization, linking competition, innovation incentives, and productivity dynamics. Subsequent work emphasizes that innovation emerges from strategic interactions among firms (Arrow, 1962; Hart, 1983; Grossman & Helpman, 1991) and that imperfect competition plays a central role in determining these incentives (Dixit & Stiglitz, 1977; Salop, 1977; Scherer, 1967). This literature has proven essential for understanding growth patterns in advanced economies. However, its empirical application on developing, commodity-dependent economies remains limited.

In the case of Bolivia, no existing work systematically connects competition, innovation approach, and productivity gaps across industries. The country offers a natural setting to explore these questions since: (i) its sectoral composition has exhibited little diversification over time, (ii) productivity differentials across firms are large, and (iii) domestic competition varies considerably across manufacturing, commerce, and services. Moreover, innovation in developing economies tends to be incremental, reliant on imported technologies, and constrained by managerial, financial, and regulatory frictions. These features imply that mechanisms central to the Schumpeterian paradigm –such as neck-to-neck competition or leader-follower– may operate differently than in high-income countries.

Despite the centrality of market structure in modern growth theory, empirical analyses of growth in developing economies continue to treat competition as a background assumption rather than an object of study. At the same time, the Schumpeterian literature has largely focused on advanced economies, where innovation is frontier-driven and patent-based, leaving open the question of how its mechanisms operate in settings characterized by incremental innovation and structural rigidity. This disconnect has limited our understanding of whether endogenous growth can emerge in commodity-dependent economies such as Bolivia.

This paper seeks to bridge this gap by providing the first systematic examination of the relationship between competition and firms' distance to the technological frontier in Bolivia. In doing so, we do not attempt to model dynamic growth processes directly. Rather, we focus on a prior and necessary step: characterizing the structural configuration of industries in terms of their competitive and technological dispersion. Because no integrated framework has yet been developed to analyze how competition, innovation, and growth interact in the Bolivian context, the literature has not identified which industries operate under balanced (neck-to-neck) conditions and which are structured around persistent leader-follower asymmetries.

Understanding this industrial configuration is a prerequisite for any subsequent dynamic analysis. The distribution of sectors across competitive regimes determines the incentive environment in which innovation unfolds and, therefore, shapes the feasibility of convergence-driven growth. By establishing this structural diagnosis, the paper lays the groundwork for future work examining the dynamic implications of these configurations.

The objective is twofold. First, characterize the competitive landscape across major industries in manufacturing, commerce, and services, identifying sectors where firms operate in neck-to-neck environments versus those dominated by a technological leader. Second, assess whether competitive pressure is associated with smaller knowledge gaps, thereby offering insights into the potential for productivity. By doing so, the study seeks to inform industrial policy discussions in a country where long-run growth has been historically tied to external shocks rather than domestic innovation.

The analysis relies on the 2017 Bolivian Survey of Medium and Large Enterprises in Manufacturing, Commerce, and Services. Using this dataset, we estimate regressions that relate sector-level competition to firms' technological distance from the frontier. The empirical strategy proceeds in multiple layers. We first estimate the average relationship between competition and productivity gaps for the full sample. We then explore heterogeneity along three key dimensions: (i) sector size, recognizing that competitive pressures differ markedly between concentrated and fragmented industries; (ii) sectoral classification, comparing manufacturing, commerce, and services; and (iii) export status, to assess differences between firms exposed to international competition and those serving domestic markets. Rather than capturing dynamic convergence *per se,* this multi-tiered approach enables us to characterize how the effects of competition vary across distinct competitive environments, particularly between sectors operating in neck-to-neck settings and those structured around leader-follower relationships.

The study makes three main contributions. First, it provides the first empirical characterization of competition and technological distance across Bolivian industries using firm-level data. Second, it integrates concepts from Schumpeterian growth theory into the analysis of a developing economy with a historically rigid productive structure –offering a framework to understand how potential growth might be endogenized through industrial dynamics. Third, by identifying which sectors are closer to neck-to-neck competition and which follow a leader-follower structure, the paper sheds light on which industries are better positioned to serve as engines of productivity growth. This knowledge is essential for designing industrial policies that reduce Bolivia's dependence on international price cycles and create conditions for sustained, innovation-driven growth.

While the analysis focuses on Bolivia, the mechanisms under study are not country specific. Many developing economies share a similar combination of structural features: persistent sectoral concentration, large within-industry productivity dispersion, and innovation processes driven primarily by imitation and incremental upgrading rather than frontier R&D. In such environments, the interaction between competition and technological distance is likely to operate through the same Schumpeterian mechanisms emphasized in this paper. Therefore, Bolivia can be viewed as a representative case of a broader class of commodity-dependent and structurally rigid economies, allowing the results to speak to more general patterns of how market structure shapes technological dispersion beyond the frontier.

The remainder of the paper is organized as follows. Section 2 discusses the theoretical underpinnings linking competition, innovation, growth and measurement challenges and differences between advanced and developing economies. Section 3 presents stylized facts for Bolivia. Section 4 outlines the empirical strategy following the results in Section 5, and finally Section 6 concludes.

2. Conceptual Framework

The relationship between competition and economic growth has long been viewed through the lens of efficiency: more intense competition pushes firms to reduce costs, expand market share, and increase productivity. Early empirical work documents a positive correlation between competition and productivity growth (Nickell, 1996; Blundell *et al.*, 1995). However, this correlation does not reveal the underlying mechanisms through which market structure shapes firms' incentives to innovate. The Schumpeterian growth literature provides a framework in which competition, innovation, and productivity are jointly determined.

2.1. Creative Destruction and Step-by-Step Innovation

Aghion and Howitt (1992) formalize the idea of creative destruction: firms innovate to replace existing technologies, earning temporary monopoly rents until displaced by the next innovator. Innovation is costly and creates a pecuniary externality: the innovator at time t does not internalize the future business-stealing effect that its innovation imposes on subsequent innovators (Tirole, 1988). Growth results from a sequence of these incremental improvements, and its long-run rate depends on the strength of product-market competition in the innovation sector.

The classical Schumpeterian framework assumes that any follower can leapfrog the technological leader in a single step. Many industries, however, exhibit incremental, step-by-step innovation, where firms differ by a discrete number of technological steps. Aghion *et al.*, (1997) and Aghion *et al.*, (2001) introduce this structure by distinguishing between two states: (i) a *neck-to-neck* state where firms operate at the frontier, and (ii) a *leader–follower* state where the follower is n steps behind. The incentives to innovate differ sharply between these states.

Innovation yields *incremental* rather than absolute rents: what matters is not the level of post-innovation profits but the difference between innovating and failing to innovate. In neck-to-neck industries, competition creates an *escape-from-competition effect*: firms innovate to differentiate themselves and earn higher rents. In contrast, when gaps are large, higher competition reduces followers' incentives to catch up, generating a classical *Schumpeterian effect* that discourages R&D.

A central implication is that the relationship between competition and innovation is state-dependent. Neck-to-neck industries respond positively to competition, whereas leader-follower industries respond negatively. Market structure thus determines the direction in which competition affects growth.

2.2. The Inverted-U Relationship and Sectoral Heterogeneity

Aghion *et al.*, (2005) extend the framework to an economy with a continuum of intermediate sectors, each operating under duopoly with innovation incentives that depend on whether the sector is neck-to-neck or leader-follower. Competition is modeled as the degree of substitutability between products. Two forces are at play: (1) in neck-to-neck sectors, competition increases R&D incentives through the escape-from-competition effect; (2) in leader-follower sectors, competition decreases followers' incentives to catch up, generating a Schumpeterian discouragement effect.

The aggregate innovation rate reflects the stationary distribution of sectors across these two states. When competition is low, neck-to-neck firms innovate slowly while followers innovate more aggressively, so the economy tends to spend more time in the neck-to-neck state. When competition is high, leaders innovate more aggressively and followers rarely catch up, so the economy spends more time in leader-follower states. These opposing forces generate an inverted-U relationship between competition and innovation.

A further implication is that technological gaps are increasing in the degree of competition: higher competition disproportionately raises the innovation intensity of frontier firms relative to laggards, thereby increasing the prevalence of leader-follower structures. Consequently, aggregate growth depends critically on the distribution of sectors across neck-to-neck and leader-follower states, since this distribution determines whether competition fosters widespread technological upgrading or instead amplifies structural heterogeneity and limits diffusion.

2.3. Imitation, Distance to the Frontier, and Development

A complementary perspective comes from Acemoglu *et al.*, (2006), who emphasize that economies far from the global frontier rely heavily on imitation, while economies close to the frontier depend more on frontier innovation. The optimal strategy for firm-level upgrading depends on this distance: imitation-based strategies may dominate when the technological gap is large, while innovation-based strategies become more profitable as economies converge toward the frontier. In developing economies, high barriers to entry, incumbency advantages, and weak competitive pressure can generate *non-convergence growth traps,* where firms face insufficient incentives to upgrade, and incumbents have strong incentives to protect existing rents.

These insights imply that the effect of competition on innovation depends on (i) the technological distance to the frontier, (ii) the ease of imitation and spillovers, and (iii) the strategic interaction between incumbents and entrants. Industries differ systematically along these dimensions, making sector-level heterogeneity a first-order concern in empirical work.

Taken together, the Schumpeterian step-by-step framework delivers two core predictions directly relevant for our empirical analysis. First, the effect of competition on firms' technological distance depends on the prevailing industrial regime. In neck-to-neck environments, stronger competition may widen technological dispersion through escape-from-competition incentives at the frontier. In leader-follower environments, competition induces catch-up among lagging firms, reducing technological gaps. Second, the aggregate relationship between competition and technological dispersion reflects the distribution of industries across these regimes rather than a uniform response across sectors.

Because long-run growth in this framework depends on the stationary distribution of industries across balanced (neck-to-neck) and unbalanced (leader-follower) states, the relative prevalence of these regimes becomes a structural determinant of whether competition can sustain convergence-driven dynamics or instead reinforce persistent technological asymmetries.

2.4. The Development Context: Adapting Measures of Competition and Innovation

While the previous section outlines the theoretical mechanisms linking competition, innovation, and distance to the technological frontier, applying this framework to developing economies requires careful adaptation of empirical measures.

Standard indicators of innovation such as R&D expenditure and patent counts, are well suited to frontier economies where innovation takes the form of new technology creation. However, in countries operating far from the global frontier, innovation often occurs through imitation, adaptation, incremental process improvements, and organizational upgrading (Bell & Pavitt, 1993; Dutrénit, 2004). These activities are frequently informal or unregistered and therefore poorly captured by patent data. In such contexts, productivity-based measures, particularly Total Factor Productivity (TFP), may more properly reflect innovation outcomes and technological upgrading (Griffith *et al.*, 2004; Benavente, 2006).

Competition, on the other hand, also presents multiple dimensions. It is measured empirically using a variety of indicators that reflect different dimensions of market power. Among the most common are the Herfindahl-Hirschman Index (HHI) and the Lerner Index, used to capture market concentration and the degree of monopolistic power, respectively (Nickell, 1996; Griffith *et al.,* 2010; De Loecker & Warzynsky, 2012). Other approaches include firm turnover (entry and exit rates), reflecting the competitive dynamics of the market, and the ease of entry measured through regulations and administrative costs (Djankov *et al.,* 2002). In contexts with less data availability, such as developing countries, sectoral proxies like aggregate profit margins or firm surveys have also been used (Hallward-Driemeier *et al.,* 2010). These metrics approximate the degree of competition without necessarily assuming fixed market structures and are better adapted to transitional or highly informal economic environments.

These measurement considerations are not merely technical. As emphasized by Cirera and Maloney (2017), developing economies often face an "innovation paradox": despite potentially high returns to technological upgrading, weak institutions, limited capabilities, and insufficient competitive pressure prevent firms from systematically adopting frontier technologies. This structural constraint reinforces the importance of examining how competition interacts with firms' distance to the technological frontier.

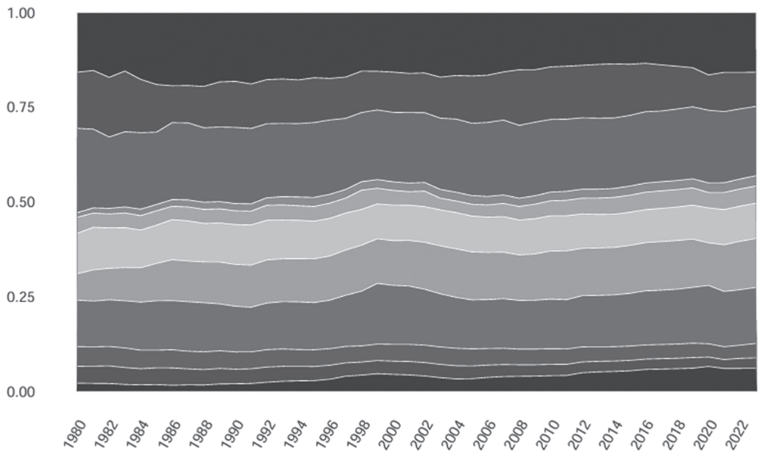
Accordingly, the empirical strategy adopted in this paper adapts standard measures of competition and innovation to the Bolivian context, employing the Total Factor Productivity as a proxy of technology and innovation, and the complement Lerner index to approach competition, ensuring consistency with the theoretical predictions outlined in the previous section while accounting for the structural features of a developing economy.

3. Stylized Facts

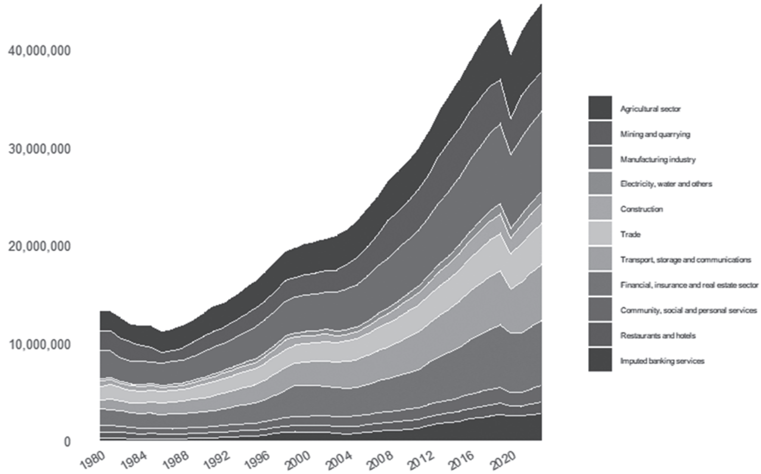
The stylized facts presented below describe the evolution of Bolivia's productive and international landscape over recent decades. The relative stability of sectoral composition and the persistence of export specialization provide a structural context for interpreting the empirical results. Rather than establishing dynamic claims about growth or innovation processes, this section documents broad patterns of sectoral allocation and international positioning that frame the subsequent industry-level analysis of competition and technological distance.

Figure 1: Industrial Participation in Bolivia (1980-2023)

(a) Evolution of the Share of Participation by Industry



(b) Evolution of Industry Participation in thousands of bolivianos (Constant Prices 1990)



Source: Own elaboration based on data from the National Institute of Statistics

Over the last four decades, Bolivia's sectoral composition of GDP has remained relatively stable. Figure 1 illustrates the evolution of broad sectoral shares between 1980 and 2022. Primary activities such as agriculture and mining, alongside manufacturing and financial services, have consistently represented the largest components of aggregate output[1]. In contrast, high-technology and knowledge-intensive sectors account for a relatively small share of total value added. This is reflected both in the share of value added by economic activity (Figure 1 (a)) and in their participation in total GDP.

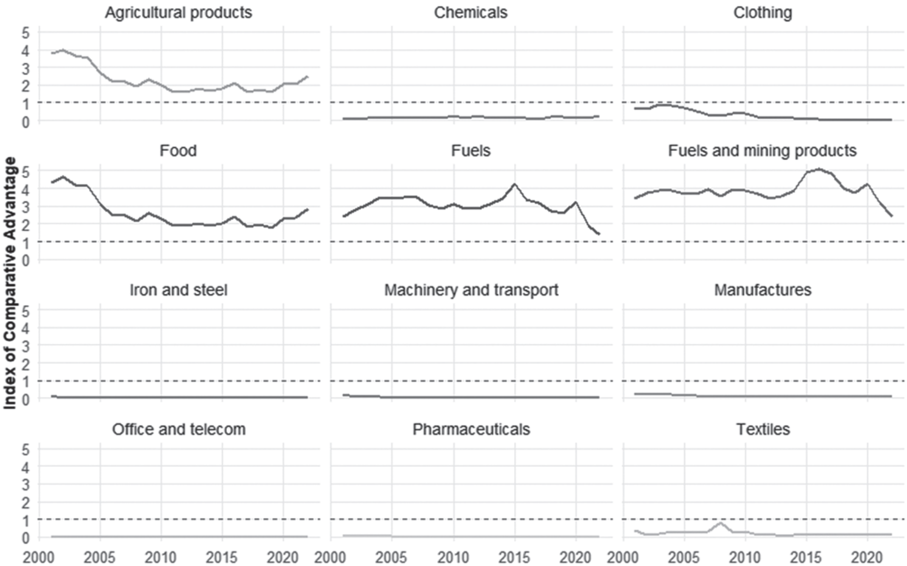
Despite episodes of aggregate expansion –particularly during the commodity boom period– the relative weights of major sectors exhibit limited structural reallocation. No substantial shift toward new high-technology or manufacturing-intensive sectors is observed in the long-run distribution of output.

This pattern reflects structural persistence in Bolivia's productive matrix. Episodes of growth have largely taken place within existing sectoral configurations rather than through significant changes in the composition of production.

1 For a cost-efficiency perspective on the Bolivian financial sector, see Salazar *et al.* (2025).

Shifting the focus to Bolivia's position in international markets, the country has historically exhibited revealed comparative advantages[2] in agricultural products, food, fuels, and mining. As shown in Figure 2, these comparative advantages display a high degree of persistence over time. No product group that initially lacked a comparative advantage subsequently crossed the threshold required to acquire one during the period analyzed.

Figure 2: Comparative Advantage Index Evolution in Bolivia (2001-2022)



Source: Own, based on data from WTO Trade Data

This pattern suggests stability in Bolivia's international specialization. Sectors such as chemicals, iron and steel, machinery and transport equipment, manufactures, office and telecommunications equipment, and pharmaceuticals display largely flat trajectories, remaining below the comparative advantage benchmark throughout the sample. Clothing exhibits a modest improvement in the early 2000s followed by a decline, while textiles experience a temporary peak around 2007, approaching but not surpassing the threshold before stabilizing at lower levels.

2 Calculated following Lane (2025).

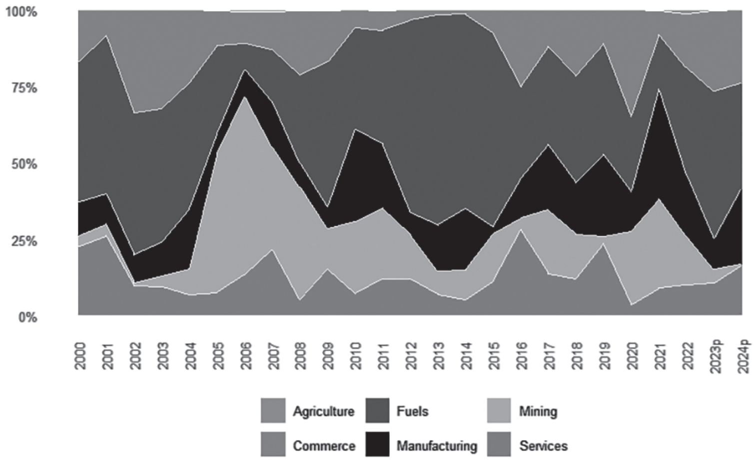
Rather than indicating a specific dynamic process, these trajectories reflect the continuity of Bolivia's export structure and the limited reorientation toward new product groups over time.

A second salient pattern is observed among sectors in which Bolivia has historically held comparative advantages. In these cases, the intensity of comparative advantage declines over time. Recent years show that fuels and mining products are approaching the threshold below which comparative advantage would be lost. Agricultural products and food also experience a decline; however, these sectors exhibit a recovery around 2019. Despite a subsequent downturn, recent trends suggest a potential for renewed strengthening of comparative advantages in these activities.

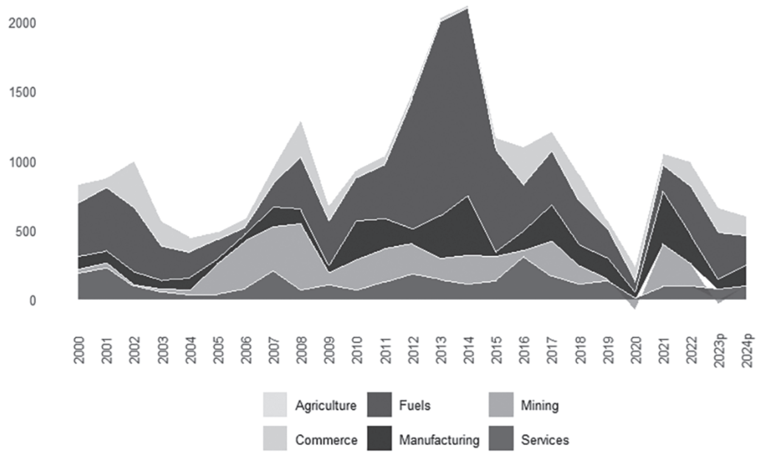
Taken together, these trends reinforce the view that Bolivia's export structure remains concentrated in a limited group of primary activities, with gradual changes in intensity but without substantial reconfiguration across product groups.

Figure 3: Foreign Direct Investment in Bolivia (2000-2024)

(a) Evolution of the Share of FDI by Industry



(b) Evolution of FDI (in millions of US$)



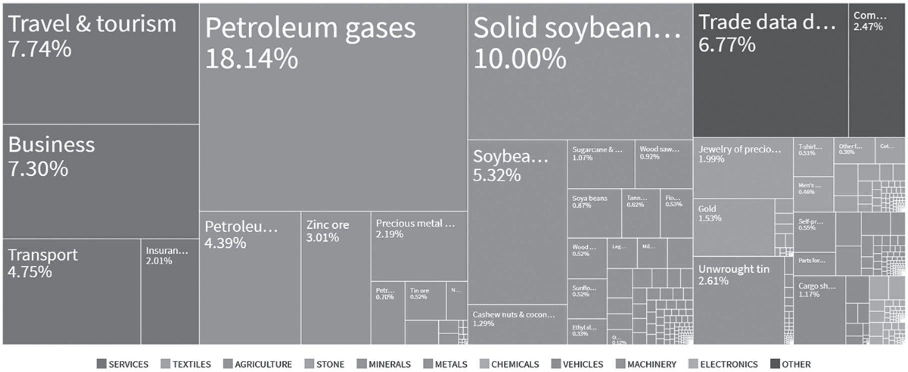
Source: Own elaboration based on data from Central Bank

Figure 3 (a) illustrates the sectoral destination of foreign direct investment (FDI) in Bolivia between 2000 and 2024. Despite some variation in sectoral shares over time, FDI has been consistently concentrated in the fuels sector, which absorbs the largest portion throughout the period. In the early 2000s, agricultural activities also accounted for a notable share of inflows, but this participation declined thereafter, while mining gained relevance for nearly a decade before experiencing a subsequent reduction. In more recent years, FDI allocation appears more evenly distributed across sectors, with mining losing a significant share, while agriculture, services, and manufacturing gradually increase their participation.

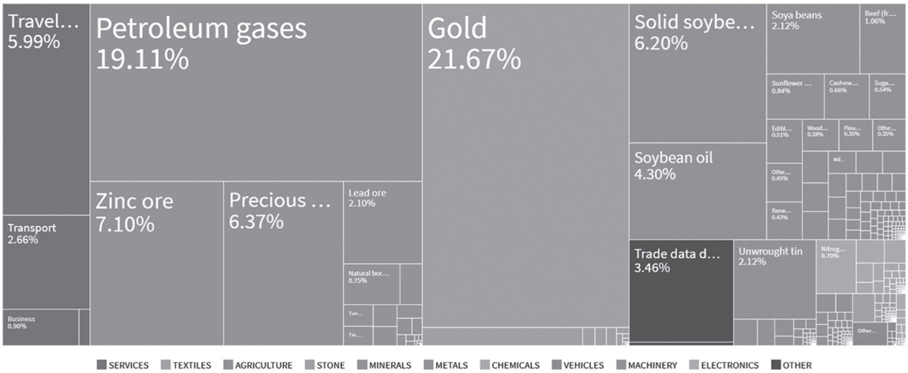
Figure 3 (b) shows that the overall expansion of FDI observed between 2009 and 2015 was largely driven by the fuels sector, as the relative shares of other activities remained broadly stable. In the same way, after 2015, a decline in FDI is evident, and it is accounted for by a reduction in investments in the fuel sector. In the latter part of 2015, a decline in foreign inflows affected all countries in Latin America and the Caribbean that were dependent on natural resources. FDI progressively shifted toward industries with higher value added, a transition in which Bolivia fell short, losing an important share of inflows. However, since then, FDI has diversified toward agriculture and manufacturing, signaling a gradual but still limited attempt to reduce dependence on extractive activities.

Figure 4: Export comparison 2003-2023

(a) 2003



(b) 2023



Source: The Atlas of Economic Complexity

Figure 4 depicts Bolivia's export structure at two points in time, 2003 and 2023. Over this period, Bolivia's export matrix shifted from a relatively more diversified composition toward one increasingly dominated by mineral and hydrocarbon products, particularly gold, zinc, and petroleum gases. This evolution indicates a growing reliance on primary commodities over time.

In 2003, services such as travel and tourism, business services, and transport accounted for a more substantial share of exports, alongside agricultural goods. By 2023, these categories had lost relative importance, while mineral exports expanded markedly. The most notable change is observed in gold, whose share increased from 1.53% to 21.67% of total exports, becoming the single most important export item.

When interpreted through the lens of revealed comparative advantages, this shift in the export matrix appears partially consistent with Bolivia's existing specialization: transport and several service activities did not exhibit comparative advantages, whereas fuels and mining products traditionally did. However, the reorientation of exports has not favored food and agricultural products, despite these sectors offering competitive opportunities. In fact, revealed comparative advantages in agricultural and food products strengthened around 2020, while those in mining products weakened over the same period. This suggests that Bolivia's export adjustment has prioritized sectors with historically established comparative advantages, rather than those where competitive potential is improving. While such a strategy may limit short-term losses, it foregoes opportunities for diversification into sectors that also exhibit comparative advantages. Crucially, sustained diversification would require not only reallocating exports across sectors but, more fundamentally, strengthening comparative advantages through productivity gains, innovation, and capability accumulation before these sectors can be scaled up in international markets.

Taken together, this section shows an economy characterized by persistent sectoral stability and sustained specialization in primary activities. Exposure to international markets through established comparative advantages suggests that Bolivia has not operated in isolation from competitive pressures. However, such exposure has not been accompanied by substantial reorientation toward new leading sectors or sustained diversification into higher value-added activities. This combination of external competitive exposure and internal structural persistence raises the possibility that the configuration of industries –particularly their internal technological dispersion and competitive structure– may play a central role in shaping productive outcomes. In this sense, understanding whether sectors resemble neck-to-neck or leader-follower configurations becomes essential for interpreting the broader patterns observed in Bolivia's productive system.

4. Data and Empirical Strategy

In this section, the empirical strategy presented is adopted to be able to identify the industrial status of some sectors of the Bolivian economy. Specifically, the goal is to explore the relation between innovation and competition across the firms and industries from three economic sectors –manufacturing, services, and commerce– controlling for some other aspects, like differences across industries composing the sectors or cities. On the following steps, sectors refer to broad economic aggregates (*e.g.*, manufacturing, commerce and services), while "industries" denote a more disaggregated classification within each sector.

While standard literature conventionally relies on patent registration as a metric for innovation output, and intellectual property, this approach proves infeasible within the Bolivian context as mentioned previously. Intellectual property legislation in the country is nascent, disaggregated data on patent filing is unavailable[3]. To circumvent these data constraints and align the analysis rigorously with the Schumpeterian framework detailed in Section 2, the empirical methodology taken in Aghion *et al.* (2005) is adopted. This approach shifts the focus to evaluating the dynamic relationship between a firm's *technological gap* (distance from the frontier) and the *industry-level of competition*. Specifically, this framework allows to infer the prevailing industrial state –*balanced* (neck-to-neck) or *unbalanced* (leader-follower)– and analyze how these different structures condition the incentives for innovation. However, data limitation does not allow to evaluate these in a dynamic environment; instead, the analysis corresponds to a static environment.

Consequently, the scope of this study is not to identify transitional growth dynamics, but rather to provide a structural diagnosis of the competitive and technological configuration of Bolivian industries. To this end, the distribution of industries across different competitive states is characterized to assess whether innovation incentives are likely to foster convergence or persistent technological leadership. This static characterization constitutes a necessary first step toward assessing the feasibility of endogenous growth mechanisms in contexts where dynamic firm-level data are unavailable.

4.1. Data and Scope

The empirical analysis employs detailed firm-level microdata sourced from the Survey of Large and Medium-Sized Enterprises in the Manufacturing, Commerce, and Services

3 For a wider review see SENAPI.

Industries[4]. This survey, compiled by the National Institute of Statistics (INE), is specific to the year 2017. The use of this year is strategically important for two reasons: first, 2017 has been recently established as the new base year for the comprehensive revision and update of the Bolivian System of National Accounts (SNA).

As highlighted by the INE[5], the 2017 update is particularly relevant as it reflects a period of relative general equilibrium across multiple sectors, making it especially suitable for an analysis that aims to characterize the structural relationship between competition and technological distance rather than short-run fluctuations. The resulting dataset results in a detailed firm-level cross section for a total of 3,151 firms across the three aforementioned non-extractive sectors. The focus is on these industries (Manufacturing, Commerce, and Services) to specifically understand the productive matrix composition beyond the traditional resource-dependent model[6].

4.2. Measuring Competition

To quantify the degree of competition at the industry level, the approach proposed by Aghion *et al.* (2005) and Nickell (1996), which is based on the Lerner Index, is followed. Initially, the Lerner Index ($Lerner_i$) is calculated at the firm level i as the percentage difference between price and marginal cost with respect to price:

$$Lerner_i = \frac{\text{Operative Income}_i - \text{Operative Cost}_i}{\text{Operative Income}_i}$$

Operative Cost is approximated using salaries, intermediate consumption, and basic service expenses (electricity, water, and fuel).

The sectoral Lerner index provides a measure of competition, but it is also sensitive to cost inefficiencies. To mitigate this issue, the index is weighted by sales, reducing the influence of extreme values on the estimated competitive pressure.

4 For detailed descriptive statistics, refer to the Annex (Table 6, and Figures 5 and 6).

5 See https://www.ine.gob.bo/referencia2017/

6 For analysis, the International Standard Industrial Classification (ISIC) is adopted, Revision 4, employing a two-digit level of disaggregation. The 2-digit classification is taken into account. Even if 3 digits would be ideal, the available data allows for the two digit which still captures substitutability patterns at intermediate aggregation.

The measure of competition for a given sector s ($Competition_s$) is then defined as the average competitive intensity (complement of the Lerner Index) across firms in that industry, where N_s is the number of firms in the sector:

$$Competition_s = 1 - \frac{1}{N_s}\sum_{i \in S} Lerner_i$$

Under this definition, a value of 1 represents perfect competition in that industry, whereas values less than 1 means the presence of some degree of market power.

4.3. Measuring Technological Gap

Due to data limitations explained above to measure formal innovation, the Total Factor Productivity (TFP) is used as a proxy for the technological level and result of innovation.

While several methods exist for TFP calculation, this approximation adopts the traditional perspective of Solow (1956), following the approaches used by Mèndez *et al.* (2012) and Rowert *et al.* (2019) in similar contexts. Under this framework, production is assumed to be the result of a combination of the two productive factors, capital and labor, operating under a given technological structure. The relationship is empirically modeled using a linearized Cobb-Douglas production function using logarithms:

$$\ln Y_i = \alpha_0 + \alpha_1 \ln K_i + \alpha_2 \ln L_i + \varepsilon_i$$

where Y_i is the value of total output for firm i, approximated by the revenue obtained from sales. K_i is the capital stock, approximated using the historical value of assets registered at the beginning of the fiscal period. L_i is the labor input, measured by the number of employees. The coefficients α_1 and α_2 represent the output elasticities of capital and labor, respectively.

A natural concern relates to the use of OLS in the estimation of the Cobb-Douglas production function and the interpretation of Total Factor Productivity (TFP). In standard settings, OLS estimates of production functions may suffer from simultaneity bias if input choices are correlated with unobserved productivity shocks. Structural approaches such as Olley and Pakes (1996) or Levinsohn and Petrin (2003) address this issue by exploiting panel variation and investment or intermediate inputs as proxies.

Two considerations justify our empirical strategy. First, the data consist of a single cross-section for 2017, precluding the implementation of dynamic panel estimators that rely on firm-level time variation. Second, our objective is not to recover structural production elasticities, but to construct a relative measure of technological position within narrowly defined two-digit industries. The technological gap is defined as the proportional distance to the industry frontier, so identification relies on cross-sectional dispersion rather than on the absolute level of TFP.

In this context, any remaining simultaneity bias would affect all firms within an industry in a comparable manner and would not mechanically generate systematic correlations between industry-level competition and relative distance to the frontier. Moreover, in developing economies where formal R&D data and patent information are unavailable, productivity-based measures constitute the most widely used proxy for technological upgrading (Griffith *et al.*, 2004; Benavente, 2006). Our approach closely follows Aghion *et al.* (2005), who also rely on TFP-based measures of distance to the frontier in the absence of patent data at comparable levels of disaggregation.

Finally, while TFP may capture both technological innovation and efficiency improvements, this distinction is not conceptually problematic in our setting. In environments characterized by incremental and imitative innovation, efficiency gains, process improvements, and organizational upgrading are precisely the mechanisms through which firms close technological gaps. Therefore, the use of TFP is consistent with the Schumpeterian step-by-step framework that motivates our analysis.

Following Aghion *et al.* (2005), the technological gap (gap_i) for a firm i within an industry s is defined as the proportional distance of its TFP from the estimated TFP frontier of that industry (TFP_{fs}):

$$gap_i = \frac{TFP_{fs} - TFP_i}{TFP_{fs}} \forall i \in s$$

Where fs represents the technological frontier of the industry –that is, the firm with the highest Total Factor Productivity (TFP) observed in the sector– while i denotes the remaining firms or industries lagging the frontier. Consequently, the technological gap is always non-negative ($gap_i \geq 0$), and it is zero for the frontier firm ($gap_f \geq 0$).

A lower gap means the firm is closer to the industry's technological frontier. Classifying it as belonging to the *neck-to-neck* (balanced) group. Conversely, a wider gap implies that the firms in that industry tend to be followers, signifying an *unbalanced* industrial state, where the leader-follower structure dominates.

4.4. Main Econometric Specification

The primary objective of the empirical strategy approached, is to formally test the predictions of the Schumpeterian growth framework by analyzing the relationship between competitive intensity and technological status in terms of having a stable incentive structure towards understanding the industrial state. The equation of interest is estimated at firm level using Ordinary Least Squares (OLS), regressing the Technological Gap on the industry-level competition measure:

$$gap_s^i = \alpha + \beta_1 Competition_s + \delta_c + \delta_s + \xi_i$$

where gap_s^i is the technological gap of firm i on industry s, defined as the proportional distance of the firm's TFP from the industry's technological frontier (Equation 4). δ_c and δ_s are sets of fixed effects: δ_c controls for city characteristics, while δ_s accounts for unobserved heterogeneity at the two-digit ISIC industry level. These fixed effects absorb invariant factors that might simultaneously affect the industry's competitive structure and the firm's technological distance.

It is important to clarify that the empirical strategy is not designed to establish causal effects of competition on technological distance. Rather, the objective is to characterize robust structural associations between market competition and firms' relative position to the technological frontier, as predicted by Schumpeterian growth theory to enable the discussion of possible outcomes developed by these characterizations. In environments where firm-level panel data or exogenous competition shocks are unavailable, documenting these patterns constitutes a necessary first step toward understanding the possible constraints on technological structures related to innovation and growth in developing economies.

The parameter of interest is β_1, which captures the partial association between of industry-level competition on a firm's technological gap. Its sign directly reflects the prevailing incentive mechanism for innovation within that industry.

A negative coefficient indicates that higher levels of competition are associated with smaller technological gaps (firms move closer to the frontier). This outcome suggests that the Schumpeterian Effect (the incentive for lagging firms to catch up) dominates. This is indicative of an unbalanced (leader-follower) industrial state.

A positive coefficient indicates that higher competition is associated with larger technological gaps (firms move farther from the frontier). This result is typically observed in a neck-to-neck (balanced) market structure, where competition primarily encourages the firms at the frontier to pull further ahead, thus widening the distance to the median firm.

5. Results

This section presents the main empirical findings. The analysis is structured into five parts, beginning with the aggregate effect of competition and proceeding toward the nuanced heterogeneity observed across firm size, sector, and exposure to foreign markets, as predicted by the Schumpeterian framework. It is important to mention that every regression result is taking clusterized (by sector) standard errors.

Table 1 reports the baseline relationship between industry-level competition and firms' technological distance to the frontier. Across all specifications, the coefficient on competition is negative and statistically significant at the 1 percent level. This pattern is remarkably stable to alternative definitions of competition (simple versus weighted averages of the Lerner complement), as well as to the inclusion of industry and city fixed effects. The invariance of the sign and magnitude across specifications constitutes the first central empirical result of the paper.

Table 1
Total Effect

	(1) Normal	(2) Normal	(3) Normal	(4) Normal	(5) Weighted	(6) Weighted	(7) Weighted	(8) Weighted
Competition	-0.069***	-0.203***	-0.075***	-0.208***	-0.041**	-0.139***	-0.044***	-0.142***
	(0.013)	(0.020)	(0.013)	(0.020)	(0.016)	(0.030)	(0.015)	(0.030)
Industry FE	N	Y	N	Y	N	Y	N	Y
City FE	N	N	Y	Y	N	N	Y	Y
Observations	3133	3133	3133	3133	3133	3133	3133	3133
R-squared	0.009	0.031	0.018	0.040	0.007	0.031	0.017	0.040

Clusterized standard errors in parentheses by sector. $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In addition, we conduct further robustness checks along the productivity dimension. Specifically, we employ an alternative measure based on labor productivity (value added per worker) and reconstruct the technological gap accordingly. This exercise strengthens the analysis by addressing potential concerns related to simultaneity in TFP estimation using OLS. For brevity, these additional results are reported in the Appendix (Tables 7 to 10), following the same structure and interpretation as in this section.

A negative coefficient implies that greater competitive intensity is systematically associated with smaller technological gaps. This pattern is consistent with the dominance of the Schumpeterian effect, whereby lagging firms appear more likely to engage in incremental upgrading in more competitive environments. In other words, the evidence is consistent with a pattern in which followers' incentives appear more responsive to competition to reduce their distance to the leader, rather than through symmetric innovation among firms located at the frontier.

This finding is economically meaningful and consistent with the interpretation that in Bolivia's non-extractive sectors, competition does not primarily generate neck-to-neck rivalry characterized by simultaneous frontier innovation. Instead, it is consistent with the prevalence of a leader-follower structure in which the technological frontier remains concentrated, and innovation incentives are asymmetrically distributed.

The fact that leader-follower structure dominates even in a year characterized by aggregate stability strengthens the structural interpretation of the results. If balanced technological competition is not observed under macroeconomic equilibrium conditions, this may suggest that such configurations are less likely to emerge in periods of macroeconomic disequilibrium or external shocks. This reinforces the view that the observed industrial configuration reflects a persistent structural feature rather than a cyclical deviation.

Table 2 explores heterogeneity in the competition-gap relationship by firm size. The negative coefficient on competition persists for both medium and large firms across all specifications, confirming that the Schumpeterian catch-up mechanism remains dominant within each size category. However, a key quantitative difference emerges: the magnitude of the coefficient is systematically larger (in absolute value) for large firms than for medium-sized firms.

Table 2
Effect of Competition by Firm Size

	(1) Normal	(2) Normal	(3) Normal	(4) Normal	(5) Weighted	(6) Weighted	(7) Weighted	(8) Weighted
CompetitionM	-0.028	-0.032	-0.142***	-0.146***	-0.011	-0.014*	-0.095***	-0.098***
	(0.022)	(0.021)	(0.036)	(0.036)	(0.014)	(0.014)	(0.025)	(0.025)
CompetitionL	-0.075***	-0.078***	-0.188***	-0.191***	-0.061***	-0.063***	-0.143***	-0.145***
	(0.022)	(0.021)	(0.036)	(0.036)	(0.014)	(0.014)	(0.025)	(0.025)
Industry FE	N	Y	N	Y	N	Y	N	Y
City FE	N	N	Y	Y	N	N	Y	Y
Observations	3133	3133	3133	3133	3133	3133	3133	3133
R-squared	0.112	0.116	0.128	0.132	0.109	0.114	0.126	0.130

Clusterized standard errors in parentheses by sector. $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This difference in magnitude carries structural implications. A stronger negative coefficient for large firms indicates that competition is associated with larger gap reductions within the large-firm segment. In the context of the Schumpeterian step-by-step framework, this suggests that technological dispersion among large firms is more pronounced: the distance between large leaders and large followers is greater than the corresponding distance within the medium-firm segment. In other words, the leader-follower configuration appears more sharply defined among large enterprises.

From a theoretical standpoint, this pattern is consistent with a setting in which large leaders enjoy substantial technological advantages, while large followers face wider distances to the frontier. When gaps become sufficiently large, followers' incentives to innovate may weaken, as the probability of catching up declines relative to the cost of innovation. Thus, although competition induces incremental catch-up, the structural asymmetry within the large-firm segment may limit the possibility of transitioning toward a neck-to-neck configuration.

The contrast with medium-sized firms is instructive. Smaller technological dispersion within the medium-firm group suggests that the transition toward neck-to-neck rivalry may be more attainable in this segment. From a policy perspective, this implies that industrial policies aimed at strengthening competitive pressure among medium-sized firms could generate dynamic effects that propagate upward. By facilitating catch-up within the medium segment, competition can move firms closer to parity, activating the escape-from-competition effect. As medium leaders face intensified rivalry, their innovation incentives increase, potentially reshaping competitive dynamics across the broader industrial landscape.

In this sense, the evidence points to a strategic sequencing implication: fostering Schumpeterian catch-up among medium firms may constitute a promising avenue for fostering broader competitive dynamism, which could subsequently exert pressure on large incumbents, although the evidence should be interpreted as suggestive rather than definitive. Rather than treating all firm sizes symmetrically, policy design must account for the technological dispersion within each segment and the distinct innovation incentives that such dispersion generates.

Table 3 deepens the analysis by interacting competition with firm size and sector, allowing the competition-gap relationship to vary across six structural subgroups. The omitted category corresponds to large firms in services, providing a benchmark against which the remaining coefficients are interpreted. Several patterns emerge. First, for large firms in manufacturing, the interaction term is negative and statistically significant. This indicates that within manufacturing, competition continues to reduce technological gaps among large firms, reinforcing a leader-follower configuration. Consistent with the results in Table 2, this suggests that technological dispersion among large manufacturing firms remains substantial, and competitive pressure operates primarily through incremental catch-up rather than symmetric frontier innovation.

Second, the coefficients associated with medium-sized firms across sectors are positive, though generally small in magnitude and only marginally significant in some specifications.

While this pattern is consistent with the emergence of localized escape-from-competition incentives, the evidence remains limited and should be interpreted with caution. These effects do not overturn the aggregate predominance of leader-follower structures documented in Tables 1 and 2. Rather, it reveals that within certain segments –particularly medium-sized firms– competitive intensity may begin to generate localized patterns consistent with escape-from-competition behavior. In these environments, technological proximity is sufficiently attainable that frontier firms have incentives to differentiate themselves further, activating the escape-from-competition effect.

The contrast between large and medium firms across sectors therefore reflects differences in underlying technological dispersion. Where dispersion is large –as in large manufacturing firms– competition induces catch-up. Where dispersion is smaller –as appears to be the case in several medium-sized segments– competition may instead widen gaps by strengthening innovation incentives at the frontier. Sectoral heterogeneity further reinforces this structural interpretation. In commerce, the interaction terms suggest limited differentiation relative to the benchmark, indicating that competitive dynamics resemble those observed in services. By contrast, manufacturing exhibits clearer asymmetries between size groups, pointing to deeper structural stratification within that sector.

Taken together, Table 3 suggests that Bolivia's industrial landscape is not uniformly characterized by a single competitive regime. Instead, the economy appears segmented: some subgroups exhibit strong leader-follower regime with catch-up responses, while others display limited evidence consistent with escape-from-competition behavior. However, the latter effects remain localized and insufficient to overturn the aggregate predominance of unbalanced regimes documented previously.

Table 3
Effect of Competition by Size and Sector

	GAP			
2-5	**Normal**		**Weighted**	
2-3 (lr)4-5	**(1)**	**(2)**	**(3)**	**(4)**
CompM-Manu	0.032*	0.030*	0.032*	0.030*
	(0.018)	(0.018)	(0.018)	(0.018)
CompL-Manu	-0.054**	-0.055**	-0.054**	-0.055**
	(0.022)	(0.022)	(0.022)	(0.022)
CompM-Commer	0.035*	0.033*	0.035*	0.033*
	(0.018)	(0.017)	(0.018)	(0.017)
CompL-Commer	0.003	0.002	0.003	0.002
	(0.019)	(0.018)	(0.019)	(0.018)
CompM-Serv	0.051**	0.049**	0.051**	0.049**
	(0.022)	(0.021)	(0.022)	(0.021)
City FE	N	Y	N	Y
Observations	3133	3133	3133	3133
R-squared	0.149	0.153	0.149	0.153

Clusterized standard errors in parentheses by sector
*p<0.10, **p<0.05, *** p<0.01

Table 4 estimates Equation 5 separately by macro-sector –manufacturing, commerce, and services– and further disaggregates each sector by export status. In addition, the analysis is replicated using an alternative measure of technological distance ($GAP2$), constructed at a finer level of aggregation. This specification allows us to examine whether the competition-gap relationship varies systematically across sectors and whether the results are robust to alternative definitions of technological proximity.

The manufacturing sector exhibits coefficients that are negative but statistically insignificant across specifications and subsamples. This absence of statistical precision suggests that competitive intensity is not systematically associated with technological distance within manufacturing in 2017. Rather than indicating the presence of neck-to-neck rivalry, the result points to a structurally muted competition-technology link in this sector. In such an environment, technological positioning appears largely decoupled from contemporaneous competitive pressure, consistent with a rigid industrial configuration in which dispersion may persist independently of marginal changes in competition.

Table 4
Effect of Competition by Industries

	(1) Normal Total Sample	(2) Normal Exports	(3) Normal Local	(4) Weighted Total Sample	(5) Weighted Exports	(6) Weighted Local
Group A: manufacture						
Competition2	-0.004	0.020	0.014	-0.108	-0.246	-0.015
	(0.067)	(0.124)	(0.039)	(0.086)	(0.190)	(0.019)
Observations	489	149	340	489	149	340
R-squared	0.000	0.000	0.000	0.013	0.036	0.001
Group B: commercial						
Competition2	-0.042**	-0.102**	-0.037*	-0.040**	-0.079*	-0.036**
	(0.018)	(0.036)	(0.019)	(0.014)	(0.031)	(0.014)
Observations	1715	164	1551	1715	164	1551
R-squared	0.011	0.008	0.023	0.011	0.023	0.025
Group C: services						
Competition2	0.031***	0.053	0.030***	0.002	-0.132**	0.005
	(0.011)	(0.087)	(0.010)	(0.020)	(0.057)	(0.018)
Observations	929	41	888	929	41	888
R-squared	0.005	0.003	0.004	0.000	0.114	0.000

Clusterized standard errors in parentheses by sector. $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

In contrast, the commercial sector displays a negative and statistically significant coefficient across both the baseline and weighted competition measures. This pattern is consistent across the full sample as well as local and exporting firms. The robustness of this negative association indicates that, within commerce, competition is systematically linked to reductions in technological distance. The structural interpretation aligns with a leader-follower configuration in which competitive pressure operates primarily through incremental catch-up among lagging firms. The consistency of the sign across subsamples reinforces the view that this relationship is not driven by a particular firm type but reflects a sector-wide configuration.

The services sector presents a distinct pattern. In the baseline specification, the coefficient is positive and statistically significant for the full sample and for local firms, indicating that higher competition is associated with larger technological gaps. This sign is consistent with escape-from-competition behavior: firms closer to the frontier respond more strongly to competitive pressure, thereby increasing dispersion. Notably, this positive association weakens among exporters, suggesting that exposure to external markets may alter the internal competitive structure of the sector.

The replication using $GAP2$ largely preserves the qualitative patterns, although statistical precision varies across subsamples. The persistence of sign consistency across alternative technological measures strengthens the interpretation of these results as structural features of sectoral organization rather than artifacts of measurement.

Taken together, the evidence in Table 4 reveals pronounced sectoral segmentation in Bolivia's non-extractive economy. Commerce is characterized by competition-induced gap compression consistent with leader-follower interaction. Services display localized escape-type behavior in domestic segments. Manufacturing, by contrast, exhibits no systematic association between competition and technological distance. These differences underscore that competitive pressure does not operate uniformly across sectors. Instead, its relationship with technological dispersion depends on the underlying structural configuration of each industry group. Any characterization of the national industrial landscape must therefore account for this heterogeneity rather than relying solely on aggregate estimates.

While the aggregate regression coefficient provides suggestive evidence that leader-follower structure prevails, it does not, by itself, establish whether such structures dominate across markets. The coefficient captures an average association, but predominance is ultimately a distributional question. To address this directly, we classify markets using the joint distribution of firm-level technological gaps. Specifically, a market is labeled neck-to-neck when a sufficiently large mass of firms operates close to the productivity frontier and dispersion in gaps is limited. Conversely, markets with low mass near the frontier and greater dispersion are classified as leader-follower. This procedure allows us to move from regression-based analysis to a structural characterization of the industrial landscape.

Table 5 reports the prevalence of regimes under alternative proximity thresholds and sample restrictions. Two features stand out. First, across the full sample of markets, between 79.7% and 81.2% are classified as leader-follower, depending on whether proximity to the frontier is defined using a 10% or 5% threshold. This indicates that the predominance of unbalanced structures is not sensitive to how "closeness" to the frontier is defined. Second, when restricting attention to markets with at least ten firms –thus excluding small and potentially noisy sectors– the share of leader-follower regimes rises substantially, reaching between 93.3% and 95.6%. This pattern suggests that neck-to-neck configurations are concentrated in smaller markets, whereas the bulk of economically relevant industries display pronounced technological asymmetries.

Specifically, we define firms as "close to the frontier" when their technological gap lies within a 5-10 percent range of the industry leader. This choice reflects a balance between economic interpretability and empirical tractability. From an economic perspective, small differences in productivity within this range are unlikely to generate substantial asymmetries in competitive behavior, making it a reasonable approximation to the neck-to-neck state described in the theoretical framework. This classification does not rely on a unique cutoff value. Rather, it provides a transparent and tractable way to map a continuous distribution of technological gaps into discrete competitive regimes. The qualitative patterns reported in the paper are robust to alternative threshold choices, as the distribution of firms remains heavily skewed toward leader-follower configurations[7].

Importantly, these distributional findings are fully consistent with the negative aggregate regression coefficient. The regressions indicate that greater competition is associated with smaller technological gaps, a pattern theoretically aligned with leader-follower regimes. The classification exercise confirms that this relationship is not driven by a subset of sectors but reflects the dominant structural configuration of markets in the sample[8].

Taken together, the regression evidence and the distributional classification provide a coherent picture of Bolivia's formal non-extractive sectors. The negative association between competition and proximity to the frontier, the sectoral heterogeneity observed across industries, and the predominance of leader-follower regimes jointly indicate that technological asymmetries are pervasive rather than exceptional. In such an environment, competitive pressure does not primarily operate through neck-to-neck rivalry among similarly positioned

7 This approach is conceptually analogous to empirical classifications commonly used in industrial organization, where firms are grouped according to relative positions within a distribution, rather than relying on exact cardinal differences.

8 We confirm that this result is not driven by the threshold selection in the Figure 7 on the Annex.

firms, but rather through interactions between frontier leaders and lagging followers. This structural configuration implies that broad-based technological convergence is limited and that innovation incentives are likely concentrated among frontier firms. In this sense, the results offer a diagnostic characterization of the country's industrial structure, consistent with unbalanced competitive dynamics across most markets.

Table 5
Prevalence of market regimes across classification rules

	Market regime prevalence		
2-4 Classification rule	***N* markets**	**Leader-follower (%)**	**Neck-to-neck (%)**
Proximity threshold: Gap ≤10% (p50 rule)			
All markets	69	79.7	20.3
Markets with N_{firms} ≥10	N_{10}	93.3	6.7
Proximity threshold: Gap ≤5% (p50 rule)			
All markets	69	81.2	18.8
Markets with N_{firms} ≥10	N_{10}	95.6	4.4

Although the empirical analysis is conducted in a single-country setting, the patterns documented here are consistent with mechanisms that extend beyond the Bolivian case. In particular, the coexistence of dominant leader-follower structures with localized and limited escape-from-competition behavior mirrors theoretical predictions for economies operating far from the technological frontier. Given that many developing countries exhibit similar structural characteristics –such as high productivity dispersion and reliance on incremental innovation– the results should be interpreted as indicative of broader empirical regularities rather than isolated features of a single economy.

6. Concluding Remarks

This paper provides the first structural characterization of how competitive intensity relates to technological dispersion across Bolivian industries. Guided by the Schumpeterian step-by-step framework, we examine whether industries are predominantly organized in neck-to-neck configurations –where firms operate close to the technological frontier– or in leader-follower regimes characterized by persistent productivity gaps.

Using firm-level data for 2017, we document three central findings. First, at the aggregate level, greater competitive intensity is systematically associated with lower intra-industry technological dispersion. Within the logic of the step-by-step framework, this pattern is consistent with the prevalence of leader-follower regimes in which competitive pressure operates primarily through a catch-up mechanism rather than through frontier expansion.

Second, a direct structural classification of industries confirms this interpretation. Between 79 and 95 percent of markets –depending on weighting schemes and sectoral aggregation– exhibit productivity distributions consistent with leader-follower configurations. This dominance persists across sectors and is particularly pronounced in larger markets. The empirical distribution of industries thus suggests that the Bolivian productive structure is characterized by technologically unbalanced configurations rather than by widespread neck-to-neck competition.

Third, we uncover systematic heterogeneity by firm size. Larger firms display greater dispersion and more persistent productivity gaps relative to medium-sized firms, indicating that competitive pressure does not translate uniformly into convergence across segments of the firm size distribution. This heterogeneity reinforces the view that competitive exposure alone does not necessarily generate transitions toward technologically balanced states.

Taken together, these findings point to a structural configuration in which competition, while associated with relative catch-up dynamics within industries, does not appear sufficient to induce widespread transitions toward neck-to-neck equilibria. In this context, competitive intensity is correlated with adjustments within existing hierarchies rather than with a reorganization of the technological structure itself.

Importantly, the analysis is cross-sectional and does not identify causal effects or intertemporal transition dynamics. The results should therefore be interpreted as a structural diagnosis of contemporaneous associations between competitive pressure and technological dispersion, rather than as estimates of the dynamic impact of competition on innovation or growth. Nevertheless, the patterns documented here are consistent with theoretical environments in which unbalanced leader-follower states can persist even under competitive exposure.

These findings have broader implications for small, resource-dependent economies. When the productive structure is dominated by leader-follower configurations, pro-competitive reforms may not automatically translate into technological convergence. Policies aimed solely at increasing competitive pressure may need to be complemented by mechanisms that facilitate technology diffusion, lower structural entry barriers, or enhance absorptive capacity among lagging firms.

More broadly, the relevance of these findings extends beyond the Bolivian case. The structural configuration documented in this paper –characterized by the predominance of leader-follower regimes alongside limited pockets of potential neck-to-neck interaction– is likely to arise in other developing economies with similar productive structures. In contexts where innovation is primarily incremental and technological gaps remain large, competition is unlikely to generate uniform convergence dynamics. Instead, it may reinforce existing asymmetries while only gradually enabling localized upgrading. As such, the Bolivian case provides a useful empirical benchmark for understanding how competition interacts with technological dispersion in economies where structural rigidities and distance to the frontier play a central role.

By documenting the distribution of technological regimes across industries, this paper contributes to understanding how competition interacts with structural heterogeneity in developing economies. More broadly, it highlights that the relationship between competition and technological structure cannot be inferred from average effects alone; it depends fundamentally on the configuration of industries across technological states.

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Annexes

Annex A: Supplementary Descriptive Statistics

Table 6
Descriptive Statistics by Sector

Variable	N	Mean	SD	P25	Median	P75
Group A: Full Sample						
Solow Residual	3133	1.739	3.773	0.490	0.934	1.926
Lerner Index	3153	0.227	0.261	0.064	0.193	0.378
Competition Index	3153	0.773	0.069	0.668	0.821	0.821
Total Sales	3153	56.90	218.0	7.530	15.80	36.90
Human Capital	3153	32.35	229.9	0.000	0.211	8.000
Group B: Manufacturing (Sector 1)						
Solow Residual	489	1.557	3.232	0.415	0.769	1.398
Lerner Index	489	0.196	0.225	0.062	0.198	0.336
Competition Index	489	0.804	0.000	0.804	0.804	0.804
Total Sales	489	115.0	385.0	8.836	19.10	59.90
Human Capital	489	48.22	195.3	0.000	1.234	17.54
Group C: Commerce (Sector 2)						
Solow Residual	1715	2.121	3.662	0.749	1.405	2.533
Lerner Index	1727	0.179	0.236	0.037	0.137	0.303
Competition Index	1727	0.821	0.000	0.821	0.821	0.821
Total Sales	1727	48.60	125.0	8.963	18.80	39.70
Human Capital	1727	17.89	86.75	0.000	0.000	4.742
Group D: Services (Sector 3)						
Solow Residual	929	1.129	4.139	0.347	0.559	0.948
Lerner Index	937	0.332	0.292	0.161	0.309	0.515
Competition Index	937	0.668	0.000	0.668	0.668	0.668
Total Sales	937	41.70	228.0	5.475	10.10	22.00
Human Capital	937	50.71	378.6	0.000	0.522	11.94

Going through the descriptive statistics for the pooled sample and disaggregated by the Manufacturing, Commerce, and Services sectors (Table 6), the sample is predominantly concentrated in Commerce ($N = 1727$), which accounts for over half of the observations.

A cross-sector analysis reveals a highly heterogeneous industrial structure characterized by deep asymmetries. For instance, while Commerce exhibits the highest average total factor productivity (Solow residual of 2.121), all three sectors display massive standard deviations that significantly dwarf their respective means. This extreme dispersion, along with the wide gap between the median values and the theoretical efficiency frontiers, provides strong empirical support for an asymmetrical market organization, where a few highly productive firms coexist with a long tail of lagging competitors. This structural heterogeneity is further reflected in the competitive dynamics and firm-level characteristics across industries.

The Services sector holds the highest degree of market power (average Lerner Index of 0.332) and the lowest competition level. In contrast, Commerce operates under the fiercest competitive conditions, which is consistent with the thin margins typical of retail and wholesale trade. Furthermore, there is a clear divergence between scale and skill intensity. Manufacturing firms heavily dominate in terms of scale, with average total sales (115.0 million Bs) more than double those of the other sectors. However, despite their smaller revenue scale, Service firms lead in human capital accumulation (50.71 thousand Bs), underscoring the skill-intensive nature of the sector, whereas Commerce relies on a much less specialized labor force (17.89 thousand Bs).

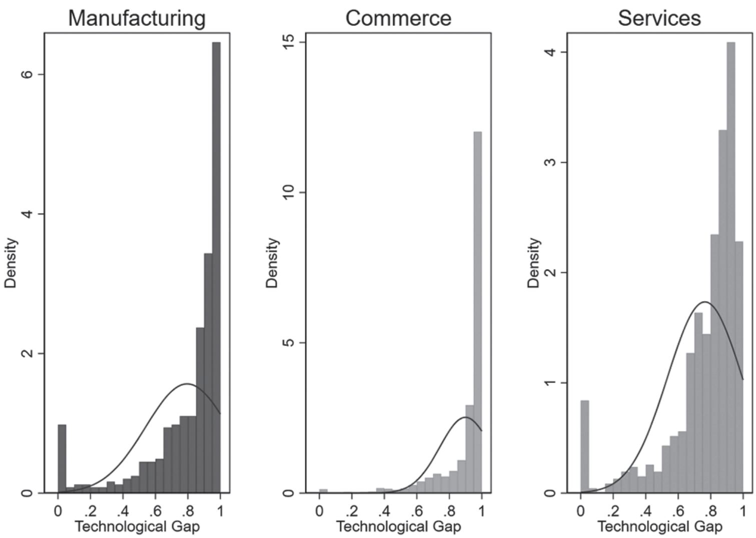
Figure 5 illustrates the kernel density estimates for the logarithm of the Solow residual across the Manufacturing, Commerce, and Services sectors, providing a clear visual representation of productivity distributions. The graph highlights structural heterogeneity both between and within industries.

The Services sector exhibits the most leftward shift and the highest peak, indicating that most service firms operate at lower, highly concentrated productivity levels. In contrast, the Commerce sector is positioned furthest to the right, visually confirming its status as the sector with the highest average productivity, though it also displays a noticeably wider dispersion. Manufacturing occupies an intermediate position.

Evidently, all three distributions share a pronounced rightward skew. The long right tails act as a visual hint of a leader and follower configuration as a massive, dense concentration of low-productivity firms forms the bulk of the market, while a small group of highly productive frontier firms stretches far out into the upper tail.

Figure 5: Productivity distribution by sector

Figure 6: Technological gap by sector



The distribution of the firm-level technological gap across the Manufacturing, Commerce, and Services sectors reveals a considerable concentration of data mass at the extreme right of the spectrum, particularly between 0.8 and 1.0. This gap is measured relative to each sector's efficiency frontier, where a value of zero denotes a perfectly efficient frontier firm (a "leader") and values approaching one represent a maximum technological lag ("followers").

As visually represented by the kernel density estimates (Figure 6), the skewness presents a concentration on the right side across sectors. Rather than a normal distribution where most firms cluster around a sector average, the market structure is characterized by a dense cluster of less efficient followers operating far below the technological frontier. Meanwhile, only a reduced fraction of firms anchors the frontier near zero. This polarization is particularly acute in the Commerce sector, which exhibits the sharpest density spike near complete technological lag, whereas Manufacturing and Services show a slightly more visible presence near the frontier, though still operating within an asymmetric industrial landscape.

Annex B: Robustness

Table 7
Effect of Competition by Size and Sector using an alternative TFP measure

	(1) Normal	(2) Normal	(3) Normal	(4) Normal	(5) Weighted	(6) Weighted	(7) Weighted	(8) Weighted
Competition	-0.010	-0.056**	-0.012***	-0.059**	-0.005	-0.039**	-0.006***	-0.041**
	(0.018)	(0.023)	(0.018)	(0.023)	(0.011)	(0.016)	(0.012)	(0.016)
Industry FE	N	Y	N	Y	N	Y	N	Y
City FE	N	N	Y	Y	N	N	Y	Y
Observations	3149	3149	3149	3149	3149	3149	3149	3149
R-squared	0.000	0.005	0.003	0.008	0.000	0.005	0.003	0.008

Clusterized standard errors in parentheses by sector
*p < 0.10, **p < 0.05, ***p < 0.01

Table 8
Effect of Competition by Firm Size using an alternative TFP measure

	(1) Normal	(2) Normal	(3) Normal	(4) Normal	(5) Weighted	(6) Weighted	(7) Weighted	(8) Weighted
CompetitionM	0.004	0.003	-0.036	-0.038	0.005	0.004	-0.024	-0.026
	(0.017)	(0.018)	(0.024)	(0.023)	(0.011)	(0.011)	(0.016)	(0.016)
CompetitionL	-0.012	-0.013	-0.051**	-0.053**	-0.012	-0.012	-0.040**	-0.041***
	(0.018)	(0.018)	(0.023)	(0.023)	(0.012)	(0.012)	(0.016)	(0.015)
Industry FE	N	Y	N	Y	N	Y	N	Y
City FE	N	N	Y	Y	N	N	Y	Y
Observations	3149	3149	3149	3149	3149	3149	3149	3149
R-squared	0.021	0.022	0.024	0.026	0.020	0.022	0.024	0.025

Clusterized standard errors in parentheses by sector
*p < 0.10, **p < 0.05, ***p < 0.01

Table 9
Effect of Competition by Size and Sector using an alternative TFP measure

	(1) Normal	(2) Normal	(3) Weighted	(4) Weighted
CompM-Manu	0.013	0.012	0.013	0.012
	(0.009)	(0.009)	(0.009)	(0.009)
CompL-Manu	0.017**	0.017*	0.017**	0.017*
	(0.009)	(0.009)	(0.009)	(0.009)
CompM-Commer	0.021**	0.021**	0.021**	0.021**
	(0.009)	(0.009)	(0.009)	(0.009)
CompL-Commer	-0.008	-0.009	-0.008	-0.009
	(0.011)	(0.011)	(0.011)	(0.011)
CompM-Serv	0.005	0.005	0.005	0.005
	(0.010)	(0.010)	(0.010)	(0.010)
City FE	N	Y	N	Y
Observations	3149	3149	3149	3149
R-squared	0.026	0.027	0.026	0.027

Clusterized standard errors in parentheses by sector
*p < 0.10, **p < 0.05, ***p < 0.01

Table 10
Effect of Competition by Industries using an alternative TFP measure

	(1) Normal	(2) Normal	(3) Normal	(4) Weighted	(5) Weighted	(6) Weighted
Group A: Manufacture						
Competition2	0.078**	0.148**	0.050**	-0.025	-0.087	0.018*
	(0.032)	(0.066)	(0.018)	(0.057)	(0.132)	(0.010)
Observations	489	149	340	489	149	340
R-squared	0.007	0.010	0.037	0.002	0.011	0.012
Group B: Commercial						
Competition2	0.034	0.034	0.034	0.027	0.035**	0.026
	(0.019)	(0.020)	(0.021)	(0.017)	(0.011)	(0.019)
Observations	1724	164	1560	1724	164	1560
R-squared	0.007	0.006	0.007	0.006	0.009	0.005
Group C: Services						
Competition2	0.031**	0.053	0.030**	0.002	-0.132**	0.005
	(0.011)	(0.087)	(0.010)	(0.020)	(0.057)	(0.018)
Observations	929	41	888	929	41	888
R-squared	0.005	0.003	0.004	0.000	0.114	0.000

Clusterized standard errors in parentheses by sector
*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Annex C: Thresholds

Figure 7: Asset distribution by sector