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The Impact of Competition Intensity on Labour Productivity Growth in Canada

by Hassan Faryaar, Carlos Rosell and Nina Stegnjaic

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Abstract

Canada's weak productivity growth over the past two decades has raised concerns about the country's long-term economic performance and has renewed interest in the role of competition policy and structural reforms. Although limited competition in several industries is frequently cited as a contributing factor, empirical evidence on the competition–productivity nexus in Canada remains relatively sparse. Building on the Department of Finance Canada's internal studies, this paper re-examines the relationship between competition and labour productivity growth using more comprehensive data and multiple measures of competition. Specifically, it employs three complementary proxies: the Herfindahl–Hirschman Index (HHI) of market concentration, the price-cost margin as a measure of markups and the Boone indicator capturing profit elasticity. This paper extends the existing literature by examining potential non-linear effects of competition on productivity growth and by assessing whether competitive pressures affect productivity leaders and laggards differently. Its results indicate that stronger competition is generally associated with faster productivity growth across most measures, though the relationship appears non-linear when competition is proxied by the HHI. Moreover, the paper finds that productivity growth among productivity leaders is significantly weaker in less competitive markets, highlighting the importance of market contestability for sustaining productivity growth.

1 Introduction

Canada's persistently weak productivity growth over the past 25 years has brought renewed attention on the role of competition policy as a lever to address this challenge to the country's long-term economic growth. As policy makers look for structural solutions (Government of Canada, 2024, 2025), the discourse has increasingly emphasized strong competitive pressure as a key driver of productivity—both at the firm level by incentivizing innovation, cost reductions and other operational efficiencies and at the industry level by reallocating resources toward more efficient firms and sectors (Organisation for Economic Co-operation and Development [OECD], 2025; Bank of Canada, 2024; Statistics Canada, 2024). Recent amendments to Canada's *Competition Act* (Competition Bureau Canada, 2023b) including the removal of the efficiency defence for mergers, align with this thinking. They signal a growing policy consensus that competition and efficiency are not trade-offs, but rather complementary objectives that warrant a sustained policy focus on competition as a catalyst for productivity gains.

Although the role of competition is broadly viewed this way, the relationship is not always straightforward or uniformly applicable across countries and industries. Factors such as market structure, firm and industry characteristics, and institutional frameworks can significantly influence how competition translates into productivity gains. In some contexts, it leads to immediate gains in productive and allocative efficiencies; in others, it may discourage longer-term innovation by weakening firms' incentives or ability to invest in research and development (R&D). In industries shaped by strong scale economies or network effects, greater competition may even encourage consolidation as firms focus on protecting strategic advantages, rather than outperforming rivals through efficiency alone. These complexities highlight the need for a context-specific approach to analyzing the competition–productivity link, considering the structural and institutional environment in which firms operate.

Against this backdrop, this paper seeks to deepen the understanding of how competition influences productivity growth in Canada, contributing to the broader policy conversation on boosting economic performance through stronger competitive forces. To date, the most comprehensive empirical analysis is the Department of Finance Canada's internal study by Armstrong (2019), which finds evidence of a positive relationship, although more robust at the industry level than for the average firm. Earlier studies—such as those by Tang and Wang (2005), Baldwin and Gu (2006), Trefler (2004), Schmitz (2005), and Lileeva (2008)—focus on specific sectors or trade liberalization episodes before 2000, offering similar but now dated insights. Other related research has provided useful context even if not directly addressing the productivity–competition link. For example, ab Iorwerth and Rosell (2018), Cette et al. (2025), and Manucha and Tombe (2022) find significant macroeconomic gains in terms of overall economic output or gross domestic product per capita from the potential adoption of more competition-friendly regulatory settings or the reduction of internal trade barriers. Faryaar (2025) and the Competition Bureau Canada (2023a) both document weakening trends in competitive intensity in Canada over the past two decades, while Gu (2024) suggests these trends may have led to a decline in capital investment—a key driver of long-term productivity growth.

Building on the work of Armstrong (2019), this paper extends the analysis to a more comprehensive firm-level dataset covering a longer period and uses three complementary measures of competition—market concentration, price-cost margins (PCMs) and profit elasticity (Boone indicator)—to examine new dimensions of the competition–productivity relationship with important policy implications. Specifically, the paper tests whether an optimal level of market competition exists—like the inverted-U hypothesis of Aghion et al. (2005)—and whether competition affects firms differently across the productivity distribution.

The results show that stronger competition generally supports productivity growth at the firm and industry levels, though the relationship is non-linear (i.e., inverted-U) when competition is measured by market concentration. The effects also differ across firms; productivity leaders grow more slowly on average than laggards in a given year and are more adversely affected when competition weakens. These findings suggest that sustained competitive pressure is essential for maintaining frontier dynamism, potentially facilitating the overall pace of technological progress and productivity growth.

The rest of the paper is organized as follows. Section 2 reviews the existing literature on productivity and competition. Section 3 outlines the empirical approach, while Section 4 describes the data. Then, Section 5 discusses the results, Section 6 discusses robustness tests and Section 7 highlights key limitations. Section 8 concludes.

2 Literature review

A vast body of research has examined how competition influences productivity, typically distinguishing between static and dynamic effects. Studies grounded in the exogenous growth tradition tend to focus on static improvements in productive and allocative efficiency within existing technologies. Conversely, those grounded in endogenous growth theory emphasize dynamic effects, linking competition to productivity through innovation, technological progress and intangible investment. Although both are important, the evidence is generally more robust for static efficiency gains, while the dynamic channel remains more context-dependent and theoretically contested.

2.1 Static effects of competition

Some of the most robust evidence for static productivity gains from increased competition comes from studies examining the effects of exogenous policy shocks, such as trade liberalization, deregulation or privatization. In Canada, for example, Trefler (2004) and Lileeva (2008) find that tariff reductions under the Canada–U.S. Free Trade Agreement generated significant productivity gains—Canadian tariff cuts drove industry-level reallocation, while U.S. tariff cuts led to within-firm improvements, particularly among new exporters. Schmitz (2005) similarly finds that increased competition from Brazilian iron ore producers following global steel market liberalization improved productivity in Canadian and U.S. firms, primarily through within-firm efficiency gains.

However, others find that such gains are not automatic, because institutional settings and firm characteristics play a critical role in moderating the impacts of competition. For instance, Aghion et al. (2008a) find that India's manufacturing deregulation raised productivity only in states with business-friendly labour laws. Beverelli et al. (2017) show that service trade liberalization improved productivity in downstream manufacturing, but only in countries with strong governance. Similar conditional effects appear in South Africa (Aghion et al., 2008b), the European Union (Konings and Vandenbussche, 2008) and Canada (Lileeva and Trefler, 2007), where the outcomes varied depending on firm-level characteristics.

Beyond direct policy shocks, most studies use indirect competition measures—such as market concentration, PCMs, firm entry or import penetration—because they are widely available, comparable across industries and allow analysis of nuanced productivity effects that rare policy interventions cannot capture. Within this line of research, early studies by Nickell (1996) and Haskel et al. (2000) show that U.K. manufacturing firms exposed to more competition experienced higher productivity, primarily driven by improvements in allocative efficiency. Similar findings emerge in the United States (Syverson, 2004), Japan (Okada, 2005) and Canada (Tang and Wang, 2005; Baldwin and Gu, 2006; Armstrong, 2019). Competition is also linked to better management practices and firm selection (Bloom et al., 2012), while differences in competitive intensity partly explain the Canada–U.S. productivity gap through Canada's weaker innovation and investment in machinery and equipment (Souaré, 2013).

While most evidence is positive, some exceptions remain. Ambashi (2013) finds that rising competition improved productivity in Japanese manufacturing but not in non-manufacturing sectors, likely because of more stringent regulation. Santos et al. (2018) report that competition in Portugal increased total factor productivity but lowered labour productivity (LP). Foster et al.

(2008) note that competition may favour more profitable firms over the technically most efficient, depending on demand conditions and pricing power. Ganapati (2018) and Peltzman (2018) disentangle prices from output data across a wide range of U.S. industries and find that higher concentration is positively correlated with productivity and real output growth.

2.2 Dynamic effects of competition

Unlike the more established link between competition and static efficiency, competition's relationship with innovation remains ambiguous in theory and empirical evidence. Two foundational theories have long framed this debate: Schumpeter (1943) argues that competition hinders innovation by eroding the rents needed to invest in R&D, while Arrow (1962) contends that competition drives innovation as firms strive to escape competitors and maintain market share. Reconciling these, Aghion et al. (2005) propose an inverted-U relationship where both effects are possible; innovation—and hence productivity—rises with competition up to a point, then declines as rivalry squeezes profit margins. This framework has profoundly shaped modern research and has since been enriched with additional features, including distinction among innovation types, the role of intellectual property regimes, and other contextual factors that mediate how competition influences innovation and productivity.

In line with theoretical ambiguities, empirical evidence on the link between competition and innovation also remains mixed. Some studies support the Schumpeterian view: Mulkay (2019) finds negative effects in French manufacturing, especially for product innovation, while Crépon et al. (1998) show that innovation is positively linked to firm size and market share. Similarly, Bérubé et al. (2012) find that market power can encourage innovation among Canadian manufacturing firms when many firms are technological laggards. In a cross-country OECD study, Bajgar et al. (2021) find that rising concentration is strongly associated with investments in innovation assets, while Bessen (2020) shows that investments in proprietary information technology explain much of the rise in industrial concentration in the United States. By contrast, Geroski (1990) and Aghion et al. (2009b) find that competition promotes innovation in U.K. and South African manufacturing, with firms that are closer to the technological frontier or those that are smaller scale and operating in less competitive markets benefiting the most (Aghion et al., 2009a). Blundell et al. (1995, 1999) offer a more nuanced view, showing that while industry-level competition fosters innovation in U.K. manufacturing, dominant or frontier firms innovate more within industries. Statistics Canada (2024, April 30) reports innovation survey results showing that firms facing greater competition are more likely to introduce innovations, adopt advanced technologies and pursue product positioning as a long-term business strategy.

The inverted-U relationship proposed by Aghion et al. (2005) has received substantial, though not universal, empirical support. Studies from the United Kingdom (Aghion et al., 2005, 2009b), the Netherlands (Lambertini et al., 2017) and Switzerland (Peneder and Wörter, 2013) consistently find that innovation increases with competition up to a certain point, after which it begins to decline. However, more elaborate extensions of the inverted-U model challenge the predictions of this theory. Beneito et al. (2017) introduce an escape-exit effect and find an unambiguous positive relationship between competition and innovation in Spanish manufacturing. Askenazy et al. (2008) include innovation costs in this framework and find that the inverted-U effect mainly applies to large manufacturing firms in France, with the curve becoming flatter or even disappearing when innovation becomes too costly. Correa and Ornaghi (2014) use different estimation techniques from Aghion et al. (2005) to account for non-linearities and find a linear positive link in the U.S. manufacturing data. Correa (2012) challenges the empirical results obtained by Aghion et al. (2005) by showing that the inverted-U relationship in their study was the outcome of a structural break in the data—reflecting a legislative change that introduced stronger intellectual property protections—rather than a true non-linear link.

Other studies point to the role of the structural and institutional context. Hashmi (2013) replicates the Aghion et al. (2005) study using U.S. manufacturing data and, by contrast, finds a robust negative relationship between innovation and competition, citing larger technological dispersion in the United States as a factor driving the different impacts compared with the United Kingdom. Cross-country variations—such as the positive impact of Chinese import competition in Europe (Bloom et al., 2016) versus the negative effects observed in the United States (Autor et al., 2020)—are interpreted through the lens of the inverted-U theory, with differences attributed to countries starting from different baseline levels of competitive intensity. Carlin et al. (2004) use extensive cross-country firm-level survey data and find that innovation is strongest when firms face a combination of pricing power and import competition. However, these effects vary across contexts: older firms tend to innovate more than younger ones, larger firms in urban areas are more likely to innovate, and firms in agriculture and services innovate less. In Canada, Tang (2006) finds that the relationship can be positive or negative, depending on the type of innovation (e.g., product or process) and specific dimension of competition: new competitors and rapid technological change promote both product and process innovation, while easy product substitution discourages product innovation. Quick product obsolescence boosts product innovation but hinders process innovation. Sharpe and Currie (2008) further synthesize this literature, highlighting the diversity of empirical outcomes, but finding that, on balance, evidence supports the positive role of competition in promoting innovation and productivity.

3 Empirical approach

This paper's empirical analysis proceeds in three steps. First, several industry-specific indicators of competitive intensity are constructed for Canada at the three-digit North American Industry Classification System (NAICS) level.[1] Second, LP is calculated at the firm and industry levels. Third, LP growth is regressed on different competition indicators to assess their impact on firm and aggregate productivity, accounting for potential non-linearities and differences between productivity leaders and laggards.

3.1 Competition indicators

Assessing competition dynamics requires a multidimensional approach, as no single metric fully captures the intensity and evolution of market rivalry. To this end, the analysis draws on three widely used measures—the Herfindahl–Hirschman Index (HHI), the PCM and the Boone indicator—each offering a distinct lens on competitive intensity and allowing robustness checks across measures.

The HHI captures market concentration and the PCM measures markups, with higher values of both typically indicating weaker competitive pressure. While these indicators are widely used and intuitive, they are static measures that can overstate market power; high concentration or margins may reflect competitive selection—where more efficient or innovative firms gain market share and profits—rather than entrenched market dominance. Also, factors such as potential entry, buyer power or product differentiation can exert competitive pressure even in concentrated markets, while a high PCM may simply reflect markets where firms naturally benefit from low marginal costs because of technological advantages or economies of scale, rather than reduced competition.

To address these limitations, the Boone indicator provides a more dynamic view of competition by examining how firm profits respond to marginal costs. In competitive markets, where firms lack pricing power, profits are highly sensitive to costs, reflecting that more efficient firms earn higher returns by keeping costs low rather than raising prices. Unlike the PCM, the Boone indicator separates efficiency from market power, and, unlike the HHI, it provides a more accurate assessment of competitive intensity regardless of the number of firms. As such, it offers a valuable complement in analyzing competitive dynamics that static measures may obscure.

1. Potential limitations of this industry aggregation are addressed in Section 7.

The methodology for each of the indicators is discussed in the following sections.

3.1.1 Herfindahl–Hirschman Index

The HHI measures market concentration based on firm market shares. It is calculated by summing the squares of market shares, S, of all firms i in industry j and year t:

$$HHI_{j,t} = \sum_{i \in j} S_{i,t}^2 \tag{1}$$

where $S_{i,t} = \frac{Y_{i,t}}{Y_{j,t}}$ is the share of firm revenue, $Y_{i,t}$, in total industry revenue, $Y_{j,t}$.

The HHI ranges from 0 to 1, with 0 indicating the textbook notion of perfect competition (i.e., where the market is composed of many firms with small market shares) and 1 indicating a monopoly (i.e., one firm with 100% of the market share). This indicator is commonly used in antitrust analysis to evaluate the potential that a merger is anticompetitive. While thresholds can vary, an HHI above 0.25 is generally considered indicative of a highly concentrated market.

3.1.2 Price-cost margin (or Lerner Index)

The PCM measures the degree of market power (i.e., markups or rents) by calculating the extent to which firms charge a price above marginal cost (Lerner, 1934). Formally, it is calculated as a share-weighted average of individual firms' PCMs:

$$PCM_{j,t} = \sum_{i \in j} S_{i,t}\, x \frac{P_{i,t} - MC_{i,t}}{P_{i,t}} \tag{2}$$

where i indexes firm, j indexes industry, t indexes year, $P_{i,t}$ is price and $MC_{i,t}$ is marginal cost.[2] Like the HHI, the PCM ranges from 0 to 1. A PCM of 0 indicates perfect competition, where prices are equal to marginal costs, while a PCM of 1 is a theoretical maximum that is not observable in practice since it implies zero costs. Rather, it is taken to represent a perfect monopoly. Unlike the HHI, there are no established thresholds for the PCM to signal excessive market power.

3.1.3 The Boone indicator

The Boone indicator measures the degree of competition in a market using the elasticity of firm profits with respect to efficiency, where efficiency is proxied by marginal costs (Boone, 2008). As in the case of the PCM, marginal costs are proxied by the average variable costs. The Boone indicator is then represented by the slope coefficient, β, from the following industry-year cross-sectional regression equation using firm-level data:

$$\ln \pi_i(j,t) = \alpha(j,t) + \beta(j,t) \ln AVC_i(j,t) + \gamma(j,t) Size_i(j,t) + \varepsilon_i(j,t) \tag{3}$$

where $\pi_i = Y_i - TVC_i$ is variable profit for firm i, TVC is total variable cost, and *Size* represents the number of employees. Since the parameter β is expected to be negative in competitive markets, a more negative value indicates greater sensitivity of firm profits to costs and thus reflects a higher degree of competition. The underlying intuition is that in highly competitive environments, even a small increase in costs leads to significant drops in profits, because firms

2. In empirical applications, the PCM is often estimated using proxies such as revenues and average variable costs since actual prices and marginal costs are rarely available in the data.

cannot raise prices to offset higher costs. Therefore, the more negative β is, the stronger the market's reward for efficiency—only highly efficient firms (i.e., with lower costs) can undercut rivals and gain market share. As a relatively new measure, the Boone indicator does not have established thresholds for what constitutes high or low competition. Instead, the trajectory of β across time provides a more meaningful indication of changing competitive pressures in the market.

3.2 Labour productivity estimation

Firm- and industry-level LP is calculated directly in the data. Firm-level LP is defined as a log ratio of real value added to hours worked:

$$\ln LP_{i,j,t} = \ln\left(\frac{Real\ value\ added_{i,j,t}}{Hours\ worked_{i,j,t}}\right) \quad (4)$$

where $Real\ value\ added$ is the difference between real total revenue and real intermediate inputs, where deflators represent industry-level price indexes for gross output and intermediate inputs.

Industry-level LP is defined as the log ratio of aggregate real value added and aggregate hours for each year and industry combination—effectively a log of the weighted arithmetic mean of firm-level productivities, where weights, $w_{i,t}$, are firm shares in total industry hours:

$$\ln LP_{j,t} = \ln\left(\frac{\sum_{i\in j} Real\ value\ added_{i,t}}{\sum_{i\in j} Hours\ worked_{i,t}}\right) = \ln\left(\sum_{i\in j} w_{i,t} * LP_{i,t}\right) \quad (5)$$

3.3 Productivity–competition regressions

The paper explores the link between productivity growth and competition intensity at the firm and industry levels using LP as a dependent variable. Distinguishing between firm- and industry-level analysis is important, because industry-level results capture aggregate trends and structural dynamics across all firms in a sector, while firm-level analysis allows for heterogeneity in firm behaviour, reflecting the average response to competition of individual firms.

The analysis starts with a basic fixed-effects panel regression and extends it in two ways. First, a non-linear relationship between competition and productivity is allowed for, drawing on the insights of Aghion et al. (2005), who document such non-linearities in the context of competition and innovation. Second, the differences in productivity responses to competition between productivity leaders and laggards are tested for.

3.3.1 Baseline firm- and industry-level models

The basic model at the firm level explores the relationship between competition and productivity for the average firm, controlling for firm characteristics, and is specified as follows:

$$\Delta \ln LP_{i,j,t} = \alpha + \beta COMP\_IND_{j,t-1} + \gamma X_{i,j,t} + \delta_t + \theta_j + \in_{i,j,t} \quad (6)$$

where i, j and t denote firm, industry and time dimensions; $\Delta \ln LP$ is the firm-level LP growth rate (expressed as a log difference between time $t-1$ and t); α is the intercept; $COMP\_IND$ is the industry-level competition indicator (i.e., HHI, PCM or Boone indicator); X is a vector of firm-level explanatory variables (i.e., log size and age); and δ_t and θ_j are time and industry fixed effects, respectively. The main parameter of interest is β. A negative sign is expected on this parameter, because the competition measures used are defined such that higher values indicate weaker competition—namely higher concentration (HHI), higher markups (PCM) and less negative (i.e., weaker) profit elasticity (Boone).

A lagged value of the competition index is used to avoid potential problems with endogeneity and to better capture the dynamic nature of productivity responses to changes in competitive intensity. Industry fixed effects control for time-invariant, unobserved heterogeneity, such as different technological opportunities and other systematic differences across industries, that could lead to a spurious correlation between productivity and competition if not controlled for. The year fixed effects capture time trends and other unobservable factors that vary across years but are common to all firms.

At the industry level, this model is similarly specified—it uses the growth rate of aggregate productivity as the dependent variable and excludes the controls for firm size and age.

3.3.2 Non-linear model

To test for a potential non-linear relationship between competition and productivity growth, Equation (6) is extended to include a quadratic term on the competition indicator:

$$\Delta \ln LP_{i,j,t} = \alpha + \beta_1 COMP\_IND_{j,t-1} + \beta_2 COMP\_IND^2{}_{j,t-1} + \gamma X_{i,j,t} + \delta_t + \theta_j + \in_{i,j,t} \quad (7)$$

where β_1 represents the linear effect of a unit increase in the competition indicator, holding the non-linear effect constant, and β_2 represents the "curvature." The impact of competition on firm-level LP growth in Equation (7) is the combined effect of β_1 and β_2.

A similar model is estimated at the industry level, excluding the controls for firm size and age.

3.3.3 Leader–laggard model

To explore the responses of productivity leaders and laggards to competitive pressures, the baseline regression is modified as follows:

$$\begin{aligned}\Delta \ln LP_{i,j,t} = \; & \alpha + \beta_1 COMP\_IND_{j,t-1} + \rho_1 Leader_{i,j,t-1} + \rho_2 Leader_{i,j,t-1} * COMP\_IND_{j,t-1} + \gamma X_{i,j,t} \\ & + \delta_t + \theta_j + \in_{i,j,t}\end{aligned} \quad (8)$$

where $Leader_{i,j,t-1}$ is a dummy variable indicating whether the firm's productivity level is in the top 10th percentile of the distribution. This indicator is lagged by a year to avoid issues with simultaneity, since leaders are classified into the frontier based on their current productivity levels. Coefficients ρ_1 and ρ_2 represent the intercept and the slope of the leaders, respectively. Specifically, ρ_1 indicates the difference in average LP growth of leaders relative to laggards, while ρ_2 captures how the LP growth of leaders changes relative to laggards as competition changes. To consider the responses of leaders when the non-linear relationship between productivity and competition is explored, additional non-linear interaction terms are included to test the curvature of the leaders' responses to rising concentration:

$$\begin{aligned}\Delta \ln LP_{i,j,t} = \; & \alpha + \beta_1 COMP\_IND_{j,t-1} + \rho_1 Leader_{i,j,t-1} + \rho_2 Leader_{i,j,t-1} * COMP\_IND_{j,t-1} \\ & + \rho_3 Leader_{i,j,t-1} * COMP\_IND^2_{j,t-1} + \gamma X_{i,j,t} + \delta_t + \theta_j + \in_{i,j,t}\end{aligned} \quad (9)$$

4 Data

Firm-level data covering 2000 to 2020 from Statistics Canada's 2020 National Accounts Longitudinal Microdata File are used. Industries are defined based on the three-digit NAICS level. This is the most comprehensive administrative database containing financial, tax and employment data for the universe of Canadian firms, including private and public corporations (about 80%); unincorporated businesses (about 8%); and other types of legal entities, such as partnerships, funds and government entities (about 12%). A key advantage of this level of coverage is that it enables internally consistent measures of all competition indicators and the estimates of productivity at the firm and industry levels. Data on industry-level price deflators required to derive real economic variables for productivity estimation were supplemented externally from industry productivity databases (i.e., KLEMS), also available at Statistics Canada. Since these deflators were available only up to 2019, all regressions of productivity growth were correspondingly limited to the 2000-to-2019 period.

To focus the analysis solely on the business sector, public sector industries (NAICS 91), the central bank (NAICS 521) and private households (NAICS 814) were excluded. Firms with fewer than three employees were also removed, as these are typically small, unincorporated businesses with limited employee data.

Additional data adjustments, such as eliminating outliers and replacing negative values for revenue, expenses and assets with zeros, were made as needed for specific calculations. For computations that required logged variables of profits (e.g., for the Boone indicator), firms with negative profits were excluded. For firm-level regressions, industries that had fewer than 10 firms were eliminated.

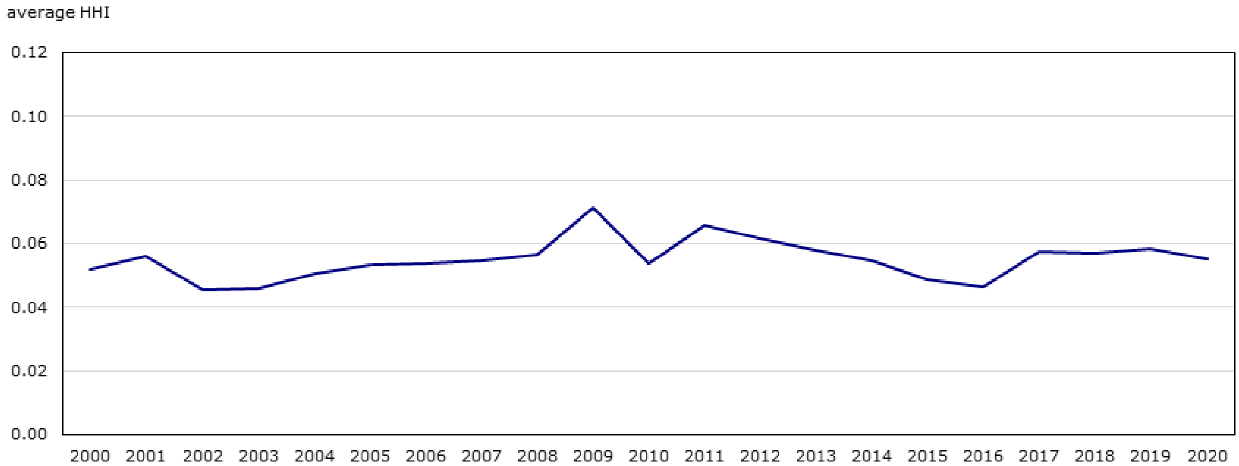
5 Results

The results provide valuable insights into the changing competition landscape in Canada and its implications for firm-level and aggregate productivity. Descriptive trends in Section 5.1 reveal that, while market concentration has remained relatively stable over time, there has been a moderate decline in competitive intensity, as reflected in higher PCMs and reduced profit elasticity (the Boone indicator). Regression results in Section 5.2 confirm a positive relationship between competition and LP growth, with some nuances when competition is proxied by concentration levels (i.e., HHI), where the relationship exhibits a non-linear pattern. Section 5.2.2 shows that these effects are not evenly distributed across firms: leader–laggard dynamics emerge clearly, with leading firms experiencing weaker LP growth than laggards and being affected more adversely when competition weakens.

5.1 Competition trends

The evolution of competition in Canada since 2000 reveals a nuanced picture when examined through multiple indicators. As shown in Chart 1, the HHI has remained relatively stable for the economy as a whole, with modest fluctuations that do not clearly signal either an erosion or an intensification of competitive pressure. This stability suggests that the overall structure of competition in terms of the number and relative size of market participants has remained relatively consistent over time.

Chart 1
Average annual Herfindahl-Hirschman Index, all industries



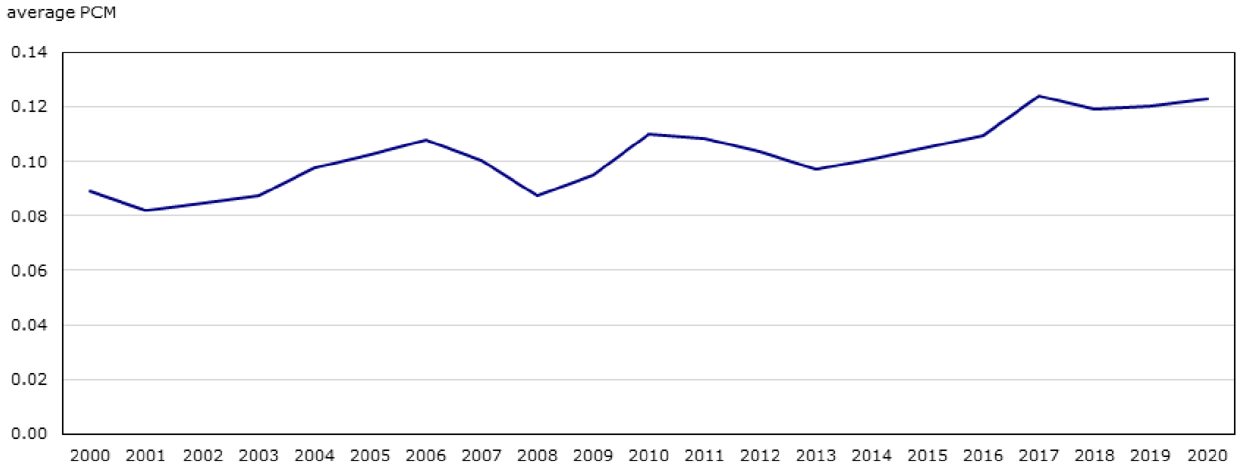
Note: HHI = Herfindahl-Hirschman Index.
Source: Calculated by authors using microdata.

However, a stable HHI does not necessarily imply that competitive intensity has remained unchanged. On the one hand, firms may compete vigorously on price, innovation or efficiency even in a structurally stable market if dominant firms use product innovation or differentiation to raise prices and market share, while weaker rivals lower theirs to retain their shares. On the other hand, a stable HHI at the three-digit industry level can obscure deeper market shifts that signify weakening competition at finer levels of industry disaggregation. The Competition Bureau Canada (2023a), for instance, shows that at the four-digit NAICS level, industries that were already highly concentrated became even more concentrated over the past two decades. This suggests that competitive pressure may be weakening within narrowly defined product markets. Moreover, a stable HHI can also hide offsetting dynamics, such as growing dominance by a few incumbents offset by the entry of smaller competitors—though Faryaar (2025) shows that entry has in fact declined in Canada from 2002 to 2019. For these reasons, complementary indicators like the PCM or Boone indicator can provide a clearer picture of how competitive behaviour is evolving beneath the surface.

Chart 2 shows a clear upward trend in the PCM, signalling a rise in market power. Firms are increasingly able to sustain or expand their markups as they face less pricing pressure from competitors or new entrants. While higher margins can sometimes reflect competitive selection—where more efficient firms earn higher profits—or shifts in industry composition toward high-margin sectors, especially those benefiting from scale or technological advantages, the simultaneous increase in the Boone indicator (Chart 3) strengthens the case for market power concerns.

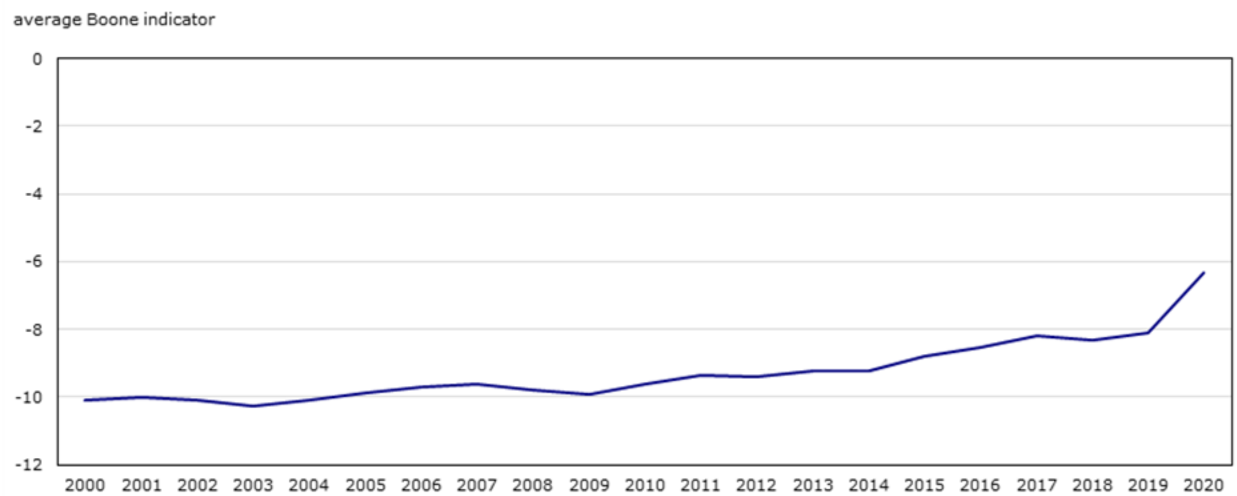
An increase in the Boone indicator—i.e., a decline (in absolute terms) in the sensitivity of profits to firm efficiency—signals that rising margins are not primarily the result of improved efficiency, but more likely reflect a firm's increased ability to sustain high profits through pricing power. This dynamic weakens incentives to innovate or cut costs and may allow less productive firms to survive in the market.

Chart 2
Average annual price-cost margin, all industries



Note: PCM = price-cost margin.
Source: Calculated by authors using microdata.

Chart 3
Average annual Boone indicator (profit elasticity), all industries



Source: Calculated by authors using microdata.

Taken together, the trends in the PCM and the Boone indicator provide complementary evidence of declining competition across the economy. These findings align with the evidence from the Competition Bureau Canada (2023a) and Faryaar (2025), both of which document rising market power in Canada over the past few decades. This underscores the need for policy makers to remain vigilant by strengthening enforcement and advancing pro-competitive reforms to foster innovation, efficiency and long-term productivity growth.

5.2 Regression results

5.2.1 Main results

This paper's main estimates reveal a generally positive correlation between competition and productivity, though the strength and significance of the correlation vary depending on the level of analysis and the competition metric used.

When competition is proxied by either the PCM or the Boone indicator (Table 1), the coefficients suggest a positive association with LP growth at the industry and firm levels. Stronger competition—reflected in lower markups (PCM) or stronger efficiency-based rivalry (Boone)—appears to support the LP growth of the average firm, as well as in aggregate.[3] This study did not find evidence of a non-linear relationship between productivity growth and these two proxies of competition. Higher values of these indicators exhibit a monotonic negative effect on firm- and industry-level LP growth, consistent with the extensive literature demonstrating that higher pricing power signals reduced competitive pressure and is associated with weaker efficiency incentives.

Notably, the relationship is statistically more significant in firm estimates, likely because firm heterogeneity at the micro level provides more variation for regressions to detect meaningful relationships between competition and productivity. The firm-level results, shown in the right panel of Table 1, suggest improvement in LP growth from increased competition could be substantial. For instance, a gain in PCM of 0.03 units (the observed increase over the 2000-to-2019 period) would correspond to about one percentage point decrease in firm-level LP growth. While this highlights the importance of competition as a driver of LP growth, the calculation is based on the magnitude observed over the 19-year period and should be interpreted as illustrative only, reflecting long-term effects whose precise timing remains uncertain.

Table 1
Industry- and firm-level regressions of labour productivity growth using the price-cost margin and Boone indicator

	Industry-level					Firm-level					
Variables	**PCM**		**SE**	**Boone**	**SE**	**PCM**		**SE**	**Boone**		**SE**
PCM_{t-1}	-0.51800	*	0.25100	...	...	-0.32700	***	0.00966	...		...
$Boone_{t-1}$	...		...	-0.00190	0.00659	...		...	-0.00850	***	0.00024
Age	...		...	...	...	0.00051	***	0.00002	0.00050	***	0.00002
Log(size)	...		...	...	...	-0.02310	***	0.00019	-0.02310	***	0.00019
Observations	1,709		...	1,709	...	4,196,197		...	4,196,197		...
R-squared	0.031		...	0.023	...	0.015		...	0.015		...
Year FE	YES		...	YES	...	YES		...	YES		...
Industry FE	YES		...	YES	...	YES		...	YES		...

... not applicable
* significantly different from reference category (p < 0.1)
** significantly different from reference category (p < 0.05)
*** significantly different from reference category (p < 0.01)
Notes: SE= Robust standard errors. PCM = price-cost margin. FE = fixed effects.
Source: Calculated by authors using microdata.

The HHI-based results point to a more nuanced association of LP growth and concentration (Table 2). In the initial linear specifications (models 1 and 3), the estimated effects varied in sign and significance across industry- and firm-level analyses and were sensitive to the inclusion of fixed effects, suggesting potential model misspecification. Introducing a non-linear (quadratic) term in models 2 and 4 stabilized the results, producing a statistically significant inverted-U relationship that held consistently across different fixed-effect setups. This pattern suggests that LP growth is weakest at very low and very high levels of concentration, implying a potential "optimal" level of HHI where the market is neither too fragmented to allow scale efficiencies nor too consolidated to hinder innovation incentives.

Interestingly, the location of this optimum differs markedly between firm and industry results. At the industry level, LP growth follows a more conventional inverted-U pattern, rising at moderate concentration and peaking around an HHI of 0.53 before declining. At the firm level, the contribution of increasing concentration to LP growth is effectively negative, as it peaks at a very low HHI of 0.12 before declining. This finding suggests that even when firm-level productivity growth is negatively associated with rising concentration, an industry can still exhibit positive aggregate growth at moderate levels of the HHI if this means that more efficient firms expand while less efficient firms shrink or exit—a process known as market reallocation. This would be consistent with Baldwin and Gu (2006), for example, who examine the Canadian manufacturing sector and find that output reallocation associated with competitive pressures is a key driver of aggregate LP growth in the sector. As explained in Section 6, this study's robustness tests also

3. Recall that in this analysis, negative coefficients imply a positive relationship with competition.

confirm that reallocation is the primary channel through which the HHI contributes to aggregate productivity growth.

Table 2
Industry- and firm-level regressions of labour productivity growth using the Herfindahl–Hirschman Index

	Industry-level				Firm-level			
Variables	**Model 1**	**SE**	**Model 2**	**SE**	**Model 3**	**SE**	**Model 4**	**SE**
HHI_{t-1}	0.27700 ***	0.09030	0.70300 ***	0.22000	-0.00795	0.00960	0.04620 ***	0.01390
HHI^2_{t-1}	…	…	-0.66400 *	0.36100	…	…	-0.19500 ***	0.04940
Age	…	…	…	…	0.00053 ***	0.00002	0.00053 ***	0.00002
Log(size)	…	…	…	…	-0.02310 ***	0.00019	-0.02310 ***	0.00019
Observations	1,709	…	1,709	…	4,196,197	…	4,196,197	…
R-squared	0.027	…	0.029	…	0.014	…	0.014	…
Year FE	YES	…	YES	…	YES	…	YES	…
Industry FE	YES	…	YES	…	YES	…	YES	…

… not applicable
* significantly different from reference category (p < 0.1)
** significantly different from reference category (p < 0.05)
*** significantly different from reference category (p < 0.01)
Notes: SE= Robust standard errors. HHI = Herfindahl–Hirschman Index. FE = fixed effects.
Source: Calculated by authors using microdata.

The divergence in results between the HHI and the other two measures of competition is not surprising, since each captures a distinct aspect of market dynamics and therefore may not be interchangeable, but rather complementary. The HHI primarily reflects the structural features of markets by capturing how market shares are distributed across firms in an industry. Moderate concentration suggests that, while no single firm dominates the market, firms may be large enough to exploit scale economies and market stability to support productivity growth. This interpretation would be consistent with a recent line of research documenting a positive association between market concentration and investment in productivity-enhancing assets (Bajgar et al., 2021; Bessen, 2020).

By contrast, the PCM and the Boone indicator are behavioural measures that capture firm pricing power rather than market structure. Moderate values of these indicators show that firms have some degree of market power, but they do not guarantee that firms operate efficiently or at an efficient scale conducive to productivity growth. As a result, higher PCM and Boone values are more directly associated with weakened competitive pressure and reduced efficiency incentives at the firm and industry levels.

Although these measures reflect different dynamics, they nonetheless seem to converge in explaining the observed slowdown in productivity growth in Canada—through both limited gains from reallocation and weakening firm-level efficiency incentives. While moderate levels of the HHI are associated with aggregate productivity gains via reallocation, the relative stability of this indicator over time suggests that the contribution of reallocation to productivity growth may have declined. This would be consistent with Gu (2019), who shows a declining contribution of reallocation to post-2000 aggregate productivity growth in Canada. At the same time, pricing power—as captured by the PCM and the Boone indicator—has increased over time. Given its monotonic negative relationship with productivity growth, this pattern would be consistent with a gradual weakening of firm-level efficiency incentives and, in turn, slower aggregate productivity growth.

That said, the paper's empirical approach is reduced-form in nature and focuses on documenting how variation in different measures of competition is associated with variation in LP growth, conditional on fixed effects and other controls. While this study finds systematic patterns that align with theory and empirical evidence from other studies, the results should be interpreted as conditional correlations rather than causal estimates.

5.2.2 Leader–laggard dynamics

The paper now turns to examine whether firms at different points in the productivity distribution—specifically those in the top 10th percentile (i.e., leaders) versus those below (i.e., laggards)—

respond differently to competitive pressures.[4] Understanding these responses, particularly at the frontier, is crucial for assessing long-term growth implications and for determining whether competition promotes convergence by helping laggards catch up or drives divergence by favouring leading firms.

Table 3 reveals a consistent and statistically significant pattern: weakening competition is negatively correlated with the LP growth of leaders and laggards, but productivity leaders fare worse. They not only exhibit lower baseline productivity growth—as indicated by the negative leader dummies in all models—but also experience sharper declines when competitive pressure weakens, reflected in the negative interaction terms with competition variables.

A more nuanced pattern emerges when using the HHI as a proxy (Model 1). While leaders and laggards display an inverted-U relationship with LP growth, this link is effectively negative across most of the HHI distribution (Chart 4). Laggards experience a brief window of positive contributions at low concentration levels—reflected in a small positive linear coefficient (0.0479)—but these gains quickly reverse beyond an HHI of 0.13 because of a sharp quadratic decline (-0.181). For leaders, the picture is consistently worse; their curve remains entirely in negative territory, with the combination of lower baseline growth (-0.151) and adverse curvature (-0.144).

Taken together, these results reveal an interesting dynamic: while the weaker baseline growth at the frontier suggests potential for convergence—conditional on competition and other factors—the negative interaction terms for leaders (i.e., steeper negative slopes) show that they may also be more responsive when competition pressure intensifies. Stronger competition could therefore lead to greater productivity gains at the frontier. Without such pressure, however, frontier firms are likely to stagnate, slowing innovation and constraining long-term productivity growth. Operating near technological or operational limits, and facing weak competition, they would likely encounter diminishing returns from further efficiency improvements and often shift toward consolidating market position rather than pursuing riskier innovations.

These results align with Gu (2019), who finds that a slowdown in frontier-firm innovation was a contributing factor to the post-2000 decline in LP growth in Canada. They are also broadly consistent with Gu (2024), who documents a decline in capital investment by Canadian firms since the early 2000s as a result of rising concentration and falling entry rates.

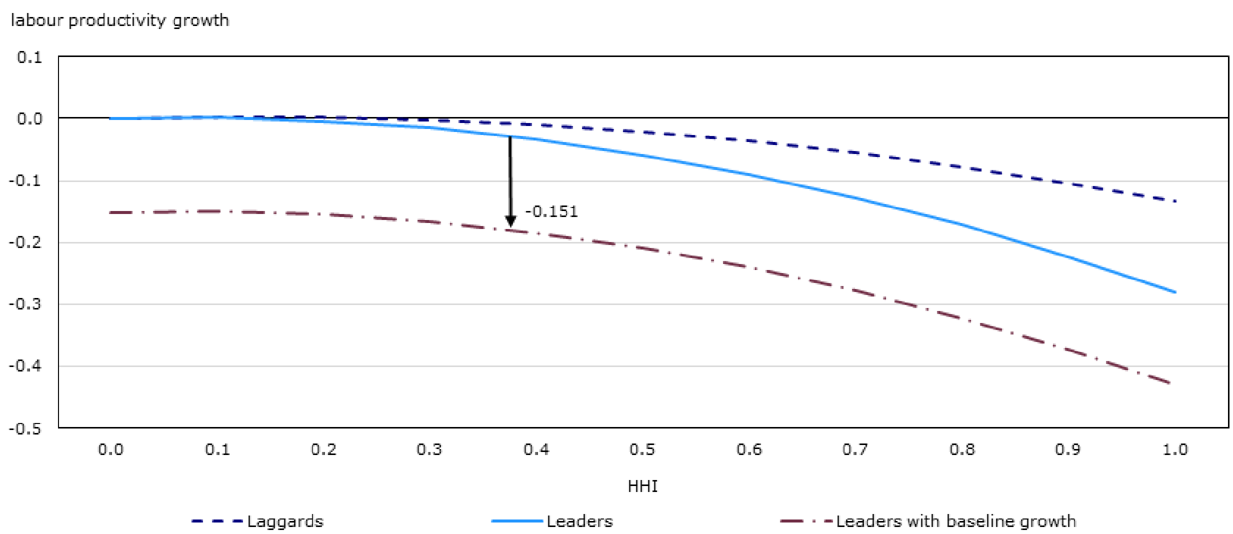
4. In this analysis, productivity leaders are not necessarily large firms.

Table 3
Firm-level regressions of labour productivity growth for leaders and laggards

Variables	Model 1—HHI		SE	Model 2—PCM		SE	Model 3—Boone		SE
HHI_{t-1}	0.04790	***	0.01390	...		...	...		...
HHI^2_{t-1}	-0.18100	***	0.04960	...		...	...		...
PCM_{t-1}	...		...	-0.32500	***	0.00960	...		...
$Boone_{t-1}$	...		...	...		...	-0.00871	***	0.00024
$Leader_{t-1}$	-0.15100	***	0.00069	-0.13700	***	0.00117	-0.18400	***	0.00158
$Leader_{t-1} * HHI_{t-1}$	-0.00225		0.02280	...		...	...		...
$Leader_{t-1} * HHI^2_{t-1}$	-0.14400	**	0.06060	...		...	...		...
$Leader_{t-1} * PCM_{t-1}$	...		...	-0.15900	***	0.01220	...		...
$Leader_{t-1} * Boone_{t-1}$	...		...	...			-0.00305	***	0.00013
Age	0.00068	***	0.00002	0.00067	***	0.00002	0.00065	***	0.00002
Log(size)	-0.02820	***	0.00019	-0.02830	***	0.00019	-0.02820	***	0.00019
Observations	4,196,197		...	4,196,197		...	4,196,197		...
R-squared	0.034		...	0.035		...	0.035		...
Year FE	YES		...	YES		...	YES		...
Industry FE	YES		...	YES		...	YES		...

... not applicable
* significantly different from reference category ($p < 0.1$)
** significantly different from reference category ($p < 0.05$)
*** significantly different from reference category ($p < 0.01$)
Notes: SE= Robust standard errors. . HHI = Herfindahl–Hirschman Index. PCM = price-cost margin. FE = fixed effects.
Source: Calculated by authors using microdata.

Chart 4
Inverted-U curves for leaders and laggards



Note: HHI = Herfindahl–Hirschman Index. The arrow shows the downward shift in the overall predicted productivity growth of leaders once the baseline growth difference between leaders and laggards is added.
Source: Calculated by authors using microdata.

6 Robustness checks

To ensure that the paper's main findings are not sensitive to particular model specifications or measurement choices, several robustness checks were conducted.

First, the study examined whether including growth in the capital–labour (K/L) ratio as a control for capital deepening in the regressions affected the results. Controlling for this variable is theoretically important, because productivity growth may partly reflect changes in factor intensity; firms with higher capital per worker may exhibit higher measured productivity growth independent of market competition. An alternative definition of net capital was also tested, calculated as the sum of existing capital and new investment, reduced by a 10% economic depreciation used in the literature as an approximation of wear and tear for machinery and equipment. This adjustment accounts for the fact that the study's firm-level data come from administrative tax records, where reported depreciation may be influenced by tax strategies rather than reflecting true economic depreciation, potentially distorting the actual value of capital. Including K/L growth with either definition of capital did not produce any qualitative changes in the results, suggesting that the main findings are not driven by variation in capital intensity or by the method of capital measurement.

Second, the study examined whether the non-linear association between the HHI and LP growth is driven by reallocation effects holds in the data. Thus, aggregate productivity growth was decomposed into within-firm and between-firm (reallocation) components using the standard Olley–Pakes framework and each component was regressed on the competition measures. This enabled an assessment of whether the responses of aggregate LP growth to competition operate primarily through improvements in firm-level efficiency or through the reallocation of activity toward more productive firms. The results confirmed that the HHI operates primarily through the reallocation channel, consistent with the interpretation that moderate concentration allows more productive firms to expand while less productive firms contract or exit. By contrast, the PCM and the Boone indicator affect primarily within-firm productivity, reflecting the behavioural channel through which pricing power and rents influence firm-level efficiency.

Finally, the persistence of the frontier status was examined to assess whether the negative coefficients on the frontier dummy reflect mechanical effects from high turnover at the top driven by the annual reclassification of firms into and out of the frontier. About two-thirds of firms identified as frontier in one year remain in the top decile the following year. This level of persistence suggests that, while some churn does occur, the negative coefficients are not purely driven by compositional changes, supporting the view that this study's leader–laggard estimates capture meaningful economic differences, rather than artifacts of annual frontier reclassification.

7 Study limitations

While this analysis provides new insights into the role of competition in shaping productivity dynamics, several limitations warrant careful consideration. They relate to data constraints and potential identification challenges. Acknowledging these caveats is important for interpreting the results accurately and for guiding future research that seeks to build on these findings.

First, the use of three-digit NAICS codes to define markets may mask important within-industry heterogeneity, especially in sectors with diverse product lines or regional segmentation. This level of aggregation can blur firm-level competitive pressures and understate or overstate true market concentration, as discussed in detail by Werden and Froeb (2018). In regression analysis, these limitations may affect the precision and interpretation of estimated relationships between competition and productivity.

Another limitation is the absence of direct measures of import competition, a commonly used proxy for competitive pressure. Trade exposure can materially influence domestic firm behaviour, and its omission may understate the true intensity of competition, particularly in highly tradable sectors. However, this concern is partly mitigated by the study's multiple competition indicators. While the HHI captures domestic market structure, behavioural measures such as the Boone elasticity and PCM reflect firms' responses to competitive pressure, including from foreign entrants. Greater import pressure constrains the ability of domestic firms to raise prices and accelerates selection—effects that are reflected in lower markups and higher profit elasticity, allowing only the most efficient firms to survive. As a result, foreign competition can generate meaningful variation in these indicators even in the absence of explicit import penetration measures, allowing for an assessment of how they correlate with productivity growth.

A further caveat concerns potential reverse causality in the leader–laggard analysis. Frontier firms may influence competition through pricing, investment or market-entry decisions, affecting observed concentration and markups. However, this paper's empirical design attenuates this concern: leader status is redefined each period and a lagged model structure limits leaders' ability to systematically shape industry-level competition in ways that feeds back into the estimation to bias the estimated interaction effects. That said, no observational study can fully eliminate endogeneity problems. The authors remain cognizant that common exogenous shocks—such as sudden surges in demand for leader output—can still create correlations between competition measures and productivity growth, mimicking reverse causality. Estimates should therefore be interpreted as robust correlations consistent with competitive mechanisms, while acknowledging the possibility of a residual common-shock effect.

8 Conclusion

This paper examined the relationship between competition and LP growth in Canada using detailed firm-level data from 2000 to 2019. The analysis explored how variations in competitive intensity affect annual productivity growth at the industry and firm levels. Overall, stronger competition is associated with higher LP growth, though the strength and statistical significance of this relationship vary depending on the level of analysis and the measure of competition used. The results also reveal asymmetric effects: while both frontier and lagging firms are negatively affected by declining competition, the impact is stronger among productivity leaders, suggesting weakened incentives to innovate and a loss of frontier dynamism. These findings underscore the importance of policies that reinvigorate competitive pressure—particularly among leading firms—while supporting laggards in catching up. This could involve tackling entrenched market power through stronger antitrust enforcement and lower entry barriers, complemented by innovation-oriented measures such as R&D incentives, technology adoption supports and knowledge diffusion initiatives. Together, such policies can sustain competitive dynamism across the firm distribution; without them, weaker competition risks producing an economy where lagging firms make modest gains while frontier firms stagnate, slowing overall productivity growth.

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