Firm Size and Business Cycle Sensitivity: The Role of Productivity and Financial Frictions*

Gabriela Contreras
Central Bank of Chile

Lucciano Villacorta
Central Bank of Chile

November 26, 2025

Abstract

This paper investigates the interplay between firm size, cyclicality, and financial frictions using extensive Chilean firm-level data from 2008 to 2019. An innovative aspect of our empirical approach involves controlling for a new measure of firm productivity. Our findings reveal substantial heterogeneity in how firms respond to aggregate economic fluctuations. When holding productivity constant, small firms display a more pronounced reaction in terms of investment, hiring, and sales to positive changes in GDP compared to larger firms. However, the link between cyclicality and firm size diminishes when considering firms with similar productivity levels and financial conditions. This suggests that financial constraints play a crucial role in explaining the diverse responses across firms to aggregate economic fluctuations. Our results support a financial accelerator mechanism, where among equally productive firms, the higher cyclicality of smaller Chilean firms compared to large ones is linked to access to financing.

Keywords: Firm size, productivity, business cycles, financial frictions, financial accelerator

JEL classification: E32, G32, L25

*We thank the seminar participants at Pontificia Universidad Católica de Chile, Central Bank of Chile, and SECHI Meetings 2024 for their valuable comments and suggestions, and Valeria Ulloa for her excellent research assistance. The views expressed are those of the authors and do not necessarily represent the views of the Central Bank of Chile or its board members. The views expressed are those of the authors and do not necessarily represent the views of the Central Bank of Chile or its board members. This study was developed within the scope of the research agenda conducted by the CBC. The CBC has access to anonymized information from various public and private entities by virtue of collaboration agreements signed with these institutions. Emails: gcontreras@bcentral.cl,lvillacorta@bcentral.cl.

1 Introduction

Do firms exhibit distinct reactions to identical aggregate shocks? If they do, what are the relevant margins that drive the heterogeneity in their responses? To answer these questions, in this paper, we explore the heterogeneity in firms' investment, labor, and sales in response to fluctuations in the overall economic environment and how those heterogeneous responses are linked to firm size, productivity, and financial frictions.

Extensive empirical literature in macroeconomics and corporate finance documents firms' heterogeneous responses to aggregate shocks (Gertler & Gilchrist, 1994; Begenau & Salomao, 2018; Moscarini & Postel-Vinay, 2012; Ottonello & Winberry, 2020). As emphasized in Crouzet & Mehrotra (2020), the literature has mainly focused on size -proxied by firm assets- as the relevant margin to explain the heterogeneous response across firms, as firm size tends to be used as a proxy of financial constraints. Financial constraints might generate a differential response in firm decisions to common shocks, as financial frictions limit the possibility of low-wealth/high-leverage firms from accessing credit to expand investments, employment, and, consequently, sales compared to their less financially constrained counterparts.

In a recent paper, Crouzet & Mehrotra (2020) reexamines the interplay among firm size, cyclicality, and financial frictions. Utilizing Census data from listed firms in the U.S., they uncover that firms of different sizes (measured by book assets) exhibit disparate reactions to changes in aggregate GDP. Interestingly, this diverse response is found to be uncorrelated with the financial standing of the firm. The study identifies a negative relationship between the marginal effect of changes in GDP growth on sales and assets of the firm, both with and without controlling for proxies of financial frictions.

Motivated by this evidence, this paper reexamines these relationships and investigates whether fluctuations in GDP yield heterogeneous effects on firms' investment, employment, and sales of firms operating in the same industry but with diverse levels of assets, productivity, and financial constraints.

Our paper makes two relevant contributions with respect to Crouzet & Mehrotra (2020). First, we focus on a large sample of private firms of different sizes and characteristics operating in a developing country. Leveraging micro-level panel data, we have meticulously tracked a highly representative set of firms for over a decade, ensuring comprehensive coverage of the spectrum of formal firms across different sectors in Chile. This is particularly relevant for understanding the role of financial friction, especially given that small private firms with limited wealth and high leverage are often the most susceptible to financial constraints, especially in an emerging economy with a less developed financial system than the U.S.

Second, and in contrast to Crouzet & Mehrotra (2020), we can control for firm productivity in our empirical specification and compare the reaction to aggregate fluctuations of firms with the same level of productivity but different levels of leverage (or wealth). This is crucial to measure the importance of financial frictions, as the ideal thought experiment would be to compare two firms with identical profitability and investment opportunities, differing only in their financial status.

For example, in a simple model with collateral constraints (see Buera et al., 2015), productivity determines the optimal size of the firm, so productive firms with low assets relative to their debt (low wealth) are the ones further away from their optimal size, whereas low productive firms with low wealth are probably no too far from their optimal size and consequently not that financially constrained. To reveal the importance of financial frictions and collateral constraints, we need to see if the response of investment, labor, and sales of a highly leveraged firm (low-wealth firm) differs from the response of an equally productive firm, with the same optimal plan for investment, labor, and sales but with a low level of leverage (high-wealth firm).

In our empirical approach, we examine the impact of changes in aggregate GDP growth on firm-level decisions on investment, labor, and sales that we obtain from the administrative records provided by Chile's tax collection agency (*Servicio de Impuestos Internos* - SII). We leverage micro-level panel data to regress firm decisions on changes in aggregate GDP, following the methodology of Crouzet & Mehrotra (2020) while accounting for firm-level heterogeneity in both observed and unobserved factors. Our regressor of interest (changes in GDP) interacts with detailed information on the firm's age, firm's size (measured by the stock of assets), and firm's leverage (or firm's wealth), obtained from the firm's balance sheet, providing an observed measure of collateral constraints. Additionally, we control for firm unobserved heterogeneity by incorporating firm-fixed effects and estimates of unobserved firm-level productivity.

To achieve the latter, we adopt the methodology outlined in the industrial organization literature, estimating firm-level productivity through the estimation of firm-level production functions, drawing on the proxy variable approach presented in Levinsohn & Petrin (2003) and Ackerberg et al. (2015). The methodology uses a proxy variable approach to capture differences in unobserved firm productivity by examining differences in the demand for intermediate inputs (materials) across firms. The rationale behind this approach lies in the intuition that more productive firms should exhibit a higher demand for intermediate inputs, conditioned in the current stock of capital and labor. However, this relationship may not hold under financial frictions, where differences in financial access across firms can lead to differences in the demand for intermediate inputs, even among equally productive firms, as highlighted in Aguirre et al. (2021). Following the estimation method in Aguirre et al. (2021), we extend the approaches presented in Levinsohn & Petrin (2003) and Ackerberg et al. (2015) to incorporate the stock of wealth as an additional control in the production function estimation. The objective is to examine the conditional difference in input demand,

focusing on extracting disparities in firm productivity based on differences in input demand among firms with the same level of wealth and, consequently, the same level of collateral constraints.

Our findings reveal significant heterogeneity in how firms respond to changes in aggregate economic conditions. Smaller firms with equivalent productivity show higher sensitivity to overall economic activity than larger counterparts. Among the top decile of productivity, sales growth semi-elasticity is 2.0% for the bottom 90%, compared to 1.7% for the top 10%. Smaller firms also display greater cyclical sensitivity in employment growth and investment-to-capital ratio than larger ones. For the first decile, a 1% GDP increase leads to a 1.3% employment boost and a 0.21% rise in the investment rate, while the top decile sees a 1.0% workforce expansion and a 0.13% increase in the investment rate.

One potential explanation is that, for firms with the same level of productivity, those with smaller firms with low assets are further away from their optimal size. When a positive aggregate economic shock occurs, these small firms seize the opportunity to increase their investment, labor, and sales more than firms closer to their optimal size. This finding is consistent with the results of Crouzet & Mehrotra (2020). Interestingly, we observe that the relationship between the firm's response to aggregate shocks and size disappears when we control for a measure of the firm's financial status. Comparing firms with similar productivity and the same level of leverage (wealth), the contribution of assets to explaining the heterogeneous response disappears. This underscores the significance of financial frictions in explaining the diversity in responses to aggregate shocks. Consequently, when productivity and leverage are held constant, small and large Chilean firms display comparable sensitivity to economic cycles, indicating no inherent size effect.

Overall, financial frictions can contribute to explaining the correlation between firm size and cyclicality in emerging countries, particularly when accounting for productivity levels. Our findings challenge Crouzet & Mehrotra (2020) conclusions, highlighting the crucial influence of financial frictions, particularly in the context of developing economies like Chile. Our findings align with the prevalent perspective that financial constraints amplify the cyclical sensitivity of small firms, emphasizing the significance of countercyclical policies focused on bolstering credit for small businesses.

The outline of this paper is as follows. Section 2 details the methodology. Section 3 presents the empirical results. Section 5 concludes.

2 Methodology

In this section, we present the methodology for comparing the responses of small and larger firms in Chile to business cycles. When we refer to greater sensitivity, we refer to a scenario where deteriorating aggregate conditions consistently lead to more pronounced declines in sales, employment, and investment within a specific group of firms. Section 2.1 describes the data used in this study, and Section 2.2 details the regression analysis conducted.

2.1 Data

Our dataset comes from administrative records supplied by the Chilean Internal Revenue Service (Servicio de Impuestos Internos - SII) from 2008 to 2019. Covering all formal-sector firms and formal wage employment in Chile, each firm in this administrative repository is assigned a unique identifier by the SII, ensuring traceability over time while upholding data confidentiality and anonymity. This dataset encompasses firms (as opposed to plants) of all ages, sizes, and sectors. Specifically, we combine the information extracted from the monthly value-added tax registry F29, the annual income tax form F22, and the annual affidavit 1887.

We use the VAT registry from the tax authority to obtain firm-level data on monthly sales, expenditures on intermediate materials, investment, and the firm's economic sector. We extract from the form F22 annual figures for total assets, total liabilities, and a proxy for the capital stock ("immobile assets"). This enables building a net worth measure, defined as the difference between reported total assets and total liabilities. We deflate all the previous nominal values in Chilean Pesos using the CPI index published by the Central Bank of Chile. Integrating this information with affidavit 1887, which reports monthly details on individual workers employed by the firm, facilitates the calculation of a monthly employment measure.

In the data cleaning process, we exclude observations with zero or missing data for our capital proxy, assets, liabilities, sales, expenditures on intermediate inputs, investment, or employment. When data on capital is missing, we construct an annual capital measure using monthly investment information, assuming a 10% depreciation rate. The resulting dataset comprises 265,714 firms and 4,087,773 quarterly observations from 2008 to 2019.

Our dataset, including income statements and balance sheet data, stands out in the literature examining differences in cyclicality by firm size. While similar information is available in datasets like Compustat, Amadeus, and Orbis for various countries, our dataset's advantage lies in its coverage of firms of all ages, sectors, and sizes. This unique feature makes it particularly well-suited for studying the impact of financial frictions, especially in the context of developing economies.

Unlike datasets such as the World Bank's Enterprise Surveys, which also include firms of all sizes in developing countries, our dataset excels in tracking specific firms over consecutive years. Importantly, unlike the U.S. Census Bureau's Quarterly Financial Report, our database facilitates constructing a total factor productivity (TFP) measure, as detailed in Section 2.2, a critical aspect of our findings.

Table A.1 provides key firm characteristics by firm size deciles, ordered by total assets. Firms with greater assets are older and exhibit higher sales, larger employment, elevated leverage (proxied by the ratio of liabilities to assets), and enhanced productivity. Employment growth diminishes with size, while sales growth follows a U-shaped pattern with size, showcasing a descending relationship up to the sixth decile and an ascending relationship for larger firms.

2.2 Regression Analysis

Our analysis assesses the responsiveness of firm-level growth to aggregate economic conditions, classifying firms based on their size, using a regression analysis similar to that employed by Crouzet & Mehrotra (2020). We account for firm fixed effects, a metric indicative of the financial accelerator mechanism, and other relevant controls, conducting the following regression analysis:

$$g_{it} = \alpha_i + \sum_{j \in J} \big(\beta_j + \delta_j \Delta GDP_t\big) \mathbb{1}_{i \in S^j_{t-4}} + \sum_{k \in K} \big(\eta_k + \gamma_k \Delta GDP_t\big) \mathbb{1}_{i \in X^k_{t-4}} + \sum_{l \in L} \big(\rho_l + \theta_l \Delta GDP_t\big) \mathbb{1}_{i \in L^l_{t-4}} + \epsilon_{it} \tag{1}$$

where the index i ranges from 1 to 265,714, representing individual firms, while the time variable t spans from 2008Q1 to 2019Q4, denoting quarters. Deciles j, l, and k, with values of 1 to 10, signify classifications based on size, a measure of productivity that holds in the presence of financial frictions, and a measure that captures financial frictions, respectively. The regression incorporates firm fixed effects (α_i) and group fixed effects (β_j, η_k, and ρ_l). The variable ΔGDP_t represents the year-on-year growth rate of GDP, and δ_j captures the semi-elasticity of firm-level growth in response to GDP growth. Standard errors (ϵ_{it}) are clustered at the firm level.

The sets S^j_{t-4}, X^k_{t-4}, and L^l_{t-4} consist of firms arranged based on their initial size, productivity, and a measure that tests the financial accelerator mechanism four quarters prior. Our size classification relies on deciles of lagged asset distribution, addressing the cyclical reclassification issue emphasized

by Moscarini & Postel-Vinay (2012).[12] This consideration also applies to the categorization based on our financial frictions proxy and various additional controls.

Our analysis focuses on three alternative outcome variables, denoted as g_{it}: sales growth, employment growth, and the investment-to-capital ratio. For sales and employment growth, we use the average between $t-1$ and t as the base for the growth rate, a practice known to mitigate the mean reversion fallacy (Davis et al., 1996).[3] This measure is bounded between 2, indicating a firm's entry into the market, and -2, signaling an exit. This feature enables us to account for firm entry and exit impacts, expanding the analysis beyond the intensive margin as in Crouzet & Mehrotra (2020).

In contrast to the dataset utilized in Crouzet & Mehrotra (2020), our data allows us to control for various firm characteristics. We introduce the firm's age[4], total factor productivity (TFP),[5] and a proxy for leverage.

We adopt a methodology from the industrial organization literature, estimating firm-level productivity through firm-level production function estimations using the proxy variable approach delineated in Levinsohn & Petrin (2003) and Ackerberg et al. (2015). This proxy variable captures variations in unobserved firm productivity, specifically examining differences in the demand for intermediate inputs (materials) among firms. The underlying logic hinges on the expectation that, given the current stock of capital and labor, more productive firms should demonstrate higher demand for intermediate inputs. However, this relationship may not hold in the presence of financial frictions, where variations in financial access can lead to divergences in the demand for intermediate inputs among equally productive firms, as emphasized in Aguirre et al. (2021).

Following the estimation method in Aguirre et al. (2021), we extend the approaches presented in Levinsohn & Petrin (2003) and Ackerberg et al. (2015) by incorporating the stock of wealth as an additional control in the production function estimation.[6] The aim is to examine the conditional disparities in input demand, focusing on extracting differences in firm productivity based on

[1]Changes in classification criteria during the business cycle introduce bias, particularly during economic expansions. During such periods, a typical firm's size increases, mechanically placing more firms in the large category, though the specific identity of these firms changes over time.

[2]We employ three alternative measures of firm size S: assets, sales, and employment. To maintain stability within size groups, we employ all three ordering variables annually, even though information regarding employment and sales is accessible at a higher frequency.

[3]In the case of sales growth and employment growth, we calculate $g_{it} = \frac{y_{it}-y_{it-4}}{\frac{1}{2}y_{it}+\frac{1}{2}y_{it-4}}$

[4]Due to the absence of entry date information in our data, it is inferred from the first period the firm begins selling. With data availability starting in 2005, the age estimation is capped at 24 years, and we categorize firms into age groups of 1-6, 7-10, 11-15, and over 16 years old.

[5]The microdata employed in Crouzet & Mehrotra (2020) lacks employment information, precluding the measurement of productivity.

[6]We refrain from directly employing the methodology proposed by Aguirre et al. (2021), as it imposes numerous data restrictions that could limit our analyses and impede the breadth of our study.

variations in input demand among firms with equivalent wealth levels and, consequently, identical collateral constraints.

The resulting distribution of deciles of productivity exhibits a substantial cross-correlation with assets deciles (exceeding 80%, as demonstrated in Table 1), while the correlation with age is notably lower at 10%.

Table 1: Cross-correlation of Groups of Firm Characteristics

	Assets	Sales	Workers	Investment	Leverage	Productivity	Age
Assets	100						
Sales	81	100					
Workers	67	75	100				
Investment	27	28	26	100			
Leverage	43	21	23	8	100		
Productivity	83	81	62	28	-6	100	
Age	20	10	11	1	20	10	100

Notes: Statistics are cross-correlation between 2008Q1 to 2019Q4 of deciles of firms, measured in percentages. Further details regarding the data utilized can be found in Section 2.

Lastly, we introduce a proxy for leverage, defined as liabilities over assets, to capture the effect of the financial accelerator. Notably, among Chilean firms, leverage positively correlates with assets of 40%, contrary to the QFR data used by Crouzet & Mehrotra (2020), where both variables are negatively correlated. In our data, leverage does not correlate with our measure of productivity, as shown in Table 1).

We examine the role of financial frictions on firms' reactions to aggregate fluctuations by comparing the responsiveness of small and large firms to aggregate economic growth, captured by δ_j. The financial accelerator mechanism suggests that external funds for constrained firms should be more cyclical, leading to increased responsiveness in net borrowing during economic expansions and recessions. Therefore, we should find that small firms respond more to aggregate shocks than large ones when we do not account for leverage. However, firms with equivalent access to financing, proxied by their leverage, should be equally cyclically sensitive regardless of their size.

3 The Cyclical Sensitivity of Large and Small Firms

Section 3.1 presents evidence that supports a financial accelerator mechanism, where among equally productive firms, smaller Chilean firms' higher cyclicality than large ones is linked to access to financing. Section 3.2 highlights that the size effect found in Section 3.1 depends on accounting

for productivity.

3.1 Role of Financial Frictions

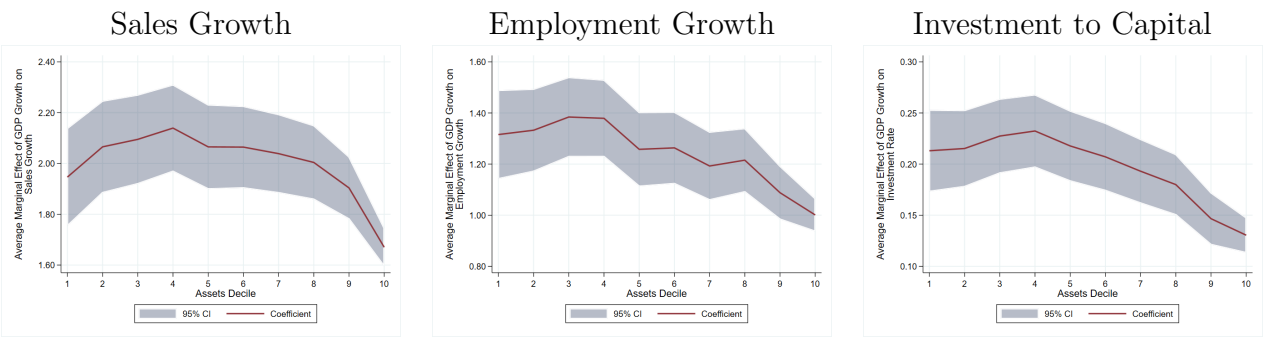
Figure 1 presents the semi-elasticity estimates of various firm-level outcomes to GDP growth after controlling for productivity (captured by δ_j coefficients in equation 1 but without accounting for leverage). The left panel depicts the sensitivity of sales growth, the middle panel represents the employment growth cyclicality, and the right panel showcases the investment-to-capital ratio sensibility. All three figures reveal a size effect that emerges when leverage is excluded from the analysis, indicating that smaller firms with equivalent productivity levels exhibit higher sensitivity to overall economic activity than larger counterparts.

In the left panel, among firms in the top decile of productivity, the semi-elasticity of sales growth is 2.0% for the bottom 90 percent, compared to 1.7% for the top decile. Notably, this size effect extends beyond the top decile when analyzing employment growth and the investment-to-capital ratio. Smaller firms consistently display greater cyclical sensitivity across the entire asset distribution. Specifically, a 1% increase in GDP leads to a 1.3% employment boost and a 0.21% rise in the investment rate for the first decile. In contrast, the top decile experiences a 1.0% workforce expansion and a 0.13% increase in the investment rate.

To ascertain if financial frictions contribute to this pattern, we investigate whether smaller firms exhibit higher cyclicality due to greater financial constraints. In times of economic expansion, small firms will take advantage of the more relaxed financial conditions to expand their size. If so, the size effect should vanish when controlling for productivity and leverage.

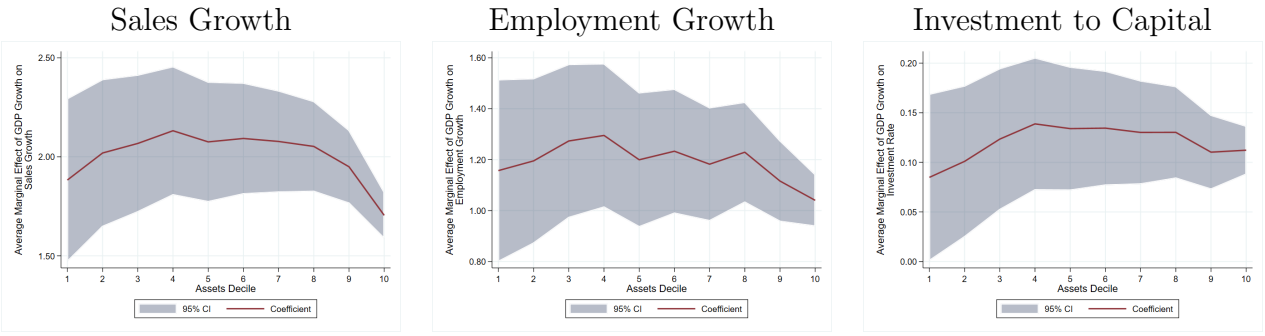
Figure 2 confirms this, indicating statistically insignificant differences in cyclicality between size groups for all three indicators. On average, a 1% increase in GDP corresponds to a 2.0% surge in sales, a 1.2% workforce expansion, and a 0.11% boost in the investment rate. Thus, both small and large enterprises exhibit comparable sensitivity to the economic cycle when considering firms with equivalent productivity and leverage.

Figure 1: Cyclicality by Assets Size Controlling for Productivity



Notes: Coefficients are displayed for the 10th decile based on productivity. Deciles of firms ordered based on the size of their initial assets four quarters ago. Further details regarding the data utilized can be found in Section 2.

Figure 2: Cyclicality by Assets Size Controlling for Productivity and Leverage



Notes: Coefficients are displayed for the 10th decile based on productivity with the highest leverage. Deciles of firms ordered based on the size of their initial assets four quarters ago. Further details regarding the data utilized can be found in Section 2.

Figures 1 and 2 show that the size effect among firms with equivalent productivity levels disappears when we control for a measure of the financial accelerator mechanism. Therefore, this evidence suggests that the observed difference in cyclicality between equally productive small and large Chilean firms is linked to access to financing.

Our findings contrast the one in Crouzet & Mehrotra (2020) that uses microdata from the U.S. Census Bureau's Quarterly Financial Report (QFR). Although their baseline regression shows evidence of a size effect in the top 1 percent of firms, none of the controls introduced by the authors to measure the financial frictions eliminate the difference in cyclicality between small and large firms.[7] Due to the confidential nature of their data, it remains challenging to ascertain

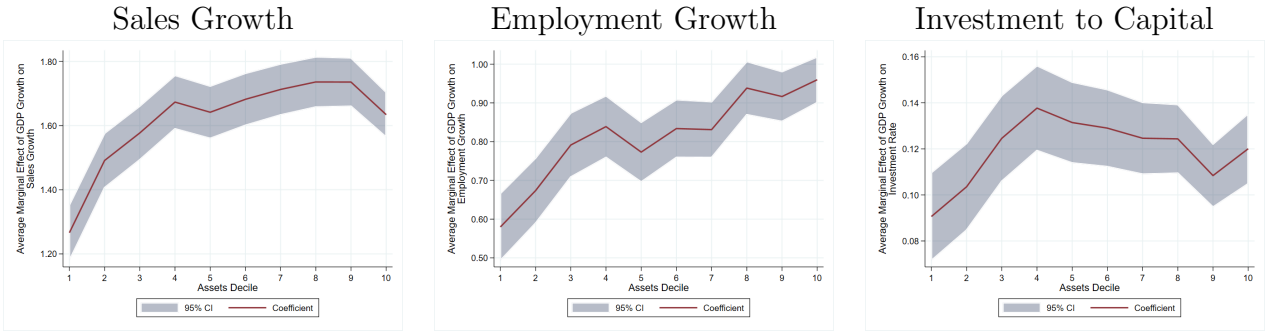
[7]As in this paper, Crouzet & Mehrotra (2020) control for the debt-to-asset ratio, a proxy for leverage. Additionally, they introduce four alternative measures of financial strength, obtaining the same result: share of bank debt in total debt (a proxy for bank dependence), cash-to-assets ratio (a proxy for liquidity), access to public debt markets, and dividend issuance.

whether the disparities stem from potential deficiencies in firm coverage, particularly the possible exclusion of smaller firms, or if they are inherent to the economic context under examination.

3.2 The Importance of Controlling for Productivity

This section shows that the results of the previous section depend on controlling for productivity. Figure 3 replicates the regression in Figure 1, but excluding a control for productivity. For all three outcome variables, the size effect undergoes a reversal, indicating that larger firms exhibit greater cyclic responsiveness than smaller ones. These figures contrast with the findings in Crouzet & Mehrotra (2020), where, based on the same regression analysis using U.S. QFR data, the top 1% of firms display lower cyclic sensitivity.

Figure 3: Cyclicality by Assets Decile Without Controlling for Productivity or Leverage



Notes: Deciles of firms ordered based on the size of their initial assets four quarters ago. Further details regarding the data utilized can be found in Section 2.

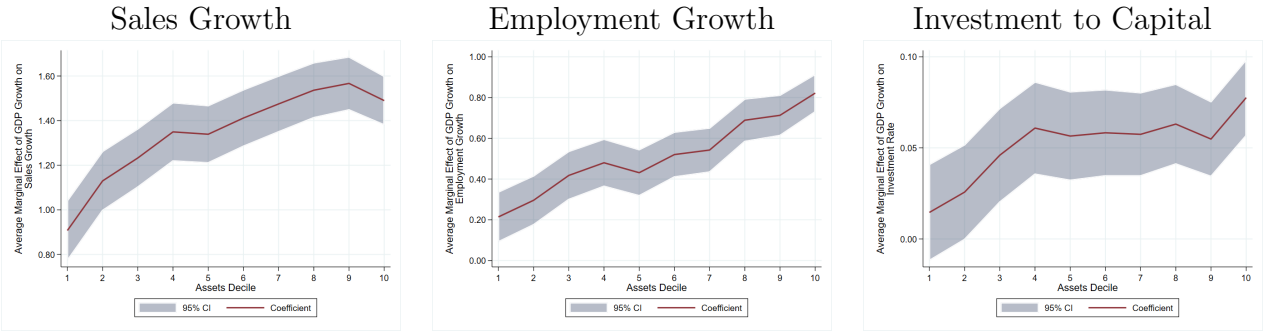
If financial frictions still have a role, then the heterogeneous effect on size would disappear after controlling for a measure of the financial accelerator mechanism. However, Figure 4 illustrates that excluding a control for productivity and controlling solely for leverage does not affect this puzzling relationship between cyclical responsiveness and size.

These results remain robust when employing alternative size measures such as annual sales and employment, as illustrated in Figures B.1 and B.2. When we focus on the effect on sales growth, this relationship persists even when accounting for the entry and exit of firms, as depicted in Figure B.3. Moreover, Figure B.4 illustrates that larger firms within key economic sectors, encompassing manufacturing, trade, construction, services, transportation, and agriculture, manifest a greater cyclically sensitive nature.[8] The findings hold even when controlling for age, leverage, and the

[8]These sectors collectively represent 80% of firms, 72% of employment, and 57% of GDP. Sectors not exhibiting this trend include mining, energy, finance, real estate, and public administration.

combination of both (Figure B.5). Therefore, larger firms consistently demonstrate a greater sensitivity to business cycles without introducing a control for productivity.

Figure 4: Cyclicality by Assets Size Controlling for Leverage



Notes: Coefficients are displayed for the 10th decile based on leverage. Deciles of firms ordered based on the size of their initial assets four quarters ago. Further details regarding the data utilized can be found in Section 2.

In the Chilean context, the size effect is reversed when productivity is not accounted for. Larger firms exhibit greater cyclical responsiveness than smaller ones. This puzzling relationship holds across various dimensions, including sectoral breakdowns, alternative size metrics, and considerations of different outcome variables, such as employment and investment.

Overall, these results highlight the relevance of accounting for firm productivity when assessing the impact of financial frictions. Ideally, we would like to compare two firms with identical profitability but differing financial statuses. In a model with collateral constraints, productivity determines the optimal firm size (Buera et al., 2015), with high-leverage, high-productive firms being farther from their optimal size, while high-leverage, low-productive firms are likely closer to their optimal size and less financially constrained.

4 Business Cycle and Financial Frictions

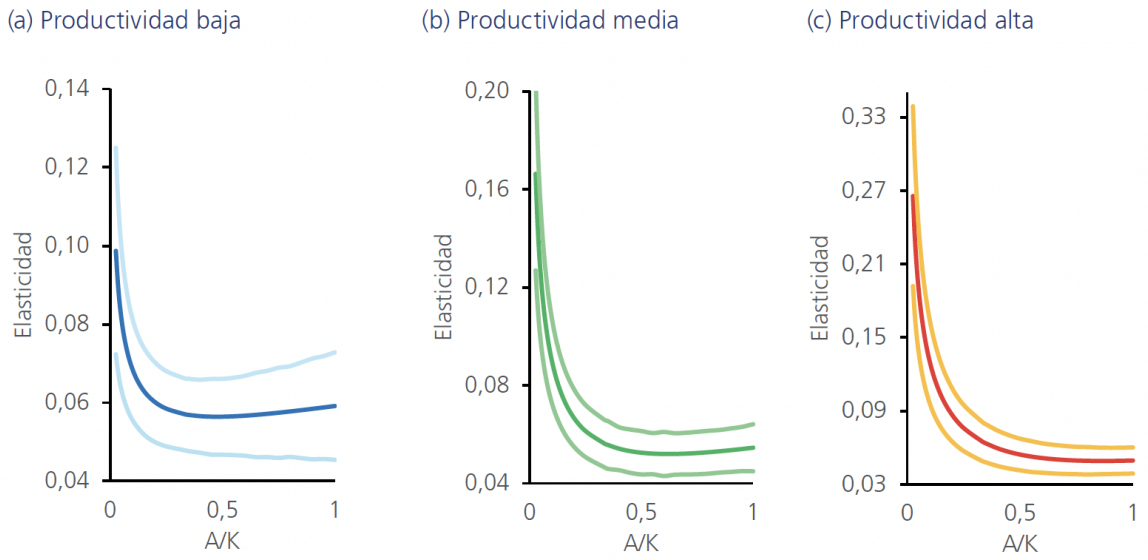
Section 3 showed that firms' investment is highly procyclical. This section analyzes how firms' investment decisions in response to the business cycle depend on their level of net assets—which, by serving as collateral, largely determines their access to financing—and on the type of shocks that generate aggregate fluctuations.

To address these questions, we estimate the response of investment by firms in the Chilean manufacturing sector for the period 2006–2016. We build on the empirical framework developed by

Aguirre et al. (2021), which introduces a methodology based on anonymized microdata to estimate firms' investment and saving reaction functions in the presence of financial frictions. We extend their work by incorporating fluctuations in GDP as a relevant variable for firms' decisions and by analyzing whether firms with different levels of productivity and financial assets react differently to the business cycle.

On the one hand, if a GDP expansion were not accompanied by an increase in the supply of credit, firms facing fewer financial constraints would be expected to be the most sensitive to the cycle, as they could increase investment in response to the demand growth generated by an expansionary cycle[9]. On the other hand, if an economic expansion were associated with an increase in the supply of credit, previously more constrained firms would be the most sensitive to the cycle, since they had been operating below their optimal level prior to the shock[10].

Figure 5: Investment elasticity to changes in GDP growth



Notes: The figure shows the marginal effect of GDP growth on investment for different values of firms' assets, defined as the ratio of net assets to capital (assuming fixed capital, so higher values of the ratio indicate higher levels of net assets). The estimated model is highly nonlinear; therefore, the figure reports marginal effects for three different levels of productivity (10th, 50th, and 90th percentiles).

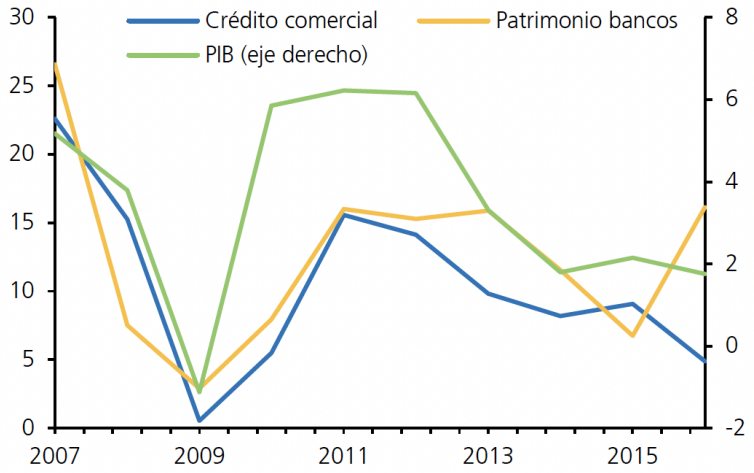
Figure 5 shows firms investment response to changes in GDP. The left, center, and right panels correspond to firms in the 10th, 50th, and 90th percentiles of the productivity distribution, respectively. The horizontal axis of each chart shows the distribution of firms' net assets. The figure shows that the investment response is greater among more productive firms (right panel)

[9]This demand effect operates in Ottonello & Winberry (2020) in the case of expansionary monetary policy shocks.

[10]This channel is present in Bernanke et al. (1999).

and among firms with lower levels of net assets (left side of the curves). This indicates that firms facing greater financial frictions (i.e., productive firms with few assets to pledge as collateral) are those that would benefit the most from a cyclical increase in GDP. This result suggests that, during the period under analysis, GDP fluctuations were accompanied by changes in the supply of credit.

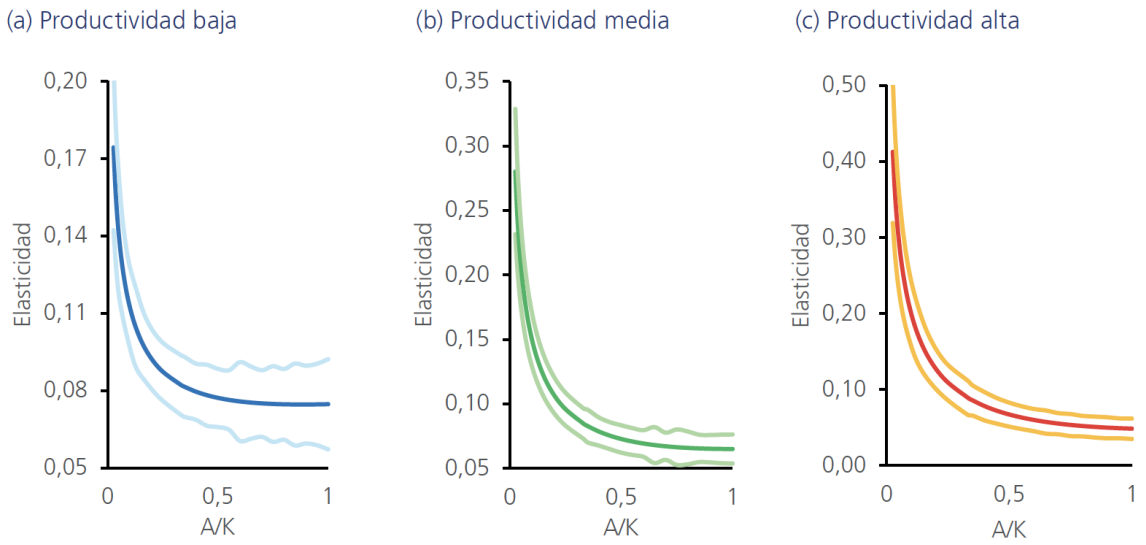
Figure 6: GDP growth, Commercial credit, and Banks' equity



Notes: The green line shows the annual growth rate of real GDP (right axis), the blue line shows the annual growth rate of commercial credit (left axis), and the yellow line shows the annual growth rate of banks' equity (left axis).

To examine the effects of the business cycle in greater detail, we study two distinct periods: (i) the one associated with the 2008–2009 global financial crisis, and (ii) another that excludes this event. As shown in Figure 6, the year 2009 was marked by a sharp decline in GDP, accompanied by a significant drop in the growth rate of commercial credit and banks' equity, suggesting that it was a recession associated with the global financial crisis, whose shock originated in the banking system. Numerous studies have used this episode to analyze the impact of banking-system shocks on firms (e.g., Paravisini et al. (2015); Paravisini et al. (2023); Gutierrez et al. (2023)). In the subsequent period (2010–2011), a rapid recovery is observed in GDP, commercial credit, and the banking sector's assets. The goal of this exercise is to compare firms' investment decisions during a period of GDP and credit-supply expansion with their investment decisions during a period of low GDP growth and scarce credit supply. It is crucial to control for shocks affecting the banking system.

Figure 7: Investment elasticity to changes in GDP growth (Financial crisis)

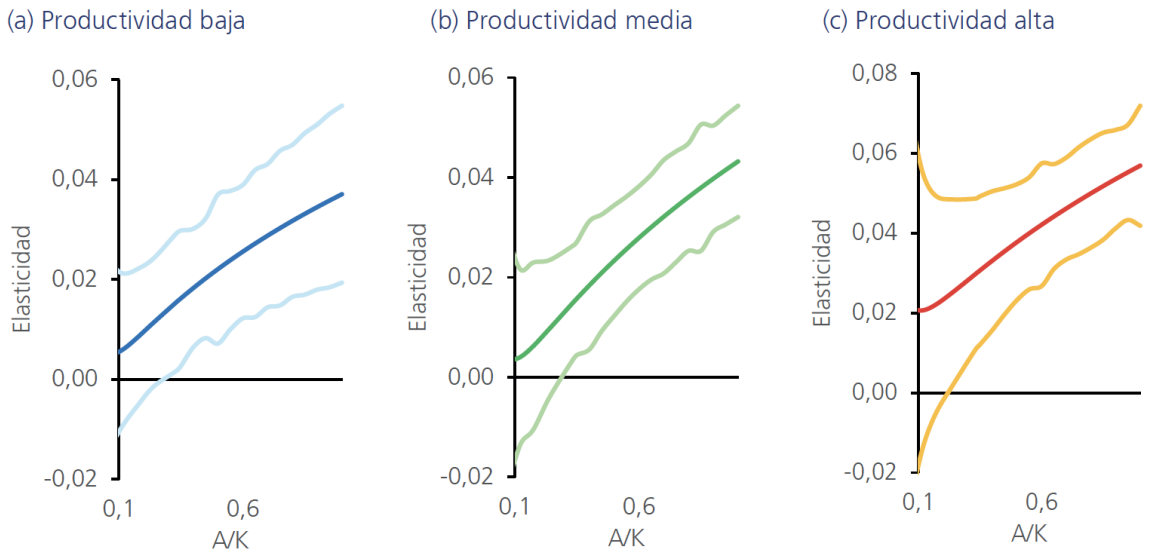


Notes: The figure shows the marginal effect of the GDP growth rate on investment for different values of firm assets, defined as the ratio of net assets to capital (with capital fixed, so higher values of the ratio indicate higher net asset values). The estimated model is highly nonlinear, so the figure reports marginal effects for three different productivity levels (10th, 50th, and 90th percentiles).

Figure 7 shows that during the global financial crisis the investment response to a decline in GDP is significantly larger for more productive firms with low levels of net assets. The elasticity of investment ranges from 0.4 for firms with a low net-assets-to-capital ratio to 0.05 for those with a high level of assets (right panel), consistent with the mechanism operating through the tightening of financial constraints following a reduction in credit supply during the global financial crisis.

Figure 8 presents the results excluding the period corresponding to the global financial crisis (2008–2009). In this case, the effect is different and more pronounced for firms facing fewer financial constraints. When business-cycle fluctuations are not accompanied by an adjustment in credit supply, investment among firms with low levels of net assets (highly leveraged firms) does not respond, whereas elasticity is positive for firms with higher asset levels, likely because their access to credit enables them to react to the increase in demand generated by GDP growth.

Figure 8: Investment elasticity to changes in GDP growth (excluding Financial crisis)



Notes: The figure shows the marginal effect of the GDP growth rate on investment for different values of firm assets, defined as the ratio of net assets to capital (with capital fixed, so higher values of the ratio indicate higher net asset values). The estimated model is highly nonlinear, so the figure reports the marginal effects for three different productivity levels (10th, 50th, and 90th percentiles).

5 Conclusions

This paper contributes novel insights into the cyclical behavior of small and large firms using a comprehensive firm-level census of Chilean businesses from 2008 to 2019. Our analysis investigates if financial frictions have a role in the heterogeneous responses of small and large firms' investment, labor, and sales in response to fluctuations in aggregate economic growth.

Our results show that smaller firms in Chile display higher cyclical responsiveness than larger counterparts with equivalent productivity. Among the top decile of productivity, a 1% GDP increase leads to a 2.0% increase in sales, 1.3% employment boost, and a 0.21% rise in the investment rate for the bottom assets decile. In contrast, the top assets decile sees a 1.7% rise in sales, a 1.0% workforce expansion, and a 0.13% increase in the investment rate.

After accounting for leverage, small and large Chilean firms exhibit comparable sensitivity to economic cycles when productivity and leverage are held constant, indicating no size effect. Therefore, controlling for a measure of the financial accelerator mechanism eliminates the size effect among equally productive firms, suggesting that the observed difference in cyclicality is linked to financing access, contradicting the findings in Crouzet & Mehrotra (2020).

However, in the Chilean context, the size effect reverses when excluding the control for productivity, with larger firms exhibiting greater cyclical responsiveness than smaller ones. This puzzling relationship holds across various dimensions, including sectoral breakdowns, alternative size metrics, considerations of different outcome variables, such as employment and investment, and after controlling for age and leverage, highlighting the relevance of accounting for firm productivity when assessing the impact of financial frictions.

Overall, this novel insight challenges Crouzet & Mehrotra (2020) conclusions and underscores the pivotal role of financial friction, especially in emerging countries like Chile. Financial frictions can contribute to explaining the correlation between firm size and cyclicality, particularly when accounting for productivity levels. Our results align with the prevailing view that financial constraints contribute to the greater cyclical sensitivity of small firms and emphasize the importance of countercyclical policies aimed at supporting credit for small businesses.

References

Ackerberg, D. A., Caves, K., & Frazer, G. (2015). Identification properties of recent production function estimators. *Econometrica*, *83*(6), 2411–2451.

Aguirre, A., Tapia, M., & Villacorta, L. (2021). *Production, Investment and Wealth Dynamics under Financial Frictions: An Empirical Investigation of the Selffinancing Channel* (Working Papers Central Bank of Chile No. 904). Central Bank of Chile.

Begenau, J., & Salomao, J. (2018). Firm Financing over the Business Cycle. *The Review of Financial Studies*, *32*(4), 1235-1274. doi: 10.1093/rfs/hhy099

Bernanke, B. S., Gertler, M., & Gilchrist, S. (1999). The financial accelerator in a quantitative business cycle framework. In J. B. Taylor & M. Woodford (Eds.), *Handbook of macroeconomics* (Vol. 1, pp. 1341–1393). Elsevier.

Buera, F. J., Kaboski, J. P., & Shin, Y. (2015). Entrepreneurship and financial frictions: A macro-development perspective. *Annual Review of Economics*.

Crouzet, N., & Mehrotra, N. R. (2020). Small and large firms over the business cycle. *American Economic Review*, *110*(11). doi: 10.1257/aer.20181499

Davis, S. J., Haltiwanger, J., & Schuh, S. (1996). Small business and job creation: Dissecting the myth and reassessing the facts. *Small Business Economics*, *8*(4), 297–315.

Gertler, M., & Gilchrist, S. (1994). Monetary policy, business cycles, and the behavior of small manufacturing firms. *Quarterly Journal of Economics*, *109*(2), 309 - 340.

Gutierrez, B., Villacorta, A., & Villacorta, L. (2023). *(unobserved) heterogeneity in the bank lending channel: Accounting for bank–firm interactions and specialization.* `https://ssrn.com/abstract=4608656`. (Available at SSRN 4608656)

Levinsohn, J., & Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. *The Review of Economic Studies*, *70*(2), 317–341.

Moscarini, G., & Postel-Vinay, F. (2012, May). The contribution of large and small employers to job creation in times of high and low unemployment. *American Economic Review*, *102*(6), 2509-39. doi: 10.1257/aer.102.6.2509

Ottonello, P., & Winberry, T. (2020). Financial heterogeneity and the investment channel of monetary policy. *Econometrica*, *88*(6), 2473-2502. doi: https://doi.org/10.3982/ECTA15949

Paravisini, D., Rappoport, V., & Schnabl, P. (2023). Specialization in bank lending: Evidence from exporting firms. *The Journal of Finance*, *78*(4), 2049–2085.

Paravisini, D., Rappoport, V., Schnabl, P., & Wolfenzon, D. (2015). Dissecting the effect of credit supply on trade: Evidence from matched credit–export data. *The Review of Economic Studies*, *82*(1), 333–359.

Appendix

A Descriptive Statistics

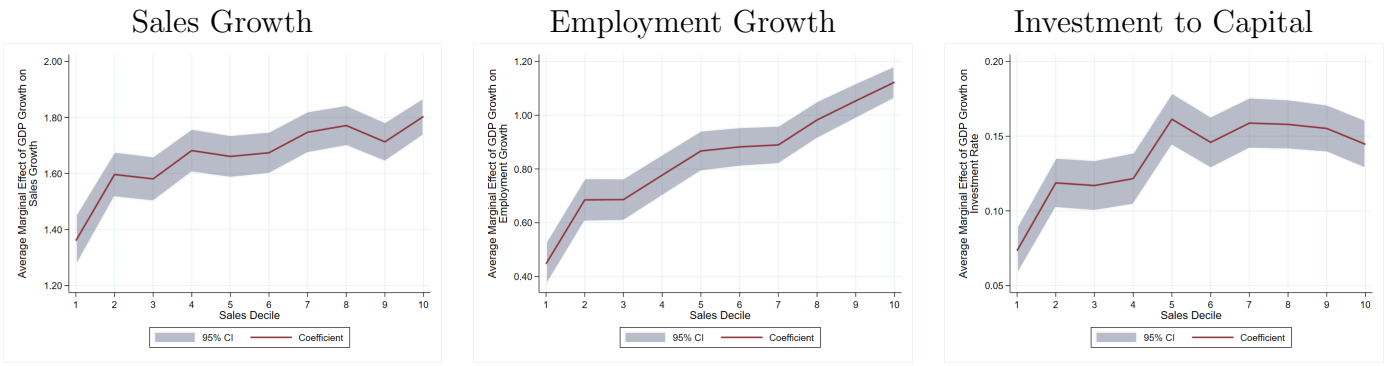
Table A.1: Firm Characteristics by Size Group

Size Group	d1	d2	d3	d4	d5	d6	d7	d8	d9	d10
Assets (millions $2018)	11	26	43	68	105	166	280	540	1370	186000
Sales (millions $2018)	41	76	114	170	223	310	454	739	1460	23400
Sales growth (%, year-on-year)	0.8	-0.6	-1.5	-2	-2.6	-3.0	-3.0	-2.7	-1.9	0.1
Employment (number workers)	2	3	4	5	7	9	12	19	34	190
Employment growth (% year-on-year)	4.9	4.7	4.3	4.4	3.7	3.0	2.6	2.3	2.0	2.1
Investment to Capital (%)	2.7	3.0	3.1	3.2	3.1	2.9	2.8	2.6	2.5	2.9
Leverage (%)	68	69	71	73	76	80	83	86	89	92
Productivity	8	13	16	20	24	28	34	44	64	167
Firm age (years)	10	10	10	11	11	11	11	12	13	14

Notes: All variables are averages from 2008Q1 to 2019Q4 within deciles of total assets. Nominal values are deflated by the CPI price index, normalized to 1 in 2018Q1 (Central Bank of Chile). Leverage is defined as the ratio of liabilities to assets. Further details regarding the data utilized can be found in Section 2.

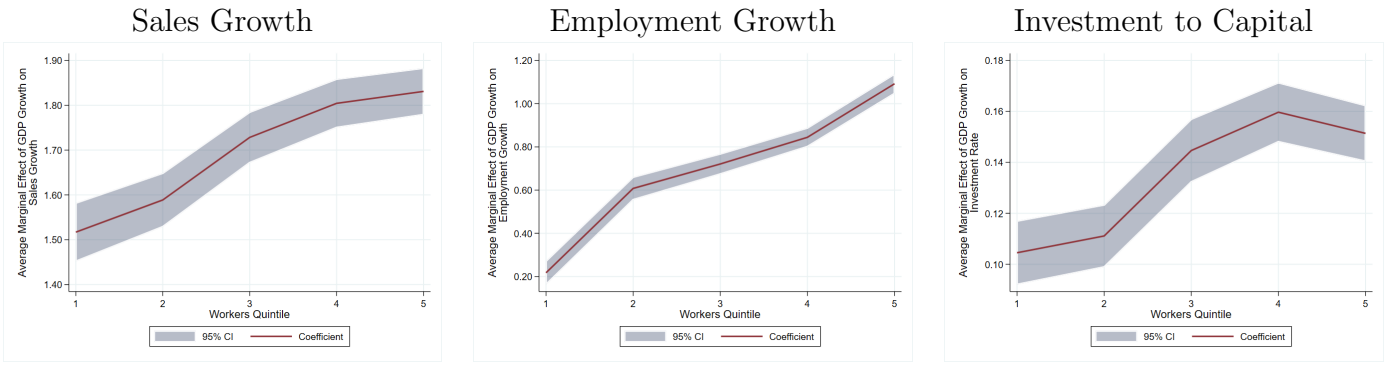
B Robustness Exercises Without Controlling for Productivity

Figure B.1: Cyclicality by Sales Size



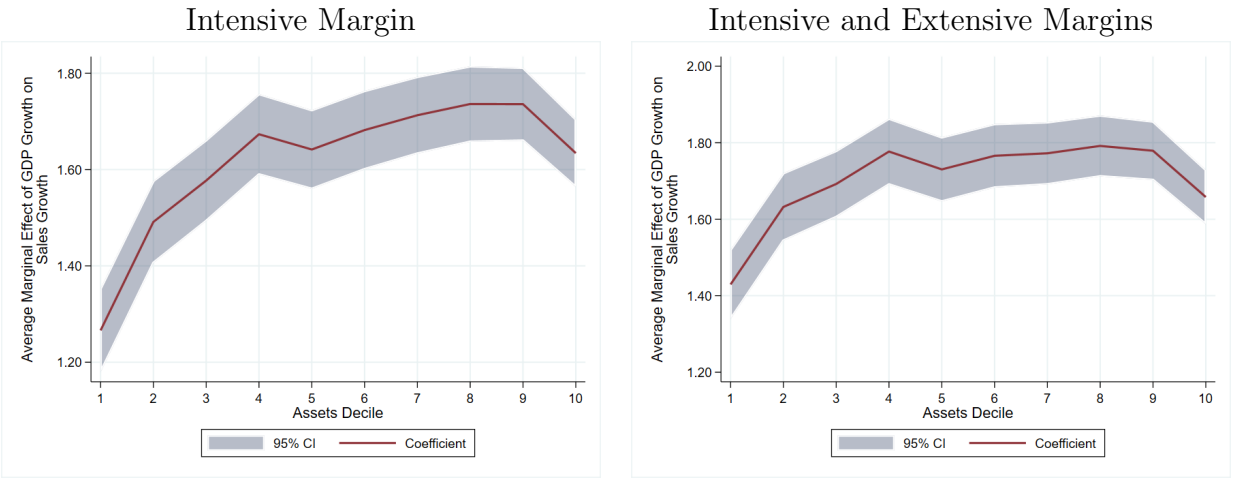
Notes: Deciles of firms ordered based on the size of their initial sales four quarters ago. Further details regarding the data utilized can be found in Section 2.

Figure B.2: Cyclicality by Employment Size



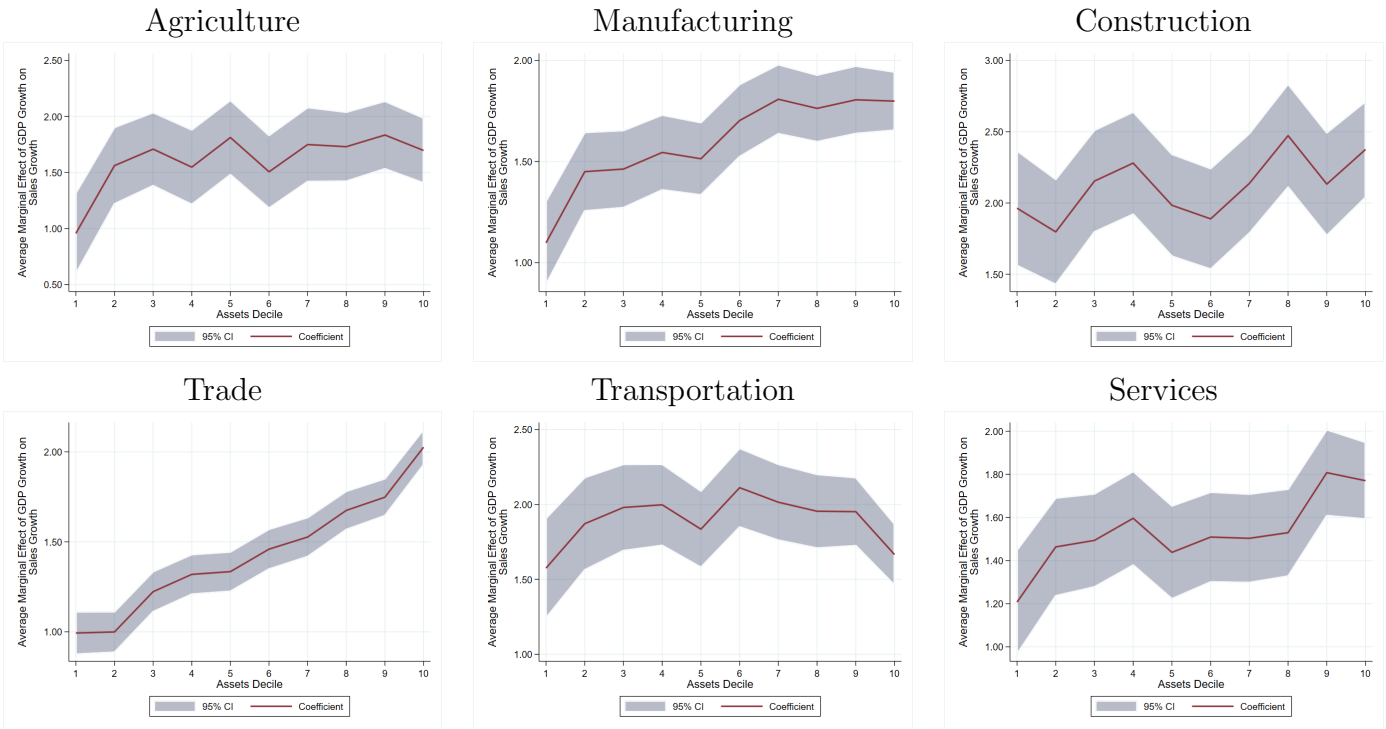
Notes: Quintiles of firms ordered based on the size of their initial employment four quarters ago. Further details regarding the data utilized can be found in Section 2.

Figure B.3: Sales Growth Cyclicality Including Entry and Exit of Firms



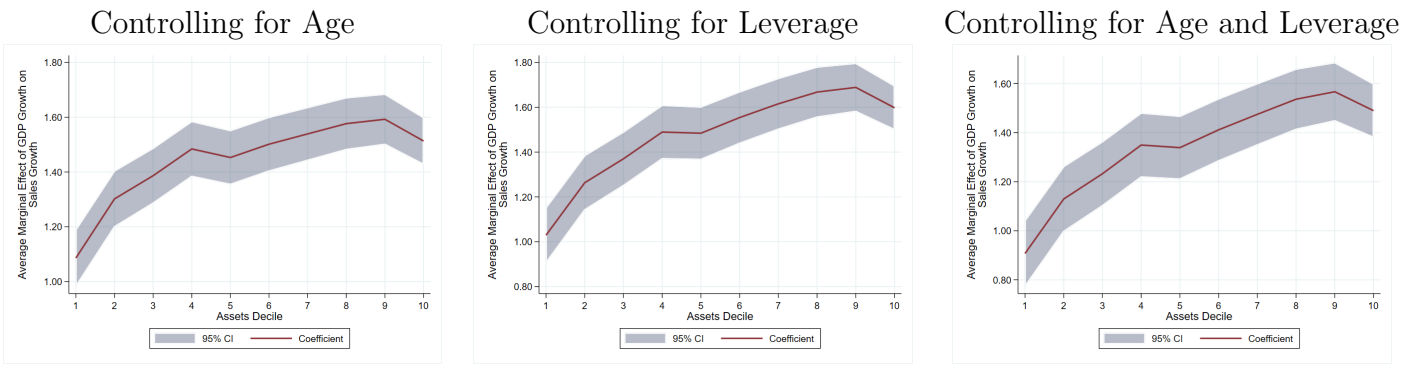
Notes: Deciles of firms ordered based on the size of their initial assets four quarters ago. Further details regarding the data utilized can be found in Section 2.

Figure B.4: Sales Growth Cyclicality for Different Sectors without Controlling for Productivity



Notes: Sectoral asset deciles were recalculated, considering only firms within the specific sector. Deciles of firms ordered based on the size of their initial assets four quarters ago. Further details regarding the data utilized can be found in Section 2.

Figure B.5: Sales Growth Cyclicality without Controlling for Productivity



Notes: Coefficients in the left panel are computed for the oldest category; the center panel presents coefficients calculated for the 10th decile based on leverage, while the right panel displays coefficients for the oldest category with the highest leverage. Further details regarding the data utilized can be found in Section 2.