Monetary Policy and Firm Dynamics: The Financial Channel*

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Abstract

We combine administrative firm-level data, information from credit records, and monetary policy surprises for Chile to estimate the impact of changes in the monetary policy (MP) interest rate on investment and employment, and document the role of financial factors in the transmission of monetary policy. We find support for the financial channel of monetary policy, showing that only firms with debt see their investment and employment affected by changes in MP. We show that firms with high leverage levels and larger fractions of overdue debt are less sensitive to monetary policy. We document the role of age and size as additional factors of heterogeneity in the transmission of monetary policy.

Keywords: monetary policy, financial frictions, employment, investment, firm heterogeneity.

JEL Codes: D22, D25, E22, E44, E52

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1 Introduction

Investment represents one of the main transmission channels of monetary policy. Recently, the availability of micro-level data has allowed the analysis of this channel at the firm level, as well as the study of the heterogeneity of their response, with evidence on the role of variables such as age, size, industry, as well as financial factors such as the availability of credit to the firm, liquidity, and the level of leverage.[1]

The findings exploiting firm-level data are important to understand the effects of monetary policy for different reasons. Caglio et al. (2021), for example, argue that the effects of monetary policy may depend on the size distribution of firms and the type of collateral used. Relatedly, a growing literature argues that monetary policy is less effective in recessions, Ottonello and Winberry (2020) suggest that changes in the distribution of default risk at the firm level is one mechanism that contributes to explaining why monetary policy may become less effective in these contexts.

In this paper we combine firm-level data for Chile, using administrative firm tax information from the Internal Revenue Service (SII for its acronym in Spanish), with credit records from the Financial Market Commission (CMF for its acronym in Spanish) for the period 2009 to 2019. We exploit monetary policy surprises (MPS) drawing on our earlier work (Aruoba et al., 2021), to estimate the impact of changes in the monetary policy interest rate on employment and investment at the firm level. Most of the existing related empirical literature analyzes data of public (listed) firms, while our data allows us to study the quasi-universe of firms in Chile. This is relevant since public firms are typically considered to be less financially constrained, and we show that they react differently to changes in monetary policy.[2] Additionally, we find evidence in favor of the financial transmission channel of monetary policy by comparing the results for firms depending on their access to credit.

We document the following main results. First, we estimate the average firm level effect of

[1]A review of the literature is provided below.

[2]Caglio et al. (2021) show that monetary policy transmission and risk-taking differ across private firms and large listed firms.

monetary policy on investment and employment. Second, we document evidence supporting the financial channel of monetary policy, showing that only firms with financial access see their investment and employment affected by changes in monetary policy. Third, we study the role of leverage, and show that firms that are above their average leverage are less sensitive to monetary policy, which is consistent with the finding of Ottonello and Winberry (2020) for public firms in the U.S. Fourth, we show that firms with a higher fraction of debt overdue with respect to their historical averages are less sensitive to monetary policy. Finally, we explore age and size, which represent key dimensions of heterogeneity for firm-level responses. We find that young and middle aged firms react to monetary policy while older firms do not exhibit a significant response. In terms of the role of size, we find that medium sized firms are the ones that drive the investment response. This could be explained by the fact that smaller firms are less likely to have access to credit while large firms may have other sources of funding, or they may already by operating close to their efficient scale.

The rest of this paper is organized as follows. We complete this section with a review of the literature, with an emphasis on empirical work exploiting firm level data to analyze the effects of monetary policy on investment, employment, and firm finance. Section 2 describes the firm-level data, and the construction of the series of monetary policy surprises. Section 3 presents the empirical analysis, describing the methodology and discussing the main results. Finally, Section 4 describes future work.

1.1 Literature Review

This study is related to several strands of the literature. In the first place, it is related to growing empirical work exploiting firm level data to analyze the effects of monetary policy on investment, employment, and firm finance. Various mechanisms and financial frictions have been explored, we dedicate most of this section to a brief overview of this specific literature. Second, and more broadly, the evidence documented in this paper is connected to the empirical literature that studies the heterogeneous response of firms to business cycle fluctuations (e.g. Bernanke et al., 1996; Crouzet and Mehrotra, 2020). Third, it is related to work exploiting monetary policy surprises to analyze the effects of monetary policy. The extraction of exogenous variation in monetary policy is not trivial,[3] the approach employed here follows Gertler and Karadi (2015), Jarociński and Karadi (2020), and draws on our previous work in Aruoba et al. (2021), in using high-frequency surprises around policy announcements as external instruments in order to identify monetary policy shocks. Specifically, Aruoba et al. (2021) compute monetary policy surprises in Chile and employ these surprises as input in a Bayesian VAR analysis to estimate the effects of monetary policy. Finally, it connects to a literature analyzing the role of working capital constraints in shaping business cycles in emerging economies (Neumeyer and Perri, 2005; Uribe and Yue, 2006; Meza et al., 2019; Mendoza and Yue, 2012).

In general, theory is ambiguous with respect to how financial constraints at the firm-level shape the response of investment with respect to monetary policy. Financial frictions imply that firms face an upward-sloping marginal cost curve for investment, which dampens the response to monetary policy more intensely for firms that are more constrained by these frictions (e.g., Ottonello and Winberry, 2020). Alternatively, more constrained firms may be more sensitive to the financial accelerator channel, under which a monetary policy shock affects cash flows and collateral values that translates into shifts in the marginal cost of investment curve (Bernanke and Gertler, 1995; Anderson and Cesa-Bianchi, 2020).

Most work in the literature has exploited data of publicly listed firms. Cloyne et al. (2018) provide evidence of how monetary policy affects investment and finance for public firms in the U.S. and the U.K. They emphasize the age of firms as a robust predictor of heterogeneity in the response of investment: younger firms make the largest and most significant adjustments. They argue that this is consistent with a balance sheet channel of monetary policy, the external finance of young firms is mostly exposed to asset value fluctuations. Also exploiting a panel of publicly listed U.S. firms, Ottonello and Winberry (2020) find that firms with

[3] A more extensive review of the literature on the different methodologies employed is presented in Aruoba et al. (2021).

low default risk (low debt burdens and high *distance to default*) are most responsive to monetary policy. They interpret these results through the lens of a model that includes the possibility of default, where low risk firms face a flatter marginal cost curve for financing investment. Lakdawala and Moreland (2019) find evidence that firms with high leverage were less responsive to monetary policy shocks before the Global Financial Crisis of 2007-2009, consistent with Ottonello and Winberry (2020), but have become more responsive since. Ippolito et al. (2018) study the role of floating rates, and show that firms with more unhedged loans display a stronger sensitivity to monetary policy, showing a channel that works through existing loans. Anderson and Cesa-Bianchi (2020) document that firms with high leverage experience a more pronounced increase in credit spreads after monetary policy tightening, and a sharper contraction in investment and debt. Jeenas (2019a,b) emphasizes the role of balance sheet liquidity, as opposed to leverage, considering that fixed costs of debt issuance will lead to firms that do not face a binding borrowing constraint but exhibit high marginal propensity to invest out of liquid income.

Bahaj et al. (2019) exploit a near-representative sample of firms in the U.K. with annual data (covering both listed and non-listed firms across all industries), focusing on the effects of monetary policy on employment. They use information on the use of housing collateral, which is particularly relevant for small and medium-sized firms, and corporate debt. They find that younger and more levered firms that are exposed to fluctuations in the value of housing collateral adjust employment the most with changes in monetary policy. In related work, Yu (2021) presents additional empirical evidence for 24 states of the U.S., exploiting a dataset with comprehensive coverage and quarterly frequency, the Longitudinal Employer-Household Dynamics of the Census Bureau. In line with previous studies, she finds that the employment of younger and smaller firms responds more to monetary policy shocks than that of older and larger firms, and argues that smaller firms are more dependent on mortgage debt collateralized against housing values which respond to interest rate fluctuations. Ferrando et al. (2020) combine a large annual dataset from Orbis provided by Bureau van Dijk for large euro area economies (Germany, France, Italy and Spain),[4] and show that young firms and those producing durable goods are more sensitive to monetary policy shocks. Gaiotti and Generale (2002) use annual data for Italian firms and find that monetary policy has a stronger effect on smaller firms, firms that have a larger share of assets that cannot be used as collateral, and firms with less liquidity. Albrizio et al. (2021) use yearly data from a comprehensive business registry dataset for Spain, they emphasize that an unexpected monetary policy easing generates the largest reaction in firms with high marginal revenue product of capital, suggesting that financial frictions are a driving mechanism.

There is work in the literature that focuses on loan information. Caglio et al. (2021) use administrative firm-bank-loan data from the U.S., and show that when monetary policy is expansionary credit demanded by private firms (SMEs) with high leverage increases more. Jiménez et al. (2012) use a comprehensive loan-level dataset for Spain and show that higher short-term interest rates reduce loan granting, establishing and quantifying the bank lending channel of monetary policy for this economy. Examining the access of firms to bank and market finance, Bougheas et al. (2006) conduct an empirical analysis on a panel of manufacturing firms in the UK and find that small, young and risky firms are more significantly affected by tight monetary conditions than large, old and secure firms.

2 Data

We combine information on monthly monetary policy surprises with monthly firm level data. In this section we describe each of these two dataset.

2.1 Monetary Policy Surprises

Our measure of monetary policy surprises (MPS) draws on our earlier work (Aruoba et.al, 2021) which conducted a comparative analysis of monetary policy surprises in Chile obtained

[4]A feature of the dataset is that firms close their accounts at different months during the year, which is exploited by the authors.

from alternative sources, including three surveys as well as swaps on monetary policy rates. As argued in that work, the most suitable source for deriving MPS is the Bloomberg survey, for it allows to construct a long sample that consistently measures expectations for every monetary policy meeting since 2001.

Ideally, when identifying survey-based monetary policy surprises, one would require that the window of time between the moment market expectations are measured and a monetary policy decision is taken is as narrow as possible. In practice, however, most surveys do exhibit long and varying windows. In Aruoba et.al (2021) we document how this is also the case for most surveys in Chile. An important exception is the Bloomberg survey, which allows respondents to freely update their expectations as many times as needed, up until a few hours before the monetary policy decision is taken, making it the most suitable source to compute MPS.[5]

Formally, a monetary policy surprise for a policy meeting at time t is calculated as follows

$$MPS_t = MPR_t - MPR_t^e \tag{1}$$

where, MPR_t is the level of the monetary policy rate decided in a Monetary Policy Meeting in t, and MPR_t^e corresponds to the median expectation of respondents in the Bloomberg survey regarding the monetary policy decision in t collected right before each monetary policy meeting.

The Bloomberg survey asks economic departments and market analysis firms –including their domestic and international clients– about their expectations for the MPR. This survey allows us to retrieve information from 2001 to 2020, with a median of 19 participants per meeting. With a total of 215 monetary policy meetings in which we can observe expectations, this survey covers the most extended period available.[6] Bloomberg presents participants'

[5]Swap data can in principle be implemented with a much narrower time window, but such markets are not sufficiently liquid in Chile and/or prices may not be consistently collected in one market, as argued in Aruoba et al. (2021). Thus, noise may affect the measurement of monetary policy surprises. An additional caveat associated to swap data is its limited time coverage.

[6]Another survey carried our by the Central Bank of Chile also extends since early 2000s, yet it is not

answers publicly under the institution's name or institution/researcher name. According to Bloomberg's experts, most large companies use only the institutional name, intending to preserve their forecast history, which is used to rank them according to their accuracy level. Based on these conditions, we expect to have up-to-date responses from participants on each round of the survey.

The survey data collection period corresponds to the two weeks prior to the monetary policy meeting. During these weeks and until 5:00 p.m. of the day of the meeting, participants can update their responses, and the platform records the exact date on which this happened. The monetary policy decisions are usually revealed at 6:00pm. This characteristic of the protocol lets us assume that respondents make their best forecast with the most updated information available. An analysis of Bloomberg's microdata lets us verify that answers are usually concentrated in the last week of the surveyed period and forecast delivery/updates are observed until the last possible day (see Aruoba et al., 2021).

Figure 1 presents the time series of monetary policy surprises computed. Out of the 215 MP meetings analyzed, 35 have displayed MPS that are different from zero, with 11 (24) positive (negative) surprises of 23 (-41) basis points, on average. Some episodes stand out in which a monetary policy decision constituted a clear surprise for the market. The first is on March 13, 2009 when the monetary policy rate was cut by 250 basis points responding to the unfolding of the financial crisis. On June 7, 2019, the Central Bank of Chile reduced the monetary policy interest rate by 50 basis points after updating some key structural parameters in its monetary policy framework which yielded a greater potential and trend growth. In summary, we use 15 MPS between 2009 and 2019 in our analysis.

2.2 Firm-level Data

Our firm-level information is obtained by combining firm tax forms with their credit records from 2009 to 2019. We benefit from an effort undertaken by the CBCh in creating and

collected the day of the monetary policy meeting.

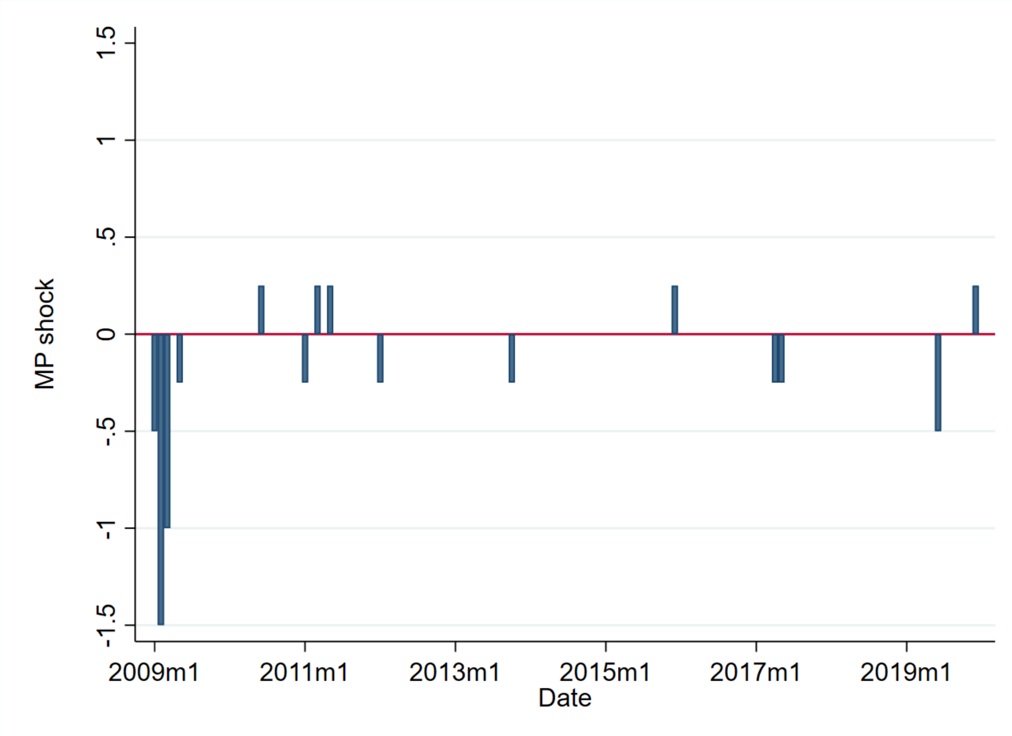


Figure 1: Times series of the 15 MPS between 2009 and 2019.

maintaining a repository with anonymized administrative datasets on the Chilean economy from various governmental agencies for economic policy and research. For the particular empirical analysis in our work we use tax records and the credit registry for the universe of firms. We describe each dataset next.

Firm Tax Records. We draw firm characteristics and outcome variables from the Internal Revenue Service (SII for its acronym in Spanish). The SII collects information from the universe of firms in Chile at both monthly and annual frequencies. Sales and investment (purchases of equipment and machinery) are reported monthly. Employment (headcount) is also reported at a monthly frequency. Firm balance sheet information on total assets is reported once a year. SII also has a directory of firms, which has the formal registration of every firm, from which we obtain the firm age and its 3-digit industry.

From this dataset we build two main variables at the firm level, that will be the subject of analysis in the next section: investment and employment growth. Our measure of investment is i_{jt}, which is the reported purchases of equipment and machinery of firm j at month t. We then normalize it by the value of total assets.[7] In the local projections exercises that we do in the next section, we accumulate the normalized investment over the horizon of the projection: $\sum_{i=t}^{h} \log\left(\frac{i_{jt+h}}{A_{jt+h}}\right)$.[8] Our measure for employment growth is $\log L_{jt+h} - \log L_{jt}$, which is the difference of the reported level of employment growth between two periods of interest. We also use monthly total sales and firm age as controls in our analysis.

Firm Financial Data. We obtain firms' domestic liabilities (loan and bonds) from the Financial Market Commission (CMF for its acronym in Spanish). The CMF compiles an anonymized credit registry with the mandatory monthly reports from every financial institution in Chile with the stock of outstanding debt that a firm has. This registry contains the type of debt, the current debt balance and the amount of deteriorated debt or "bad debt." The latter is the debt amount that the firm has already defaulted on the creditor, or the expected default expected by the financial institution for a particular firm. It also includes loans that are 90 days behind repayment, the refinancing of loans that are 60 days behind, or loans that have been subject to forced restructuring or partial forgiveness. Last, we add to this information a compilation of publications on corporate bonds by firms also from the CMF, which contains the issuance and repayment of the bonds, which allows us to calculate the monthly outstanding amount.

We use two measures of firm's financial position to proxy for credit access. First, we measure leverage as the firm's debt-to-asset ratio, where debt is the sum of the stock of current bank debt, the deteriorated bank debt, and the future repayment of existing bonds.[9] Second, we measure firms' repayment capacity as the ratio of deteriorated debt to total debt.

We merge these datasets using unique tax IDs of the firms that are common across sources. We impose the following filters to ensure that we have regular firms in our sample. We restrict our sample to firms that invest at least twice in the sample, have at least 3

[7] Total assets are reported annually, so we update this value every December for each firm.

[8] This is proportional to $\log k_{jt+h} - \log k_{jt}$ as used in the literature. In Appendix B, we show the derivation.

[9] The stock of assets considered here is, again, total assets, obtained from annual tax forms.

employees, have regular monthly reporting,[10] and report total assets in the annual form. Also we exclude firms in two industries, utilities and public administration. Table 1 presents simple summary statistics of the final sample used in our analysis. We winsorize our sample at the top and bottom 0.5% in order to ensure our results are not driven by outliers.

Table 1: Summary Statistics of Firm-Level Variables

	Mean	Median	S.D.	95th Perc.
Sales*	323.6	42.5	1307.7	1142.0
Capital stock*	941.3	26.7	25999.8	1223.8
Total assets*	7666.3	434.3	41057.2	22033.7
Investment*	4.8	0	29.8	13.5
Age	11.5	10	7.1	24
Nº employees	57.6	14	165.1	230
Normal debt stock*	509.1	15.5	2351.2	1837.9
Domestic bond stock*	268.8	0	10560.6	0
Bad debt stock*	2.8	0	24.3	0
Total debt*	512.0	17.3	2352.0	1843.5
Sale-asset ratio	0.2	0.1	0.3	0.6
Leverage ratio	0.2	0.1	0.3	0.7
Bad debt ratio	0.0	0	0.1	0
Nº firms	57459			
Observations	4718460			

Summary statistics of firm-level variables for the period 2009m1 to 2019m12. The values shown in the table have already being winsorized at the top and bottom 0.5%. *All currency related variables in million chilean pesos (CLP).

Table 1 shows presents simple summary statistics of the complete sample used in our analysis. We have 57,459 unique firms and about 4.7 millions firm-month observations. Investment is lumpy, most firms do not purchase equipment and machinery every month, only 20.6% of our observation reports positive monthly investment. 75% of our observations have debt and 91% of firms have debt at some periods. Only 3% of our observations have bad debt, but these include about 20% of our firms. In some of our analysis, we restrict our sample to a subset of observations that have debt, to reduce the noise from the firms-month

[10]Firms must have reported at least 12 consecutive months and must have reported at least 75% of the entire sample. Also, we exclude monthly observations in which a firm reports no sales.

observation that do not have debt.[11].

3 Empirical Analysis

The widespread textbook macroeconomics mantra on monetary policy based on simple IS-LM models can be summarized as follows: contractions in the monetary base trigger outright movements on the LM curve and a higher real interest rate; because investment is negatively affected by interest rates, the monetary contraction triggers a decrease in investment and therefore a contraction in GDP. Moreover, because of the lumpy nature of investment, we typically assume this transmission to take between 1 and 2 years to fully materialize. Despite the widespread nature of this mantra, there is little causal firm level evidence supporting this transmission mechanism. Moreover, this channel assumes that the interest rate is the relevant cost of funds for every firm in the economy. The advances in empirical macroeconomics have shown that firms are heterogeneous in their reliance on financial markets. Moreover, in a small open economy, not every firm relies exclusively on the domestic financial market. In this section we use monetary surprises and monthly firm level data to provide causal evidence for the financial transmission of monetary policy.

We estimate dynamic firm level responses in investment and labor using a panel local projection (Jordà, 2005) methodology. Our unique database improve upon the literature in at least three dimensions. First, we use monthly frequency data. The lowest frequency in the literature uses quarterly frequency data. Because central banks meet at least once a quarter, the identification from quarterly data is extremely imperfect. Second, we have the universe of firms in the Chilean economy while most of the literature only uses large public firms. Third, our panel has not only investment and financial variables, but also employment. Therefore, we can directly study if monetary policy has also an effect in the labor dynamics of firms. In fact, if firms use working capital loans to pay monthly wages (Neumeyer and Perri, 2005; Uribe and Yue, 2006), then we should also see a financial channel

[11] In Appendix C, we also show the summary statistics for this subset of observations.

affecting employment dynamics after monetary policy surprises.

3.1 The Dynamic Effect of Monetary Policy

We first study the average firm level effect of monetary policy. In particular, we propose the following empirical model:

$$y_{jt+h} = \alpha_j + \alpha_{sq} + \beta_1 \varepsilon_t + \beta_x X_{jt} + \epsilon_{jt+h}, \tag{2}$$

where the dependant variables y_{jt} can be either cumulated investment $\sum_{i=t}^{h} \log\left(\frac{i_{jt+h}}{A_{jt+h}}\right)$ or employment growth ($\log L_{jt+h} - \log L_{jt}$). The index $h \geq 1$ denotes the forecasting horizon of the local projection. We include firm fixed effects denoted by α_j and industry-quarter fixed effects (α_{sq}) that control for any industry specific shock with quarterly dynamics. The main coefficient of interest is β_1 as it shows, for every horizon, the effect of the monetary surprise (ε_t) on the dependent variable. We also include firm level controls that determine firm dynamics, in particular, X_{jt} includes size (employment), age, sales-to-asset ratio, leverage (total debt-to-asset ratio), and the bad-debt ratio. When studying changes in employment dynamics we omit the size control. Consistent with the literature, we use a double cluster for standard errors at the firm and industry-quarter level.

Figure 2 plots the coefficient of interest β_1 at different horizons with 90% confidence bands for the investment and employment regressions. Consistent with the textbook wisdom, Panel 2a shows that investment to assets responds negatively when monetary policy tightens. In fact, the dynamic response becomes significant at 11 months and stabilizes after 24 months. The magnitude of the coefficient can be interpreted as 100 basis points decrease in a MPS leading to an increase of accumulated investment as a ratio of total assets of between 0.1% to 0.2%.[12] Therefore, we find direct evidence supporting a significant effect of monetary

[12] Our investment variable only considers equipment and machinery as the monthly data does not include property purchases. Recall that we normalize investment by total asset (See Appendix B). Using the perpetual inventory method for the stock of machinery and equipment we get an asset to capital stock ratio of 17.7. Therefore, the estimated effect at 24 months of 0.18%, becomes a decrease in the stock of machinery

policy on investment at the 1 to 2 years window. Panel 2b shows the equivalent figure for employment dynamics. Although the estimate is always negative, the confidence bands do not show systematic significance. We can directly interpret these coefficients as the response of employment growth to the MPS. For example, the estimated effect of a 100 basis points decrease in a MPS, leads to 1% increase in the employment growth after 24 months.[13]

3.2 The Financial Channel of Monetary Policy

The basic transmission mechanism always alludes to the domestic interest rate being the relevant cost of investment. In this sense, the usual narrative assumes a financial transmission channel for monetary policy. Given the richness of our data we can directly study the nature of the transmission channel that links monetary surprises and firm dynamics. In fact, if the transmission is financial in nature, we should expect that the responses from Figure 2 are mainly driven by firms with debt. To explore this hypothesis we modify Equation (2) to distinguish between firms with and without debt, in particular:

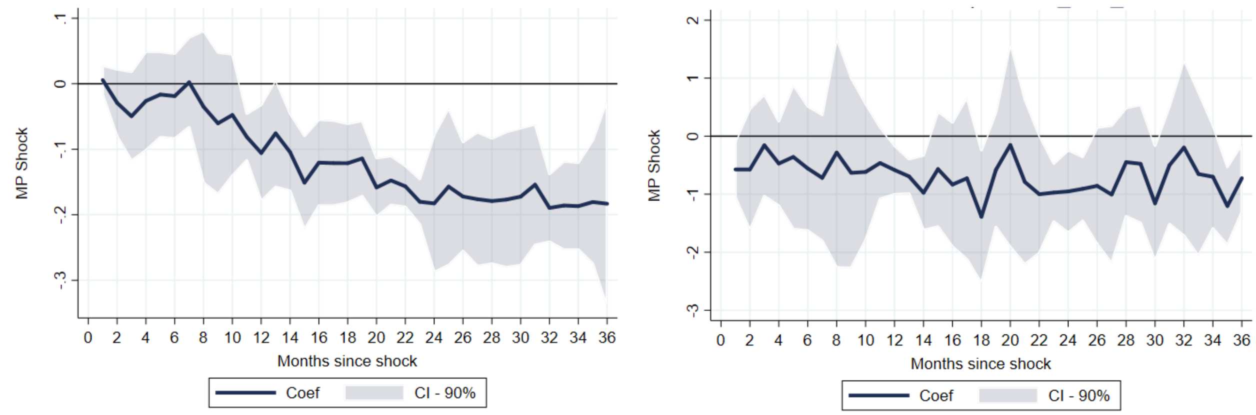
$$y_{jt+h} = \alpha_j + \alpha_{sq} + \beta_1 \varepsilon_t + \beta_x X_{jt} + \beta_2 \varepsilon_t * D_{jt} + \beta_3 D_{jt} + \epsilon_{jt+h}, \tag{3}$$

where the main difference is the inclusion of a dummy variable (D_{jt}) that indicates whether a firm j has debt in month t. Figure 3 shows the dynamic responses of investment and employment for firms with ($\beta_1 + \beta_2$) and without debt (β_1) to a monetary policy surprise.

Consistent with a financial channel, Panel 3a shows that only firms with financial access see their investment affected by monetary policy. Moreover, Panel 3b shows now a consistent decrease in employment after a monetary surprise for firms with access to finance. Thus, we find evidence of a financial transmission channel for monetary policy affecting investment

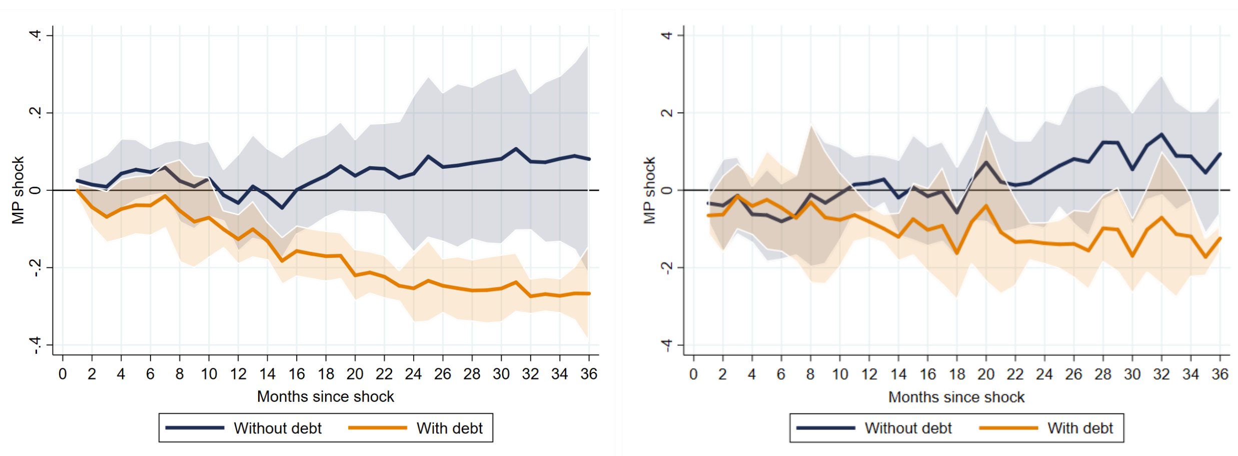
and equipment of 3.19% for an 100 bp increase in the interest rate.

[13] Appendix A.1, shows all the coefficient of the baseline regression at 24 months. All coefficients have the expected sign and are statistically significant. Appendix A.2, shows the results of a weighted regression. because our main object of interest is the response of the average firm (typically a small non-public firm), we prefer unweighted regressions.



(a) Effects on Investment (b) Effects on Employment growth

Figure 2: Dynamics of response to MPS. Reports coefficient β_1 in our baseline equation 2 and its 90% error bands.



(a) Effects on Investment (b) Effects on Employment growth

Figure 3: Dynamics of differential response by having debt and not to MPS. Reports coefficient β_1 (for firms without debt) and $\beta_1 + \beta_2$ (for firms with debt) in our equation 3 and their 90% error bands.

and employment decisions at the firm level.

3.3 Heterogeneous Financial Conditions

To further study the financial transmission of monetary policy we exploit firm level heterogeneity in the access to finance among firms with debt. We consider two firm level variables that could capture the firm sensibility to interest rates. First, and consistent with a large literature on firm finance, we study the role of leverage. Second, we make use of the richness of our financial data and we study the fraction of past due debt that the firm has. In particular, we extend Equation (2) as follows:

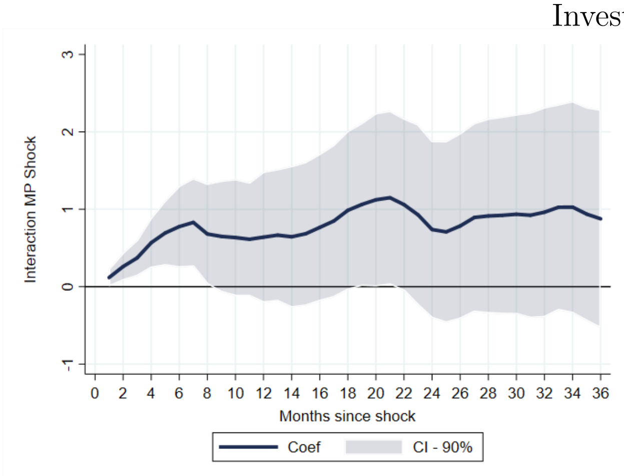
$$y_{jt+h} = \alpha_j + \alpha_t + \beta_x X_{jt} + \beta_1 \varepsilon_t * leverage_{jt} + \beta_2 \varepsilon_t * baddebt_{jt} + \epsilon_{jt+h}, \quad (4)$$

Note that, we include monthly time fixed effects (α_t) to fully absorb the direct impact of monetary surprises and we also demean the relevant financial variables (*leverage* and *baddebt*) when we interact them with the monetary surprise. A positive value for β_1 indicates that when monetary policy relaxes, the more leverage a firm has with respect to its historical mean, the less investment will increase. Similarly, a positive value for β_2 indicates that with a negative MPS, more overdue debt a firm has with respect to its historical mean, the response of investment will be lower. In order to reduce noise, we restrict our sample only to firm observation that have positive leverage. In our Appendix A.3, we repeat the same exercise with all the firms.

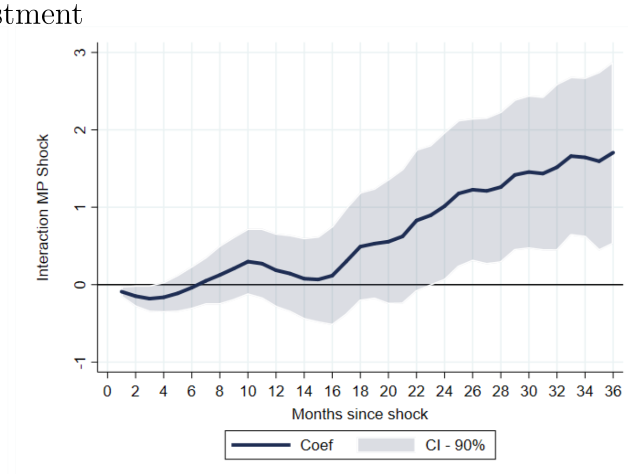
Figure 4 shows the results of each interaction for investment and employment dynamics. Panel 4a show that, consistent with Ottonello and Winberry (2020), firms that are above their average leverage are less sensitive to monetary policy.[14] Note that we observe some significant responses in the short-run, but the heterogeneity quickly becomes insignificant. In the case of employment, Panel 4c shows a mostly insignificant effect of leverage on employment

[14] Appendix A.4, uses the sample of Chilean public firms to replicate Ottonello and Winberry (2020)'s exercise. The Chilean data is consistent with their US-Compustat results.

Investment

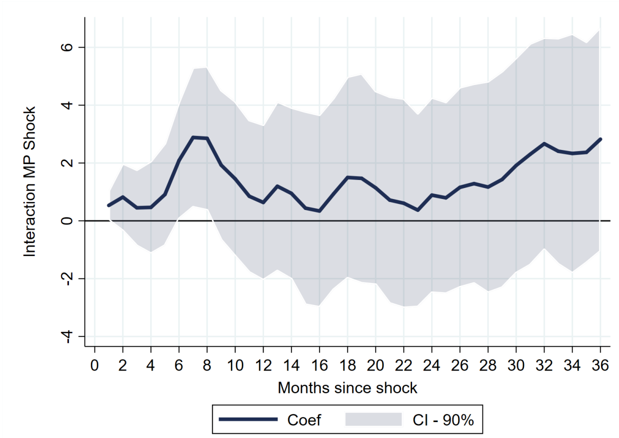


(a) Leverage interaction

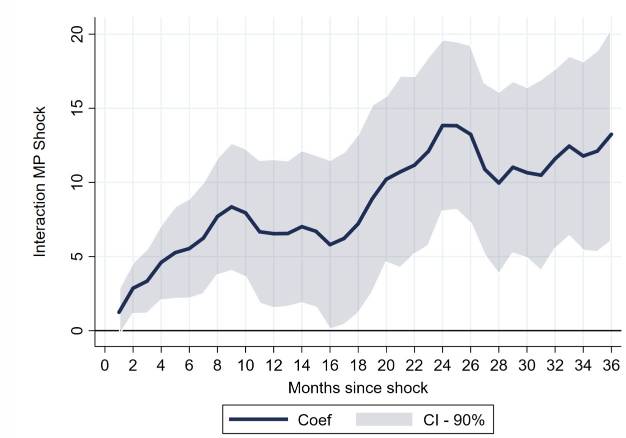


(b) Bad Debt interaction

Employment Growth



(c) Leverage interaction



(d) Bad Debt interaction

Figure 4: Dynamics of differential response by Leverage and Bad Debt to MPS for observation with month debt. Panel 4a and 4b shows effects on investment, while Panel 4c and 4d shows effects on employment growth. Reports interaction coefficient between MPS and financial conditions over time, β_1 (for leverage) and β_2 (for bad debt) in our equation 4 and their 90% error bands.

dynamics. Taking Panels 4a and 4c together, we see that leverage seems to be more important for investment than labor dynamics. The fraction of debt that is overdue shows a much more robust pattern. In fact, Panel 3a show that firms that increase their fraction of debt overdue with respect to their historical averages are less sensitive to monetary policy. This heterogeneous effect becomes significant after 20 months for investment. Interestingly, Panel 4 shows a systematic and robust effect of debt overdue on employment dynamics. in fact, the heterogeneous effect grows steady for two years and then stabilizes. The importance of bad debt for employment dynamics could be related with the fact that firms use short-maturity non-collateralized debt to finance working capital needs month to month. In fact, when a firm is in bad credit standard, it is likely for them to loose their non-collateralized credit and be unable to access working capital loans to finance wages.

3.4 Additional Dimensions of Heterogeneity: Age and Size

The literature often considers age and size as proxies for financial frictions. Because we have direct financial information, we do not rely on other proxies for financial access. Nevertheless, age and size could exhibit interesting heterogeneous responses to monetary policy. To explore how firms of different age and size react to monetary surprises we estimate the following regression:

$$y_{jt+h} = \alpha_j + \alpha_{sq} + \beta_1 \varepsilon_t + \beta_x X_{jt} + \beta_2 \varepsilon_t * Bin2_{jt} + \beta_3 \varepsilon_t * Bin3_{jt} + \beta_4 Bin2_{jt} + \beta_5 Bin3_{jt} + \epsilon_{jt+h}, \quad (5)$$

where we include dummies that capture the differential response of each group.[15] For instance, we divide firms in three age categories: young (less than 3 years old), middle aged (3

[15] Our firm level controls X_{jt} are slightly different to previous exercises. When studying size bins, we do not include size (employment) as a control. When studying age bins, we do not include age as a control. Also, when studying changes in employment dynamics we omit the size control. As a results, X_{jt} always includes sale-to-asset ratio, leverage, and bad-debt ratio, and includes size and age controls in the aforementioned cases where they are not omitted.

to 9 years), and mature (10 years or more).[16] The response of young firms is captured by β_1, the response of middle aged firms is captured by $\beta_1 + \beta_2$, and the response of mature firms is captured by $\beta_1 + \beta_3$. Similarly, when studying heterogeneous responses by size, we divide firms in three groups: small (less than 50 employees), medium sized (50 to 499 employees), and large firms (more than 500 employees).

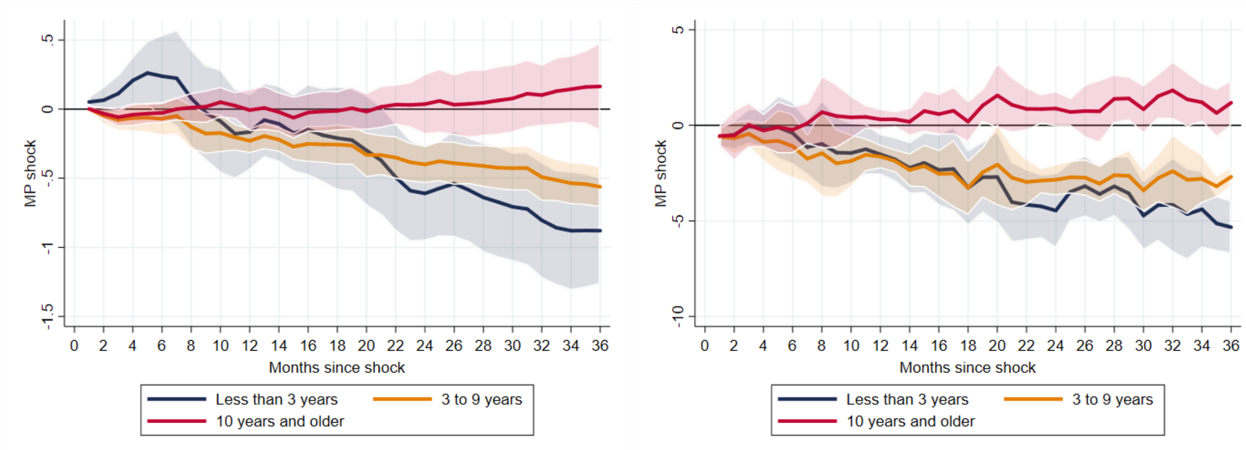
Figure 5 shows the heterogeneous responses of investment and labor for firms on different age groups to monetary policy surprises. Panels 5a and 5b show the same dynamics, it is young and middle aged firms that react to monetary policy, older firms do not exhibit a significant response. In fact, if older firms have already reached their efficient scale and have access to other sources of funding, we could expect them to rely less on the local financial market and therefore react less to monetary policy.

Figure 6 explores the heterogeneity along the size dimension. Panel 6a shows that medium sized firms are the ones that drive the investment response. In fact, small firms are likely to have little access to the domestic financial market while large firms have either other sources of funding or have reached already their efficient scale. Thus, it is not surprising that medium sized firms are the most affected by monetary policy. Panel 6b shows more volatile dynamics. Nevertheless, consistent with the investment dynamics, only the middle size group shows a significant negative response in employment at different horizons.

4 Future Work: Financial Flows Data

We have provided evidence that supports a financial channel for the transmission of monetary policy. In response to an increase in monetary policy, firms decrease investment and labor when interest rates increase. This response is driven exclusively by firms that rely on the financial market. An even stronger characterization of the financial transmission requires direct measurement of the effects of monetary policy on the cost of funds for firms. We have

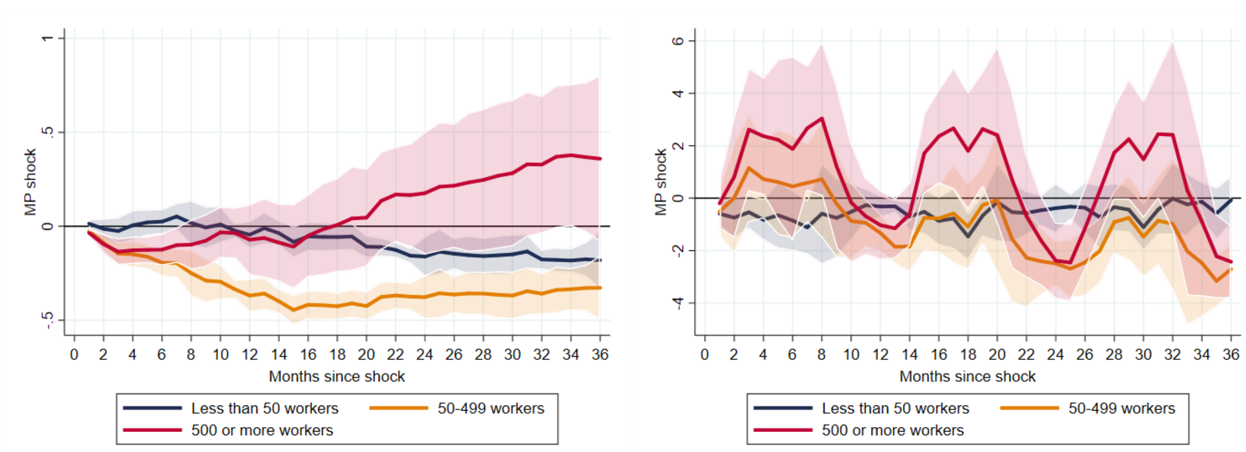
[16]Note that a young firm can be 2 years old at the moment of the shock but its 24 months response show the effects when the firm is 4 years old. Thus, age bins are defined at time t and not at horizon h.



(a) Effects on Investment

(b) Effects on Employment Growth

Figure 5: Dynamics of differential response by age group to MPS. Reports coefficient β_1 (for less than 3 years old), $\beta_1 + \beta_2$ (for 3 to 9 years old) and $\beta_1 + \beta_3$ (for 10 years old or older) in our equation 5 and their 90% error bands.



(a) Effects on Investment

(b) Effects on Employment Growth

Figure 6: Dynamics of differential response by size bins to MPS. Reports coefficient β_1 (for less than 50 workers), $\beta_1 + \beta_2$ (for 50 to 499 workers) and $\beta_1 + \beta_3$ (for 500 workers or more) in our equation 5 and their 90% error bands.

access to loan level flows data at the origination level for the universe of Chilean firms. Table 2 provides some descriptive statistics of this data

Table 2: Summary Statistics of Financial Flow Data - Preliminary

	Mean	Median	S.D.	95th Perc.
Loans (MM $CLP)	79.4	2.6	392	258
Duration CLP (months)	9.5	2.4	28.4	37.3
Annual interest rate (%)	8.9	6.7	6.7	23.1
Nº firms	464,095			
Nº observations	7,106,021			

Summary statistics of loan-level observations for the period 2012m4 to 2019m12. The values shown in the table have already being winsorized at the top and bottom 0.5%.

Because of the lumpy nature of investment, financing machinery and equipment should be associated with infrequent and relatively large loans. Nevertheless, working capital needs to pay monthly wages should be associated with monthly loans of a similar magnitude proportional to a firm's labor force. Figure 7 shows the distribution of the number of months per year a firm borrows, when it borrows more than 2 month a year (about 92% of firms borrow 1 or 2 month a year). We see that 0.8% of firms or 2,563 firms borrow at least 10 months per year. Figure 8 shows the standard deviation of loan size (only positive) for firms in each group. We can see that recurrent borrowers tend to generate loans that are homogeneous. The average maturity of these loans is 90 days. Thus, these borrowing patterns are consistent with working capital financing.

We are currently matching this loan level data to our monthly panel to study how monetary policy affects the probability, amount, interest rate, and maturity of loans. We conjecture that bad debt standings are particularly damaging for small firms that rely on month-to-month borrowing to finance working capital needs. While lumpy borrowing should likely be delayed, it should exhibit a lower interest rate pass-through given the collaterized nature of these loans. For these investment loans, firm's leverage should be more important relatively to the working capital rollover financing.

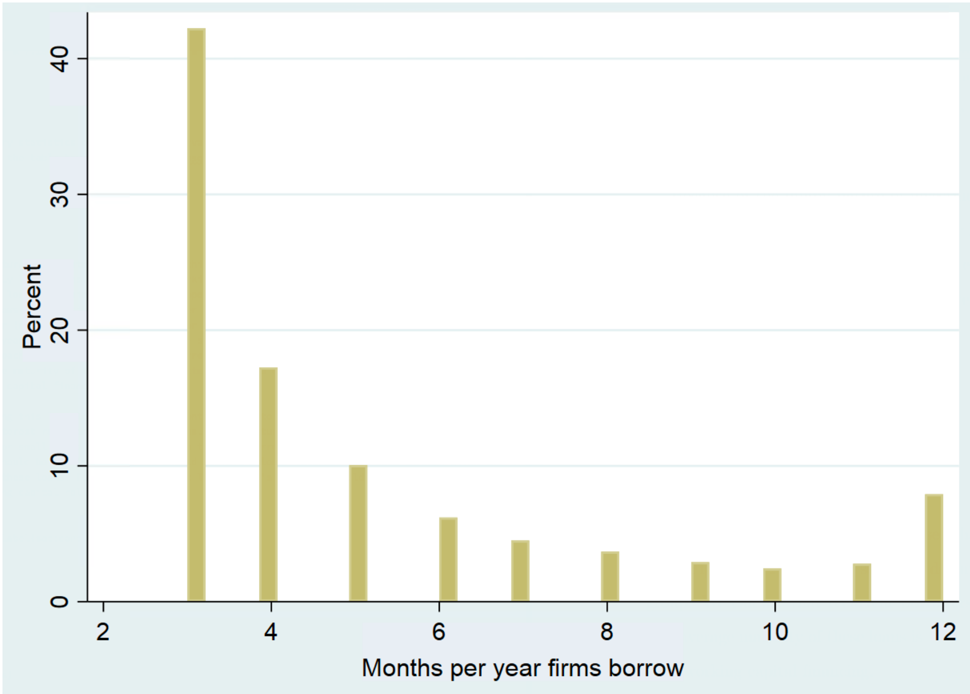


Figure 7: Distribution of the number of months per year firms borrow

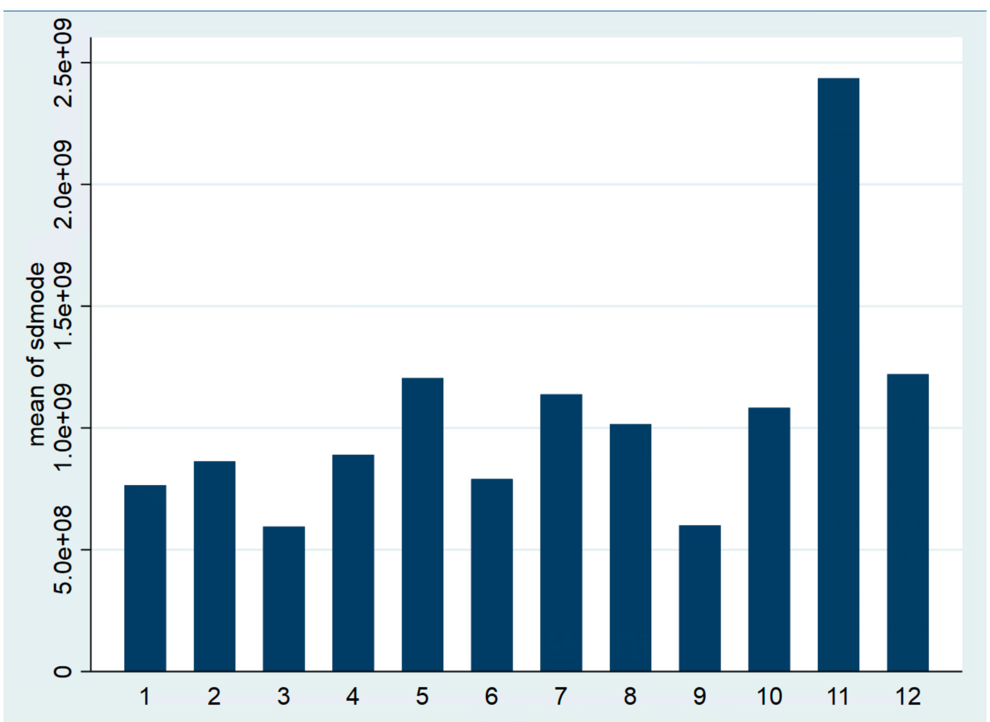


Figure 8: Standard Deviation of loan amount per number of month firms borrow in a year

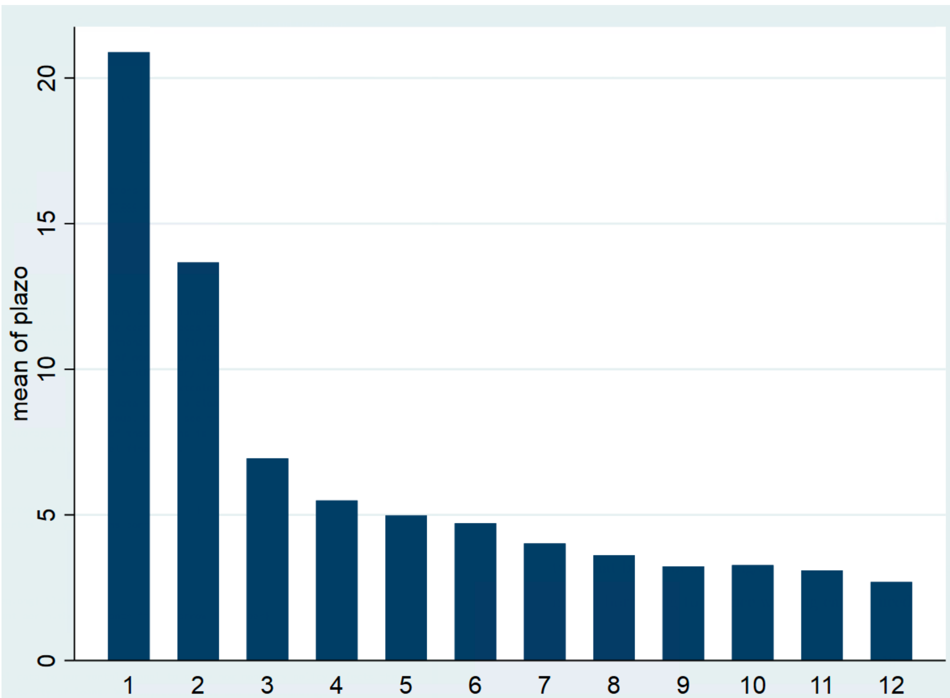


Figure 9: Mean of loan maturity per number of month firms borrow in a year

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Appendix A Additional Empirical Results

A.1 Baseline Regression Coefficient

The monetary policy shock has a negative effect on investment and employment, similar to the effects of age, size, leverage and the ratio of bad debt (all the signs are expected).

Baseline Specification - Investment - 24 month horizon

	(1)	(2)	(3)
MP shock	-0.175***	-0.182***	-0.183***
	(0.0629)	(0.0639)	(0.0640)
Age	-3.732***	-3.689***	-3.682***
	(0.235)	(0.232)	(0.233)
Size	-1.975***	-1.957***	-1.960***
	(0.100)	(0.0992)	(0.0990)
Sales	0.972***	1.000***	0.999***
	(0.0393)	(0.0378)	(0.0378)
Leverage		-1.335***	-1.333***
		(0.268)	(0.268)
Bad debt ratio			-0.795**
			(0.295)
Observations	2209859	2209859	2209859
R^2	0.641	0.641	0.641

Results from estimating equation 2 at 24 month horizon, $\sum_{i=t}^{h} \log\left(\frac{i_{jt+24}}{A_{jt+24}}\right) = \alpha_j + \alpha_{sq} + \beta_1 \varepsilon_t + \beta_x X_{jt} + \epsilon_{jt+24}$. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

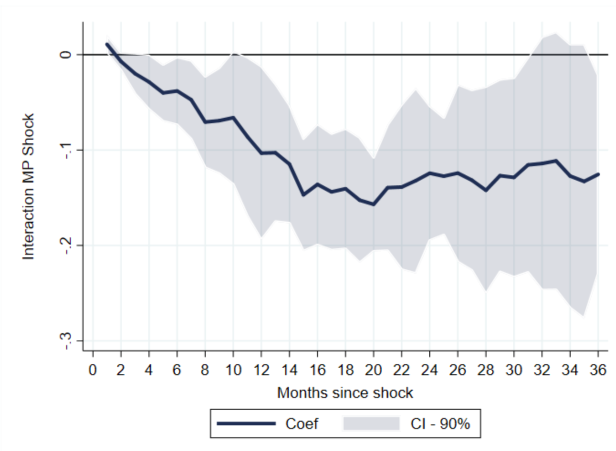
Baseline Specification - Employment - 24 month horizon

	(1)	(2)	(3)
MP shock	-0.908**	-0.952**	-0.952**
	(0.423)	(0.433)	(0.0640)
Age	-24.47***	-24.13***	-24.14***
	(1.003)	(0.977)	(0.978)
Sales	-4.402***	-4.197***	-4.195***
	(0.222)	(0.217)	(0.217)
Leverage		-9.130***	-9.135***
		(0.926)	(0.926)
Bad debt ratio			1.679*
			(1.506)
Observations	2159838	2159838	2159838
R^2	0.364	0.365	0.365

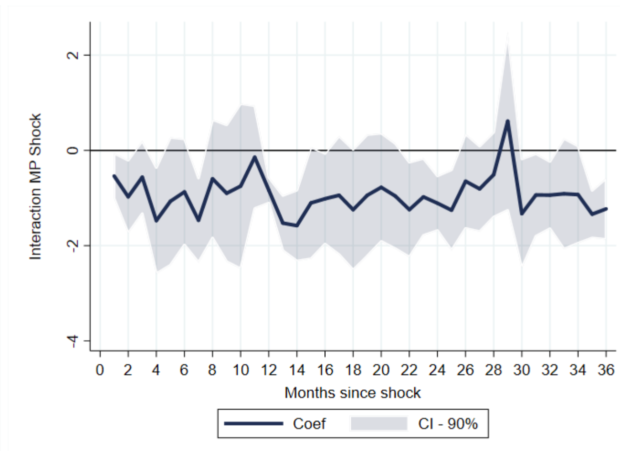
Results from estimating equation 2 at 24 month horizon, $\log L_{jt+24} - \log L_{jt} = \alpha_j + \alpha_{sq} + \beta_1 \varepsilon_t + \beta_x X_{jt} + \epsilon_{jt+24}$. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

A.2 Weighted Baseline Regression

Figures 10a and 10b show the dynamic responses of investment and employment, respectively, to monetary policy shocks, using our baseline equation 2 weighted by the sum of sales of firms in the previous 12 months.



(a) Effects on Investment



(b) Effects on Employment Growth

Figure 10: Weighted Dynamics of response to MPS. Reports coefficient β_1 in our baseline equation 2 weighted by the sum of sales in the last 12 months and its 90% error bands.

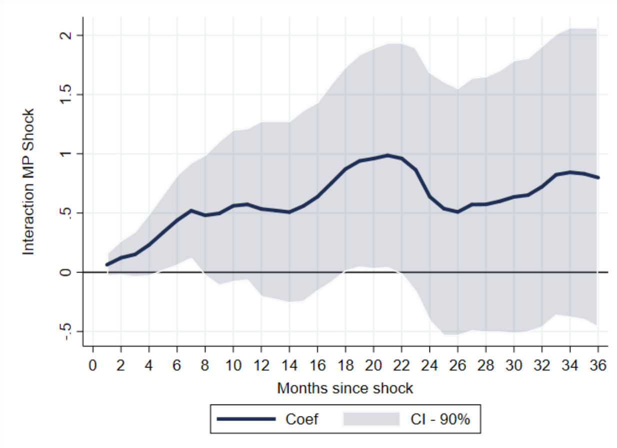
A.3 Heterogeneous Financial Conditions with All Firms

We estimate the differential response by leverage and *bad debt* to monetary policy shocks for the entire sample in 11a and 11b, respectively, for investment, and 11c and 11d for employment.

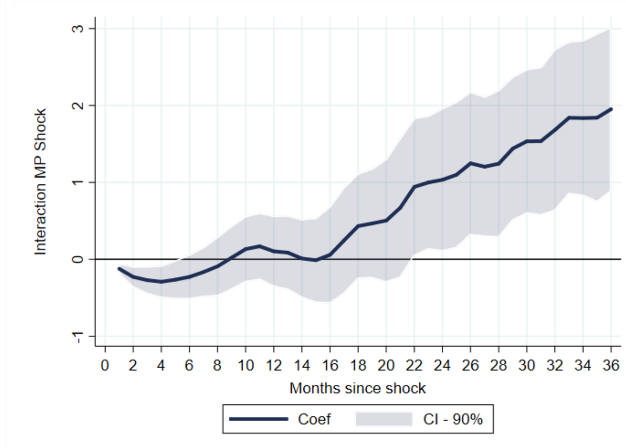
A.4 Replication of Ottonello and Winberry (2020)

In this section we analyze public firms (FECU) with debt (intensive margin). We absorb the time effect, and we focus on the interaction of MPS and demeaned firm leverage. In Figure 12, we observe a positive significant response for firms with higher leverage than their historical average to the monetary policy shock, in the first month as well between 18 and 36 month.

Investment

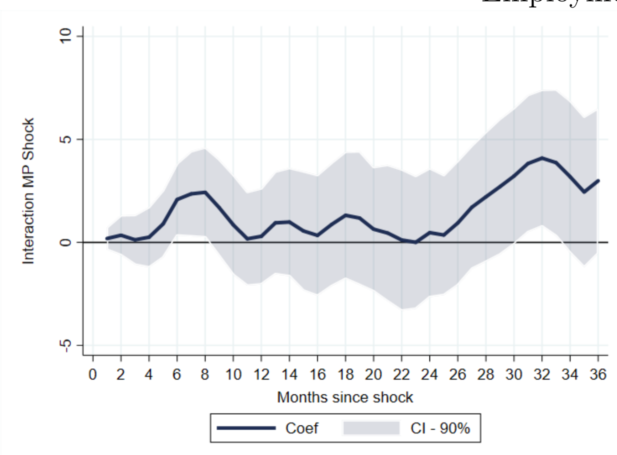


(a) Leverage interaction

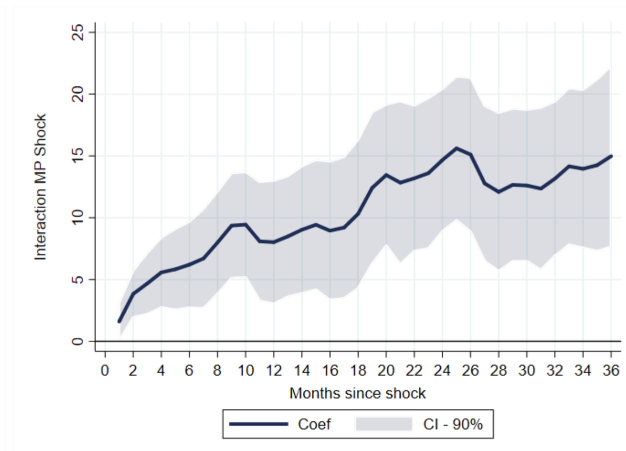


(b) Bad Debt interaction

Employment Growth



(c) Leverage interaction



(d) Bad Debt interaction

Figure 11: Dynamics of differential response by Leverage and Bad Debt to MPS for entire sample. Panel 4a and 4b shows effects on investment, while Panel 4c and 4d shows effects on employment growth. Reports interaction coefficient between MPS and financial conditions over time, β_1 (for leverage) and β_2 (for bad debt) in our equation 4 and their 90% error bands.

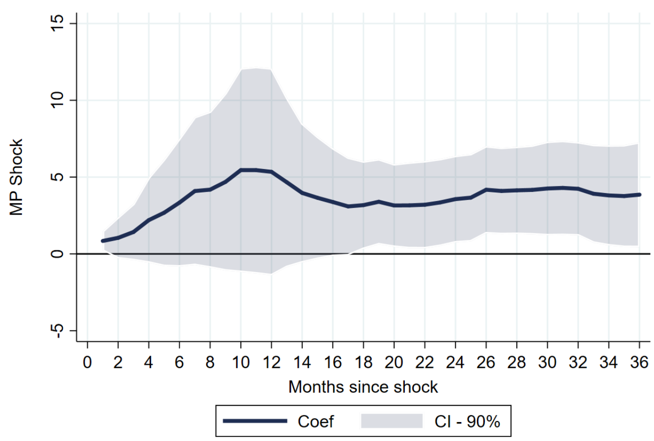


Figure 12: Dynamics of differential investment response by Leverage to MPS for public firms with debt. Reports interaction coefficient between MPS and leverage over time, β_1 in our equation 4 and their 90% error bands.

Appendix B Derivation for Accumulated Investment

In the literature, particularly works using Compustat data such as Ottonello and Winberry (2020), the main measure of investment is $\Delta \log k_{jt+h}$, where $\log k_{jt+h}$ is the book value of tangible capital stock of firm j. Although we have highly quality data on monthly purchases of capital goods, we do not have available an accurate measure of firms' capital stock given that we do not observe depreciation at the firm-level nor the sales of capital. We do have a reliable measure for total assets, which is an annual report of every tangible asset that a firms owns (including constructions and property purchases). Below, we show that our accumulated investment to total asset ratios is proportional to the measure of change in investment used in the literature.

$$\sum_{i=0}^{h} \log\left(1 + \frac{\tilde{I}_{t+i}}{K_{t+i-1}}\right) \propto \log(K_{t+h}) - \log(K_t)$$

$$\sum_{i=1}^{h} \log\left(1 + \frac{\tilde{I}_{t+i}}{K_{t+i-1}}\right) \propto \log(K_{t+h}) - \log(K_t)$$

$$\begin{aligned}
\log(K_{t+h}) - \log(K_t) &= \log(K_{t+h}) - \log(K_{t+h-1}) + \log(K_{t+h-1}) - \log(K_t) \\
&= \log(K_{t+h}) - \log(K_{t+h-1}) + \log(K_{t+h-1}) - ... - \log(K_{t+1}) + \log(K_{t+1}) - \log(K_t) \\
&= \log\left(\frac{K_{t+h}}{K_{t+h-1}}\right) + \log\left(\frac{K_{t+h-1}}{K_{t+h-2}}\right) + ... + \log\left(\frac{K_{t+2}}{K_{t+1}}\right) + \log\left(\frac{K_{t+1}}{K_t}\right) \\
&= \sum_{i=1}^{h} \log\left(\frac{K_{t+i}}{K_{t+i-1}}\right) \\
&= \sum_{i=1}^{h} \log\left(1 + \frac{K_{t+i} - K_{t+i-1}}{K_{t+i-1}}\right) \\
&= \sum_{i=1}^{h} \log\left(1 + \frac{\tilde{I}_{t+i}}{K_{t+i-1}}\right) \propto \sum_{i=1}^{h} \log\left(1 + \frac{i_{jt+i}}{A_{jt+i}}\right)
\end{aligned}$$

where $\tilde{I}_{t+i} = K_{t+i} - K_{t+i-1} = I_{t+i} - \delta K_{t+i-1}$

$$\sum_{i=1}^{h} \log\left(1 + \frac{\tilde{I}_{t+i}}{K_{t+i-1}}\right) \approx \frac{A}{K} \sum_{i=1}^{h} \log\left(1 + \frac{i_{jt+i}}{A_{jt+i}}\right)$$

Using the perpetual inventory method for the stock of machinery and equipment we get that $\frac{A}{K}$, the asset to capital stock ratio, is 17.7.

Appendix C Restricted Sample

Some of our exercises analyze specifically the financial transmission of MPS, considering observations that have no debt may introduce more noise to these results. Therefore, we construct a subset of our entire sample that only includes the firm-month observations with monthly debt.

Table 3: Summary Statistics of Firm-Level Variables - Restricted Sample

	Mean	Median	S.D.	95th Perc.
Sales*	396.8	51.8	1604.9	1412.8
Capital stock*	1077.8	32.8	27612.9	1503.5
Total assets*	9573.7	533.1	51644.4	27091.3
Investment*	6.0	0	37.0	16.7
Age	11.7	11	7.0	24
Nº employees	67.6	17	190.5	274
Normal debt stock*	720.8	50.1	3098.0	2731.5
Bad debt stock*	4.5	0	36.3	0
Total debt*	725.3	53.4	3099.0	2740.3
Sale-asset ratio	0.2	0.1	0.3	0.6
Leverage ratio	0.2	0.1	0.4	0.8
Bad debt ratio	0.0	0	0.1	0
Nº firms	52586			
Observations	3544034			

Summary statistics of firm-level variables for the period 2009m1 to 2019m12. The values shown in the table have already being winsorized at the top and bottom 0.5%. *All currency related variables in million chilean pesos (CLP).

Appendix D Financial Flow Data Description

This is a data set from the Financial Market Commission (CMF) and records every loan issued by a financial entity in Chile to a person or firm. It contains the borrowers' unique tax ID which allows us to merge it with our other firm level data. It also contains the issuers' ID, so we can control for lenders characteristics. We also observe the currency of the loan, which are mostly in domestic currency (84%), inflation indexed units (3%) and U.S. dollar (12%). The other variables that this data includes are amount of the loan, the duration, annualized interest rate, interest rate type (fixed, variable, or mixed). Also we have additional loan characteristics such as whether the loan is a reprogrammed from a previous loan or if it is a government guaranteed or subsidized credit.

We restrict this data set to exclude loans issued to individual persons and certain types of loans that are not of our interest such as home mortgages, education loans, and unclassified loans. The preliminary data has 7,106,021 loan-level observations for 464,095 firms. Additional cleaning will be performed in our next steps.