

# The Loan Puzzle in México\*

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## Abstract

Empirical evidence for advanced economies suggests that following a monetary tightening, commercial and industry bank loans show a positive “puzzling response” (Den Haan et al. (2007) and Den Haan et al. (2009)). Since there is no wide evidence for the Mexican case, this paper aims to analyze the response of bank loans at the sectoral level after a monetary contraction. For this purpose, I estimate a structural VAR model with block exogeneity to identify a monetary shock for a small open economy, as it is the case of Mexico. The results show evidence of firms’ loan puzzles during the period 2001-2019 characterized by an inflation-targeting regime in Mexico. Those loan puzzles are mainly observed in the relatively safer sectors.

**Keywords:** Bank Lending Channel, Loan Puzzle, Monetary Policy Shocks, SVAR

**JEL classification codes:** E51, E52 E58

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## 1 Introduction

A textbook mechanism suggests that following a monetary tightening, credit volume should decrease. However, Den Haan et al. (2007) examine the role of monetary policy on the level of bank loans for the United States and find that following a monetary tightening, commercial and industry bank loans increase.<sup>1</sup> This finding is considered a “perverse” reaction or “loan puzzle”. Den Haan et al. (2007) suggest that in a context of high interest rates and low dynamism of economic activity, banks may prefer to grant loans to firms (which pay high interest rates and are relatively safer sectors) compared to the sector of real estate (which could be relatively riskier).

More recently, Lelebicioglu and Valcarcel (2018) analyze the impact of monetary policy on bank loans in emerging economies (Turkey, México and Chile) from 1986 to March 2016. They find that in the case of a domestic monetary expansion, there is a “perverse response” of commercial and industrial loans in all three countries. However, Lelebicioglu and Valcarcel (2018) only consider a historical sample and limits their investigation on aggregate responses. This paper expands on this analysis by considering a modern sample. Furthermore, it conducts a sectoral study by reviewing which industries (primary sector, mining, manufacturing, commerce, tourism, financial sector and household consumption) show this perverse reaction. The literature suggests that in general, sectors that depend most on bank credit, such as, manufacturing and small firms tend to be more affected following a monetary tightening. Gertler and Gilchrist (1993) point out that consumers and small businesses generally rely more on bank credit compared to larger businesses because access to other money markets may be more difficult. As a result, credit to consumers and small firms is more sensitive to a contraction in monetary policy than credit to large firms (usually concentrated in the manufacturing sector).

I leverage information from Banco de México and from the National Mexican Institute of Statistics (INEGI) during the time period July-2001 to December-2019. My approach is similar to that of Cushman David and Zha (1997), in which a SVAR model with block exogeneity is estimated for a small open economy. The identification of the SVAR model is similar to that proposed by Den Haan et al. (2007), Cushman David and Zha (1997) and Lelebicioglu and Valcarcel (2018). Particularly, the question of interest is whether the “loan puzzle” is a response that is widely observed in any sector of the economy.

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<sup>1</sup>They also find that consumer and real estate bank loans show a significant reduction following a short-term rate hike.

I extend the analysis by answering three important questions. First, I set out to determine whether the loan puzzle is a feature of the Mexican<sup>2</sup> economy in a modern sample. Second, I investigate whether the perverse reaction can be explained in a lending channel mechanism that incorporates sectoral dynamics. Third, I evaluate whether the puzzle occurrence is an inherently domestic phenomenon, or whether an open economy model can shed light on its dynamics.

My results suggest that various domestic and open-economy structural VAR specifications show evidence of loan puzzles in a modern sample characterized by an inflation-targeting regime in Mexico. I find that commercial and industry bank loans increased during the first seven months after the monetary shock. At the sectoral level, I find that loan puzzles are mainly observed in the relatively safer sectors such as manufacturing, commerce and finance.

The organization of this document is as follows: Section 2 presents a brief literature review regarding the role of monetary policy on bank loans, both from the microeconomic and aggregate point of view. Section 3 describes the data and sources of information that will be used to carry out this analysis. Section 4 shows the proposed methodology and identification of the SVAR Model with exogeneity block that I employ to analyze the impact of monetary policy on bank loans by industry. Sections 5 and 6 describe the main findings and conclusions that emerge from this research document.

## 2 Literature Review

The transmission of monetary policy on bank loans can be understood through supply and demand factors. Among the factors that may influence the demand for bank loans, the role of firms' balance sheets is worth highlighting. Following a monetary contraction, firms' cash flows and the assets value may decrease. Consequently, the value of the collateral that the companies could use to get a bank loan may reduce as well. As a result, firms would have more incentives to undertake riskier projects. This could generate an adverse selection problem if riskier firms resort to requesting bank loans to finance said projects. A volatile environment that makes it more difficult for banks to identify risk may lead to hikes in risk premia as well as increased barriers in access to credit.

On the other hand, the effects of a contractionary monetary policy can be transmitted via a loan supply reduction through the "lending channel". Following an interest rate increase,

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<sup>2</sup>Analysis of the Mexican economy is important for two reasons. First, most of the evidence on the Loan Puzzle has centered in advanced economies, such as USA and Canada, and not in emerging economies, in which bank loans can be a powerful channel for the monetary policy transmission. Second, analysis of the credit channel for the Mexican case is relevant in the context in which some reforms have been implemented to improve the regulation and development of financial markets (Ibarra (2016)).

it becomes costlier for banks to obtain loanable funds, Bernanke et al. (1988). This higher costs may imply higher interest rates at which banks will be willing to lend money. This may restricts access to credit for agents who are more dependent on bank credit, such as consumers and small firms. The transmission of monetary policy through the lending channel may be more effective to the extent that bank funding is one of the most relevant sources for obtaining loans.

Gertler and Gilchrist (1993) analyze the role of the credit market in the transmission of monetary policy. The authors use information for the the United States case during the period from 1975 to 1991. The authors note that consumers and small businesses generally rely more on bank credit compared to larger businesses, because access to other money markets may be more difficult for consumers and small businesses. The authors consider this to be a credit market imperfection. Gertler and Gilchrist (1993) suggest that in this context, credit to consumers and small firms is more sensitive to a contraction in monetary policy than credit to large firms.

Gertler and Gilchrist (1994) analyze firms behavior following an U.S monetary tightening with quarterly information for the period 1960 to 1991. They find that in general terms, small firms are more sensitive to a monetary tightening. In particular, they observe that the drop-in sales and inventories of small firms is more quick and pronounced in relation to larger firms. They argue that small firms are seen as riskier and not very well collateralized, which could represent a friction in the financial markets to have access to credit. On the other hand, they point out that large firms tend to increase debt in the short run to accumulate inventories.

Bernanke and Gertler (1995) analyze the role of the lending channel in the transmission of monetary policy during the period 1965-1993. They find that economic activity and the price level show a reduction following a monetary tightening. However, when decomposing GDP into inventories and final demand, they find that inventories react positively in the first two years,<sup>3</sup> which is considered a “puzzling response”, contrary to the suggested textbook prediction. The authors conclude a mechanism where after a monetary tightening firms face a worsening of their cash flows as they have to pay more interest or have lower sales. However, even in such a scenario, firms have to continue paying the financing for the accumulation of inventories and working capital. This may lead to a greater need for funding, which Bernanke and Gertler (1995) consider as one of the reasons for the delay in the negative response of inventories.

Suzuki (2004) analyzes the effect of a monetary tightening in Japan over bank loans. And finds that after a monetary contraction, there is a significant reduction in the number of new

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<sup>3</sup>However, after two years, inventories fall.

bank loans after the first quarter. He also finds that the interest rate associated with these loans showed an increase during the first four quarters. However, he notes that the interest rate on new bank loans seems to be more rigid than the reference interest rate following a monetary tightening.

Fernandez (2005) analyzes the transmission of monetary policy through the lending channel in Chile. He finds that a contractionary monetary policy, the depreciation of the Chilean peso and an economic growth reduction are factors that negatively affect bank loans volume. However, larger, more efficient and banks with more liquid assets tend to be less affected by a monetary tightening. On the other hand, Fernandez (2005) finds that bank loans to the manufacturing and financial services sectors tend to be more sensitive to an increase in interest rates.

Den Haan et al. (2007) analyze the effect of monetary policy on bank loans in the United States during the period 1977 to 2004. The authors find that following a monetary tightening, consumer and real estate loans showed a significant reduction, while commercial and industry bank loans increased during some quarters. This last finding is considered a “perverse” reaction of bank loans (loan puzzle). Den Haan et al. (2007) suggest that in a context of high interest rates and low dynamism of economic activity, banks may prefer to grant loans to industry and commerce (which pay high interest rates and are relatively safer sectors) than to the sector of real estate (which could be relatively riskier).

Den Haan et al. (2009) study the transmission of monetary policy on bank loans in Canada during the period 1972 to 2007. Den Haan et al. (2009) find that following a monetary tightening, consumer bank loans tend to decrease, while industry bank loans increase during some quarters. The authors point out that this finding documents that consumers are more likely to be constrained instead firms, possibly because the existence of some frictions in the credit market.

Leblebicioglu and Valcarcel (2018) analyze the impact of monetary policy on bank loans in emerging economies. The authors used monthly frequency data of Turkey, Mexico and Chile. The time period of analysis is from 1986 to March 2016, and starting from 1994 for the Mexico’s case. Initially, the authors build a spillover index based on the forecast error variance decomposition by which they find that the United States monetary policy has effects on the bank loans volume in the three countries. Finally, they conclude that following a monetary expansion in the United States, there is a puzzling (negative) response of commercial and industry bank loans for the case of Chile and Turkey. While in the case of a domestic monetary expansion, in all three countries there is a “perverse response” of commercial and industry bank loans.

Cantú et al. (2019) analyze how specific characteristics of banks affect the loans supply after different economic shocks in México (including a contractionary monetary policy). The authors find that banks with strong balance sheets (well capitalized) and more diversified sources of income generally tend to offer more bank loans. Furthermore, they find that highly capitalized banks with more liquid assets tend to respond less negatively to a monetary tightening. Whereas banks with higher risk indicators tend to be more sensitive to an increase in interest rates. They find that foreign subsidiaries tend to be even more sensitive to both domestic and external shocks, one reason for this is that these institutions are more capable of diversifying risk within the bank at the international level. They also indicate that credit growth is greater for firms with long and high credit scores. In addition, they find that during periods of financial stress, large firms are less affected by the credit growth.

In addition to Fernandez (2005) and Cantú et al. (2019)), there is a large number of authors who have analyzed the transmission of monetary policy through the lending channel from the microeconomic perspective. These authors use panel data information for a set of banks of a specific country. The consensus of these documents is that generally well-capitalized and highly liquid banks are the least affected by a contractionary monetary policy, that is the case of Uruguay (Lorenzo et al. (2010)), Brazil (Coelho et al. (2010)), Italy (Gambacorta (2005)), Ukraine (Golodniuk (2006)) and Malaysia (Abdul Karim et al. (2011)).

Some of the recent literature on the lending channel transmission of monetary policy has centered on microeconomics dynamics. I suggest the use of aggregated information at the national level for the Mexican case in the tradition of Leblebicioglu and Valcarcel (2018).

### 3 Data

I consider a modern sample at monthly frequency from July-2001<sup>4</sup> to December-2019. The reasoning behind starting the analysis with data since 2001<sup>5</sup> is because, Banco de México established in 2001 the beginning of an inflation targeting regime in order to conduct Mexico's Monetary Policy. Specifically, the Central Bank set an annual inflation target of 3 percent. In addition to that, according to Chiquiar et al. (2010), inflation rate began to show a more stable behavior from 2001.

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<sup>4</sup>After 2001, the Mexican economy started a period of lower and more stable inflation rates, which allowed for a better a development of the financial markets due to lower uncertainty in the economy (Ibarra (2016))

<sup>5</sup>For more details about Monetary Policy Implementation through an Operational Interest Rate Target, please visit: <https://www.banxico.org.mx/indexen.html> (MP implementation mechanisms).

First, I have bank loans ( $B$ ), which are desegregated at the industry level. The data corresponding to bank loans by economic sector (primary sector, mining, manufacturing, commerce, tourism, financial sector, construction and household consumption) come directly from Banco de México.

As a measure of economic activity, I consider ( $Y$ ) a seasonally adjusted Index for Aggregate Economic Activity at the National Level (IGAE)<sup>6</sup>. The source for this variable is INEGI. The price level ( $P$ ) was obtained directly from INEGI and corresponds to the National Consumer Price Index<sup>7</sup> (INPC). The nominal exchange rate ( $EXCH$ ) is measured in Mexican pesos per US dollar and corresponds to the FIX Exchange Rate. The FIX Exchange Rate is determined by the Central Bank as an average of the quotes in the foreign exchange market for operations payable in 48 hours.

I assume the monetary policy indicator ( $R$ ) as the annual interest rate of 28-day Treasury Certificates (CETES-28). One of the reasons why this interest rate is used as an indicator of monetary policy in Mexico is because it is considered by Banco de México as a representative interest rate of the prevailing conditions in the money market. In addition, Banco de México charges up to twice the 28-day CETES rate for negative balances in banks' current accounts with the Central Bank. The use of this indicator of monetary policy in the case of Mexico is consistent with: Kamin and Rogers (1996), De Mello and Moccero (2009), Cermeño et al. (2012), Cortés Espada (2013) and Carrillo and Elizondo (2015).<sup>8</sup>

For the United States variables, I incorporate US Industrial Production ( $Y^*$ ), US Consumer Price Index ( $P^*$ ) and the US Federal Funds Rate ( $R^*$ ), all obtained from the Federal Reserve Bank of St. Louis. However, I replace the the Federal Funds Rate with the shadow Federal Funds rate of Wu and Xia (2016) during the zero lower bound period. The reason behind that strategy is because the Federal Funds rate became not very informative about the US monetary policy during the zero lower bound period.

All variables, except for interest rates, were transformed to indices based on 2019 equal to 100, and then the logarithms<sup>9</sup> of the variables were obtained.

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<sup>6</sup>According to INEGI, the Global Indicator of Economic Activity (IGAE) makes it possible to know and follow up on the monthly evolution of the real sector of the economy. The following are used for its calculation: the conceptual scheme, the methodological criteria, the classification of economic activities and sources of information, which are used in the annual and quarterly calculations of the Gross Domestic Product.

<sup>7</sup>There is not an official seasonally adjusted Consumer Price Index, as a result, the variable used in this research has not that characteristic.

<sup>8</sup>The information on the exchange rate and the short-term interest rate comes from Banco de México.

<sup>9</sup>Note that the estimation of the SVAR models will be done using the logarithm of the variables in levels (the logarithm is not applied to the interest rate). This strategy is consistent with the seminal works of Sims (1980) and Sims et al. (1990). The argument is that differencing discards important information concerning the co-movements in the data. However, I recognize that the estimation of the VAR models with the variables in levels implies losing some estimators efficiency but importantly, not consistency.

## 4 Empirical Framework

My approach is similar to that of seminal work of Cushman David and Zha (1997) and Kim and Roubini (2000) who study the impact of monetary policy for the case of small open economies (SOE's).

Cushman David and Zha (1997) argue that recursive VAR models to identify monetary policy shocks make sense for relatively large and closed economies, such as the United States, given that monetary policy decisions in large economies are unlikely to have some influence from smaller countries. However, for the small open economies case, shocks from some larger economies may have an impact on their monetary policy decisions.

Kim and Roubini (2000) follow the work done by Cushman David and Zha (1997) and analyze the impact of a monetary policy shock for six economies smaller than the United States. Kim and Roubini (2000) estimate a SVAR in which they assume that the variables of each of these countries may have an influence of the U.S variables, but not vice versa. Kim and Roubini (2000) find that by following a monetary tightening, under this SVAR identification there is not evidence of puzzling responses on the price level and the exchange rate. As a result, taking seriously the critique about the use of recursive models to identify monetary policy shocks in small open economies (as is the case of Mexico), for this paper, the methodology is in the spirit of Cushman David and Zha (1997) and Kim and Roubini (2000), although with some modifications. For which, initially I consider the use of a VAR model. The reduced form representation of this model is described below:

$$z_t = B_1 z_{t-1} + \dots + B_q z_{t-q} + u_t \quad (1)$$

Where  $z_t$  is the vector of endogenous variables,  $B$  is a matrix of coefficients for lagged variables,  $q$  is the number of lags,  $u_t$  is a vector of residuals for each equation. Since the possibility of some contemporaneous relationship of the variables is omitted in that equation, I have that the variance-covariance matrix is full ( $E[u_t u_t' | y(t-s), s > 0] = V$ ). To allow for contemporaneous relationship of the variables by identifying  $A_0$ , it is possible to rewrite the previous model in its structural form as follows:

$$A_0 z_t = A_1 z_{t-1} + \dots + A_q z_{t-q} + \varepsilon_t \quad (2)$$

Where the variance-covariance matrix is diagonal for structural shocks. Following Cushman David and Zha (1997),  $z_t$  is divided into two blocks of variables,  $z_{1t}$  and  $z_{2t}$ .  $z_{1t}$  includes the variables from Mexico and consequently  $z_{2t}$  refers to the set of variables corresponding to the United States. Note that Mexico is assumed to be a small economy, since, according

to the World Bank, Mexico's Gross Domestic Product represented 5.9 percent of the United States' GDP in 2018. On the other hand, it is assumed that Mexico is an open economy since approximately 80 percent of its exports go to the United States, which represents approximately 37 percent of Mexico's GDP. While in the case of the United States only 16 percent of its exports go to Mexico. Therefore, I can rewrite the equation as follows:

$$A(L)z(t) = \varepsilon(t) \quad (3)$$

$$z(t) = \begin{bmatrix} z_1(t) \\ z_2(t) \end{bmatrix}, A(L) = \begin{bmatrix} A_{11} & A_{12} \\ 0 & A_{22} \end{bmatrix}, \varepsilon(t) = \begin{bmatrix} \varepsilon_1(t) \\ \varepsilon_2(t) \end{bmatrix} \quad (4)$$

Where  $z(t)$  is a vector of  $m \times l$  observations,  $z_1$  is a vector of  $m_1 \times l$  that contains the set of domestic variables and  $z_2$  is a vector  $(m - m_1) \times l$  that in this case contains the observations of the variables of the United States.  $\varepsilon_1(t)$  and  $\varepsilon_2(t)$  are vectors of the structural residuals of dimensions  $m_1 \times l$  and  $m_2 \times l$ , respectively. The dimensions of  $A_{11}$  are  $m_1 \times m_1$ , for  $A_{12}$  dimensions are  $m_1 \times m_2$ , for  $A_{21}$  dimensions are  $m_2 \times m_1$  and for  $A_{22}$  dimensions are  $m_2 \times m_2$ , where  $m_1 + m_2 = m$ .

I also assume that:

$$E [\varepsilon(t)\varepsilon(t)' | y(t-s), s > 0] = D, E [\varepsilon(t) | y(t-s), s > 0] = 0 \quad (5)$$

The  $A_{21} = 0$  restriction that implies that the U.S variables are not affected by the Mexican variables contemporaneously and with a lag (under the assumption that Mexico is a small open economy).

In the case of Mexico, the following variables are considered:  $B, Y, P, EXCH, R$  -in that order-. And for simplicity a recursive order is assumed. The order<sup>10</sup> of the variables is similar to Carrillo and Elizondo (2015) and it implies that Banco de México can react contemporaneously to production, prices and the exchange rate shocks, but these variables react with a lag to monetary policy shocks.

However, given my interest in analyzing heterogeneity in the responses of bank loans at the industry level, we decompose  $B$  into an index of bank loans for each industry (primary sector, mining, manufacturing, commerce, tourism, financial sector, construction and household consumption). A SVAR model with Block Exogeneity is estimated for each economic sector.

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<sup>10</sup>I also allowed for a different order  $Y, P, EXCH, R, B$  in which bank loans may react contemporaneously to the short term interest rate. Nonetheless, results are found to be similar to the ones under the first specification.

In a similar way that to the case of Mexico, I assume a lower triangular order for the United States variables ( $Y^*, P^*, R^*$ ), which is consistent with Cushman David and Zha (1997).

Regarding block  $A_{12}$ , I assume that Bank loans do not respond to US variables. Based on the knowledge that 80 percent of Mexican exports to the United States represents more than a third of Mexican domestic production, my identification leaves the relationship between economic activity in Mexico and in the United States unrestricted. Similarly, I assume that the price level in Mexico may be influenced by the international prices of goods and services. As a result, the price level of the United States<sup>11</sup> is used as a reference for prices at the international level. I also assume that both, the exchange rate (pesos per dollar) and the interest rate respond contemporaneously to the set of variables in the United States, this assumption is consistent with Cushman David and Zha (1997), with the exception that Cushman David and Zha (1997) do not assume that the Canadian interest rate responds contemporaneously to the industrial production of the United States. In the case of Mexico, within the analysis carried out by Banco de México prior to its monetary policy stance, the three variables of the United States are considered in the timeliest manner possible. The following matrix shows in a general form the identification of the SVAR block exogeneity model that will be used throughout this research document.

The first block  $A_{11}$  (in the upper left corner) shows the way in which the domestic variables interact with each other. The second block  $A_{12}$  (in the upper right corner) establishes the way in which the Mexican variables react to the United States variables. The third block  $A_{21}$  (in the lower left corner) is the exogeneity block by which it is established that the variables of the United States never react to the Mexican variables. The fourth block  $A_{22}$  (in the lower right corner) shows the relationship of the United States variables with themselves.

$$A(0) = \begin{matrix} B \\ Y \\ P \\ EXCH \\ R \\ \\ Y^* \\ P^* \\ R^* \end{matrix} \begin{pmatrix} a_{11} & 0 & 0 & 0 & 0 & \cdot & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & 0 & \cdot & a_{26} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 & 0 & \cdot & 0 & a_{37} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} & 0 & \cdot & a_{46} & a_{47} & a_{48} \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & \cdot & a_{56} & a_{57} & a_{58} \\ \cdot & \cdot \\ 0 & 0 & 0 & 0 & 0 & \cdot & a_{61} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & \cdot & a_{71} & a_{72} & 0 \\ 0 & 0 & 0 & 0 & 0 & \cdot & a_{81} & a_{82} & a_{83} \end{pmatrix} \quad (6)$$

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<sup>11</sup>Under this assumption I allow for the Mexican monetary policy indicator to react on impact to external variables.

## 5 The Effects of Monetary Policy Shocks in Mexico

First, I review whether the variables are stationary or not, using Dickey Fuller (ADF) Test. From those results it can be concluded that all variables in levels are  $I(1)$  by using the ADF test (See Figure 1 ), while all variables are stationary in first differences. And I proceeded to estimate the VAR<sup>12</sup> models by using the variables in log-levels.

### 5.1 *The Effects of Monetary Policy Shocks in Mexico at the National Level*

I proceed to estimate the SVAR model described above with information for the period July-2001 to December-2019. An important reason why a modern sample is desirable is that it encompasses a period of relative economic stability. Furthermore, in 2001 the Mexican Central Bank began adoption of an inflation targeting regime. For the structural VAR estimation, I follow the strategy of Den Haan et al. (2007) and Den Haan et al. (2009) whereby bank loans are desegregated<sup>13</sup> into consumer and commercial and industrial<sup>14</sup> loans, as well as proceeding to review the transmission of monetary policy via an increase in short-term interest rates (monetary contraction).

Figure 3 shows that following a monetary tightening<sup>15</sup> consumer bank loans respond negatively with a lag of approximately 4 months after the monetary shock, this result is consistent with Den Haan et al. (2007) and Den Haan et al. (2009). On the other hand, commercial and industry bank loans respond with a lag of 1 month and their response shows an increase that lasts approximately 4 months. This last result is contrary to what the textbook suggests and is known as the “loan puzzle”. It should be noted that an important characteristic of the loan puzzle is that it is a short-run phenomenon (Den Haan et al. (2007), Den Haan et al. (2009) and Leblebicioglu and Valcarcel (2018)). However, I find that following a monetary tightening, the duration of the positive response of firms bank loans in Mexico is shorter than that reported by Den Haan et al. (2007) and Den Haan et al. (2009) for the case of the United States and Canada, respectively (the authors report positive

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<sup>12</sup>The number of optimal lags according to the Akaike criterion (AIC) was obtained for each VAR model. The confidence intervals of the Impulse Response Functions (IRFs) were estimated according to the Bayesian method suggested by Cushman David and Zha (1997). The computation is based on 5000 MonteCarlo draws of which 10 percent were burned. The bands of the coefficients correspond to the 16th and 84th percentiles of the previous computations.

<sup>13</sup>I assume for simplicity that there is no contemporaneous relationship between consumer and commercial and industry bank loans.

<sup>14</sup>Consumer (excluding housing) and commercial and industry bank loans represent on average 74 percent of the total bank credit to the private sector. Housing is excluded because credit to this sector could be more sensitive to long-term interest rates.

<sup>15</sup>I also estimate a SVAR model with block exogeneity by considering the bank credit at the aggregate level (consumer loans plus firms loans). And I find that following a monetary tightening, bank credit increases during the first 4 months, probably influenced by the firms loans response.

responses that seem to last more than a year). However, in terms of the duration of the response of the firm's bank loans, my results are more similar to those found by Leblebicioglu and Valcarcel (2018) for emerging economies, Mexico included. Leblebicioglu and Valcarcel (2018) report for the Mexican case a loan puzzle response duration of less than one year. Although Leblebicioglu and Valcarcel (2018) analyze the case of a monetary expansion.

Some of the reasons for observing this differentiated response from consumers and commercial and industry bank loans are that following a monetary tightening, banks could be discriminating between consumers and firms according to their risk level. For example, in Figure 4 it is observed that although during the entire time period of analysis (July-2001 to December-2019) the firms risk<sup>16</sup> is relatively higher (6.5 percent) compared to the consumers risk index (5.0 percent), if I consider the period from January-2006 to December-2019 (which represents the 76 percent of the entire time series), the consumers risk is more than 2 times the firms risk level. In such a case, banks could restrict credit to relatively riskier agents, but could increase it to less risky agents for a short period of time.

The negative consumer bank loans response that I find is consistent with Gertler and Gilchrist (1993) and Gertler and Gilchrist (1994) who argue that generally following a monetary tightening, consumers and small businesses are more relatively affected, in part because their consumption and investment are largely dependent on of bank credit. Den Haan et al. (2009) argue that after an interest rates an increase, banks could reduce credit to consumers and use those resources to lend them to firms, which would be more attractive for banks, since they would pay higher interest rates and at a lower risk. Another possible explanation for the firms loan puzzle to occur is that companies may anticipate that after a monetary shock there could some subsequent interest rates increases and consequently, taking into account their expectations and a high credibility on the Central Bank, companies may increase their bank loans demand prior future monetary contractions. In line with this last hypothesis, Bernanke and Gertler (1995) point out that after a short-term interest rates increase, large firms could anticipate some banks borrowing for funding some short-run duties like for example, inventories investment and paying working capital<sup>17</sup>. In line with that hypothesis, Banco de Mexico indicates<sup>18</sup> that during the period from August 2019 to April 2020, in

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<sup>16</sup>I use the loan delinquency rate to approximate the consumer and firms bank loans risk.

<sup>17</sup>Since identifying if it is the bank loans demand or the supply what it is causing the loan puzzle was not possible in this paper, I find very interesting continue analyzing it in the future. Nevertheless, part of that work has already been done for the Mexican case by Cantú et al. (2019), in which they point out that generally large firms with longer relationships with banks and higher credit scores are less affected during shock periods.

<sup>18</sup>Banco de México. Quarterly Report, January-March 2020 in the Box: Impact of monetary policy easing on firms' financing costs. Downloadable at <https://www.banxico.org.mx/publications-and-press/quarterly-reports/quarterly-reports-prices-banc.html>.

which short-term interest rates (TIIE) were reduced, the firms' financing costs may have decreased, mainly in the case of large firms. Since for example, in March 2020, 85 percent of large firms bank credit was related to variable interest rates (66 percent for small firms).

On the other hand, according Figure 5, within this analysis, the response of the national production (IGAE) seems to negatively respond quickly after the monetary contraction. In addition, the exchange rate (EXCH) falls after 8 months, however, the price level seems to be a more persistent and rigid variable after the short-term interest rates increase. I now turn to a domestic SVAR approach. And I find that through a recursive VAR model for the period July-2001 to December-2019, according to Figure 6 suggest that consumers and commercial and industry bank loans responses are also similar to those found for the open economy model. In this case, the "loan puzzle" is still a response found for commercial and industry bank loans.<sup>19</sup> The results of Figure 6 show that following a monetary tightening, the consumers and commercial and industry bank loans responses seem to be more related to domestic factors than to external variables. Figure 7 shows, that on a closed economy model, Mexican economic variables are found to respond similarly compared with a SOE model after a monetary positive shock. However, the SOE model seems to produce a more appropriate response for the price level (INPC).

Furthermore, when the price and output variables are removed within the set of domestic variables, the responses of bank credit remain similar to those previously found. The results of Figure 8 show that the response of the bank loans volume to the short-term interest rate shocks are robust to the inclusion or exclusion of INPC and IGAE. However, the set of foreign variables helps to improve the response of economic variables (prices and production) after a monetary contraction.

## *5.2 Effects of Monetary Policy Shocks in Mexico at the Sectoral Level*

Once having identified that there is a puzzling response of commercial and industry bank loans at the aggregate level, I proceed to carry out a sectoral analysis<sup>20</sup>, through which I decompose commercial and industry bank loans for 7 economic sectors<sup>21</sup>: primary (PRIM), mining (MIN), tourism (TUR), financial (FIN), construction (CONST), manufacturing (MAN) and commerce (COM). The idea of this exercise<sup>22</sup> is to observe if the response of commercial and industry bank loans is heterogeneous across the different sectors or not. The results are shown in Figures 9 and 10, and I find that the banks loans for the manufacturing, commerce,

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<sup>19</sup>However, through this identification of the monetary policy that considers Mexico as a closed economy, a "price puzzle" emerges.

<sup>20</sup>One SVAR model with Block Exogeneity is estimated for each economic sector.

<sup>21</sup>Bank loans to these 7 sectors represent on average of 76 percent of the total firm's bank credit.

<sup>22</sup>I assume for simplicity that there is not a relationship across the bank loans for each sector.

tourism and financial sectors show a positive response after the monetary tightening. The banks loans response of the manufacturing and commerce sectors having the longest duration response, while in the case of the tourism and financial sectors, the loan puzzle barely lasts 1 month. On the other hand, bank credit for the primary and mining sectors seems to responds negatively after the monetary shock. In this regard, it is worth pointing out some reasons that may explain this heterogeneous bank loans response across the different economic sectors.

In the first place, note that according to Figure 11, during the period July-2001 to December-2019, bank loans for the manufacturing sector have represented on average 28.8 percent of the total firms bank credit (the highest participation with respect to the rest of the sectors). Therefore, it makes sense that since bank credit for manufacturing is the most relevant, the bank loans for this sector largely explains the commercial and industry loan puzzle at the aggregate level.

Regarding the puzzling response of bank credit in the manufacturing, commerce, tourism and financial sectors after an interest rate increase, one of the characteristics that those sectors share is that on average, during July-2001 to December-2019, these sectors showed the lowest risk compared to the other sectors. Figure 12 shows that the riskiest economic sectors are the primary (PRIM), construction (CONST) and the mining sector (MIN). Therefore, this strengthens the hypothesis that following a monetary tightening, banks could give more funding to relatively safer sectors. In this regard, I would like to focus on the case of the manufacturing sector, given its high relevance within the distribution of bank loans (28.8 percent). Regarding the manufacturing sector, it is convenient to mention, as shown in Figure 13, that in this sector most (43 percent) of the country's large companies are concentrated. And according to Figure 14, large companies are relatively much less risky (3.6 percent risk) than small and medium-sized companies (6.0 percent risk). This context strengthens the hypothesis suggested by Bernanke and Gertler (1995) which point out that sectors, such as manufacturing, in which large companies are concentrated could observe a greater access to the credit market compared with some other sectors that may be riskier and less relevant.

In another strategy <sup>23</sup>, I include the bank credit of all the economic sectors in one VAR model. In order to carry out that sectoral analysis, since decomposing bank credit by economic sector would imply a high number of variables and a significant loss of degrees of freedom. I proceed to the estimation of a Bayesian VAR (BVAR)<sup>24</sup> model similar to the one

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<sup>23</sup>Under this strategy, US variables are treated as exogenous variables. Which is different from the previous strategy in which all variables were treated as endogenous. Nevertheless, we find that American variables have a modest contribution to explain the firms' loan puzzle.

<sup>24</sup>Bayesian techniques help to solve the dimensionality issue of a frequentist VAR model. The total number of iterations is 20,000, the number of burn-in iterations is 19,000.

previously estimated, with the difference that in this exercise the USA variables are treated strictly as exogenous. The idea is to use an informative prior to shrink the unrestricted VAR model towards a parsimonious naïve benchmark, thus reducing parameter uncertainty. That is, I assume that each endogenous variable in the model presents a unit root in its first own lag, and as a result, my prior for those coefficients is equal to 1. I also assume that parameters for lags higher than 1 and cross-variable (included exogenous variables) lag coefficients are equal to zero. Hence, I also assume that the variance of those priors has to be relatively small. The reduced form representation of this model is described below:

$$z_t = B_1 z_{t-1} + \dots + B_q z_{t-q} + C x_t + u_t \quad (7)$$

Where  $z_t$  is a vector of Mexican endogenous variables,  $x_t$  is a vector of American exogenous<sup>25</sup> variables,  $B$  is a matrix of coefficients for lagged variables,  $q$  is the number of lags,  $u_t$  is a vector of residuals for each equation. To allow for contemporaneous relationship of the variables I assume a recursive order of the endogenous variables and a Cholesky decomposition is used to identify the Mexican monetary policy shock.

The variance of parameters in  $B$  that relate endogenous variables to their own and cross-lags is defined as follows:

$$\sigma_{a_{ij}}^2 = \left( \frac{1}{\sigma_j^2} \right) \left( \frac{\lambda_1}{l^{\lambda_3}} \right)^2 \quad (8)$$

where  $\lambda_1$  is an overall tightness parameter,  $l$  is the lag for each coefficient and  $\lambda_3$  defines the rate at which coefficients higher than 1 (second lag, third lag...) converge to zero with greater certainty.  $\sigma_j^2$  is the unknown residual variance for variable  $j$  in the Bayesian VAR model. That variance is approximated by individual auto-regressive models.

For the exogenous variables, such as in this case, the USA variables, the variance for their coefficients is defined as follows:

$$\sigma_c^2 = (\lambda_1 \lambda_4)^2 \quad (9)$$

where  $\lambda_4$  is a large or infinite variance parameter.

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<sup>25</sup>Under this specification I also included a trend variable  $t$  as an exogenous variable and I find that results are robust to the exclusion or inclusion of this variable. I also did the same when disaggregating bank credit into consumer and bank loans and results do not change after including the trend variable.

A Normal Inverse-Wishart <sup>26</sup> prior distribution is assumed for the variance of the parameters. As well as the following hyper-parameters<sup>27</sup> for the coefficients in  $B$ : Auto-regressive coefficient: 1; Overall tightness ( $\lambda_1$ ): 0.2; Lag decay ( $\lambda_3$ ): 2; Exogenous variable tightness ( $\lambda_4$ ): 100; Block exogeneity shrinkage ( $\lambda_5$ ): 0.001.

From this second strategy, I provide evidence of robustness for the previous industry results (Figures 15 and 16). As we can observe in Figure 15, the sectors in which I find the puzzling response are the same that I previously indicated, (manufacturing, commerce, tourism and finance). However, under this second strategy bank loans volume in the manufacturing sector seem to respond faster compared to the first strategy. Responses of bank loans of the mining and primary sectors are pretty similar (in terms of timing, direction and duration) to the ones of the first strategy (Figure 16).

## 6 Concluding Remarks

This paper expands on the research that Leblebicioglu and Valcarcel (2018) conducted for the Mexican economy, in which the authors analyze the transmission of the monetary policy through the bank credit to the private sector.

This paper addresses a number of questions. My interest lies in determining whether the loan puzzle is a feature of the modern Mexican economy. In addition, can an open-economy model shed light on its dynamics? Finally, can this perverse reaction be explained in a lending channel mechanism that incorporates sectoral dynamics?

Having carried out a comprehensive investigation involving information available from July-2001 to December-2019, I find commercial and industry bank loans increased during the first seven months after the monetary shock. This shows the loan puzzle in Mexico.

Some of the reasons that the literature identifies for this phenomenon to occur rely on supply and demand factors for loanable funds. Den Haan et al. (2009) argue that following a monetary tightening, banks could reduce their loans supply for consumers in order to try to offer more loans in relatively more attractive sectors, that is, sectors that would pay higher interest rates at a lower risk.

In an open economy identification strategy, I find a modest contribution of the set of foreign variables within the VAR model in explaining the monetary policy transmission on

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<sup>26</sup>The normal-Wishart variance-covariance matrix of  $B$  is a special case of the Minnesota variance-covariance matrix where  $\lambda_2$  is equal to 1.

<sup>27</sup>Priors for hyper-parameters  $\lambda_3$ ,  $\lambda_4$ ,  $\lambda_5$  are the ones suggested by Dieppe et al. (2016). The prior for  $\lambda_1$  is similar to Dieppe et al. (2016), but instead of using  $\lambda_1 = 0.1$ , I assume  $\lambda_1 = 0.2$  to allow for less shrinkage of the parameters,  $\lambda_1 = 0.2$  is consistent with Canova (2011).

bank credit. My finding of the loan puzzle in a modern sample derives from a domestic as well as an open economy approach.

Finally, to obtain more information on the loan puzzle identified for the firms' case, I desegregate bank loans by economic sector. And I find different changes of responses across sectors. For example, the response of credit to the manufacturing and financial sector is positive, while the response of the primary and mining sectors is negative. This is interesting, because the manufacturing and financial sectors are those that historically have shown to be less risky, while, on the other hand, the primary sector and the mining sector have registered higher delinquency rates. Overall, monetary policy may not transmit to bank credit evenly across sectors.

The goal of this paper is to broaden the understanding of the monetary policy transmission through the credit channel. Especially with the pandemic amid this difficult environment in which monetary policy can serve as an important instrument to mitigate the adverse effects of the economic crisis on business activity.

Among the future research avenues that I would like to address, it is my interest to conduct an analysis of monetary policy the transmission through the bank credit desegregated by firms' size. I find this analysis interesting, especially now that bank credit can help to mitigate the economic crisis that most affects small and medium-sized firms.

I would also like to analyze the response of bank loans after a non-monetary shock and compare those results with the found here. It would be also interesting trying to identify the Mexican monetary policy shock by considering some other assumptions, such as some sign restrictions.

Variable	Variables in Levels			First Differences		
	t-Statistic	C.V.	Result	t-Statistic	C.V.	Result
R	-1.8755	-2.8753	Unit Root	-3.9662	-2.8753	Stationary
P	-0.7039	-2.8753	Unit Root	-3.3075	-2.8753	Stationary
Y	-0.9110	-2.8753	Unit Root	-6.1428	-2.8753	Stationary
EXCH	-0.8335	-2.8753	Unit Root	-10.1587	-2.8753	Stationary
Y*	-2.1165	-2.8753	Unit Root	-3.9191	-2.8753	Stationary
P*	-1.1635	-2.8753	Unit Root	-9.7781	-2.8753	Stationary
FFR*	-2.1681	-2.8753	Unit Root	-3.5629	-2.8753	Stationary
CVICON	-2.1998	-2.8753	Unit Root	-2.1757	-1.9424	Stationary
CVIEMP	-0.1920	-2.8753	Unit Root	-12.0938	-2.8753	Stationary
CVIPRIM	0.2760	-2.8753	Unit Root	-5.3419	-2.8753	Stationary
CVIMIN	-0.9568	-2.8753	Unit Root	-9.2494	-2.8753	Stationary
CVIFIN	-0.8636	-2.8753	Unit Root	-12.7288	-2.8753	Stationary
CVIMAN	0.0964	-2.8753	Unit Root	-7.7511	-2.8753	Stationary
CVICONST	-1.7160	-2.8753	Unit Root	-3.5757	-2.8753	Stationary
CVICOM	-1.3440	-2.8753	Unit Root	-5.5585	-2.8753	Stationary
CVITUR	-0.2588	-2.8753	Unit Root	-16.2363	-2.8753	Stationary

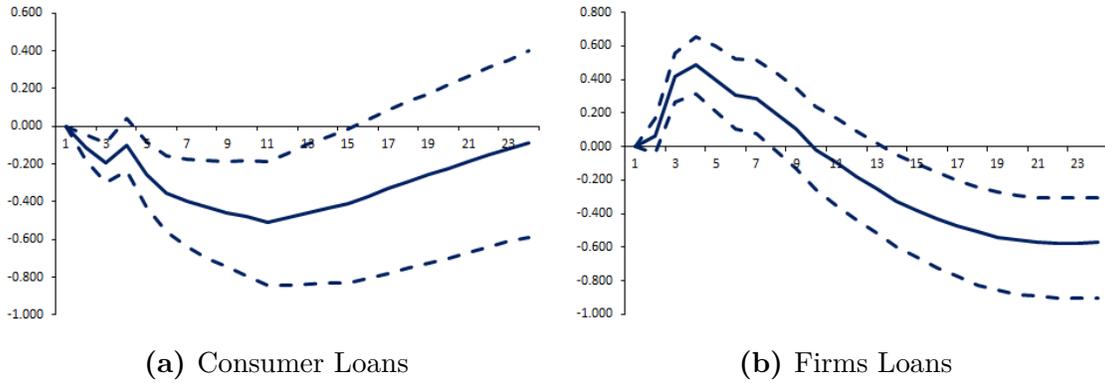
**Figure 1: Augmented Dickey Fuller Tests.**

Note: For the ADF tests an intercept was included and the selected number of lags was according to the Akaike Criterion (the maximum number of lags established was 14), MacKinnon (1996) one-sided p-values were considered to test the null hypothesis. Critical Values (C.V.) are at the 95 percent confidence level. First difference of variable CVICON is stationary without including intercept and trend.

VAR Model	Significance Level Q-Test
IRF's on Figures 3,5	0.76
IRF's on Figures 6,7	0.69
IRF's on Figure 8	0.16
IRF's on Figure 9 (a)	0.74
IRF's on Figure 9 (b)	0.69
IRF's on Figure 9 (c)	0.92
IRF's on Figure 9 (d)	0.91
IRF's on Figure 10 (a)	0.69
IRF's on Figure 10 (b)	0.94

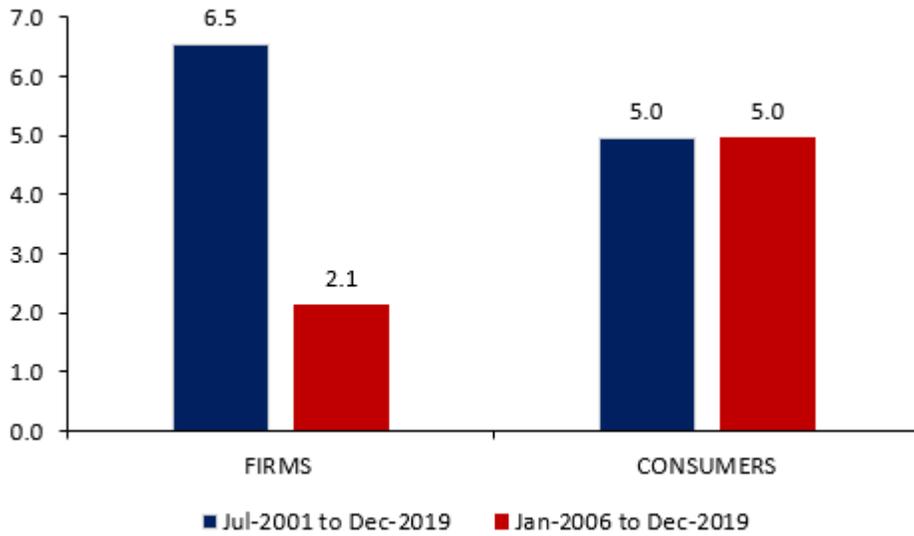
**Figure 2: Autocorrelation Tests.**

Note: The null hypothesis is that residuals from the VAR models are not serially correlated.

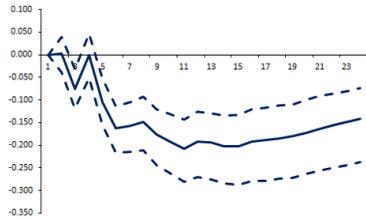


**Figure 3: Responses to a One Standard Deviation Increase in the Short-Term Interest Rate.**

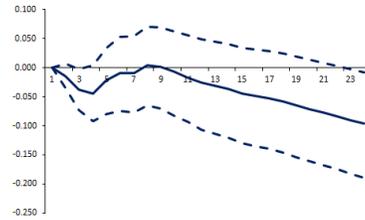
Note: Time in months (horizontal axis) and units in percent (vertical axis).



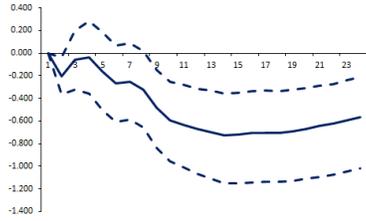
**Figure 4: Loan Delinquency Rate by Economic Sector**  
Source: Banco de México.



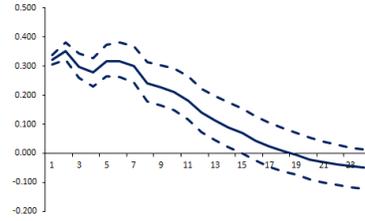
(a) IGAE



(b) INPC



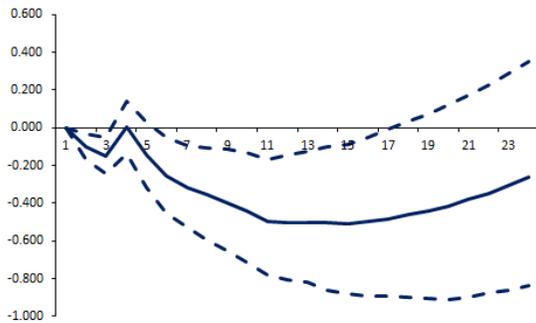
(c) EXCH



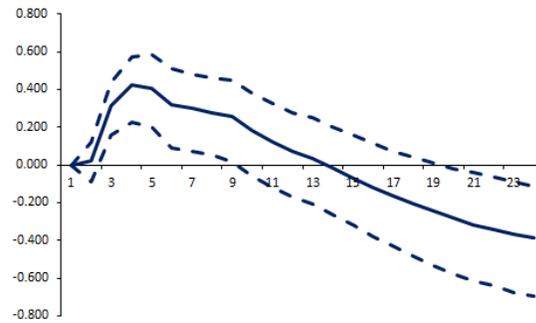
(d) R

**Figure 5: Responses to a One Standard Deviation Increase in the Short-Term Interest Rate.**

Note: Time in months (horizontal axis) and units in percent (vertical axis).



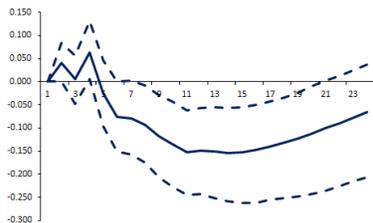
(a) Consumer Loans



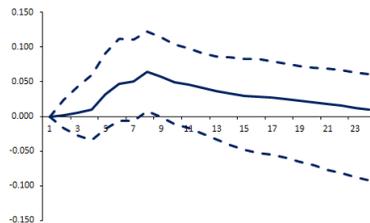
(b) Firms Loans

**Figure 6: Responses to a One Standard Deviation Increase in the Short-Term Interest Rate.**

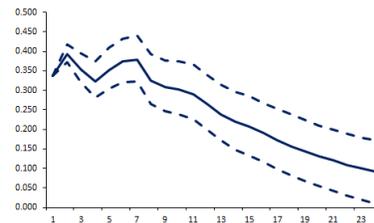
Note: Time in months (horizontal axis) and units in percent (vertical axis).



(a) IGAE



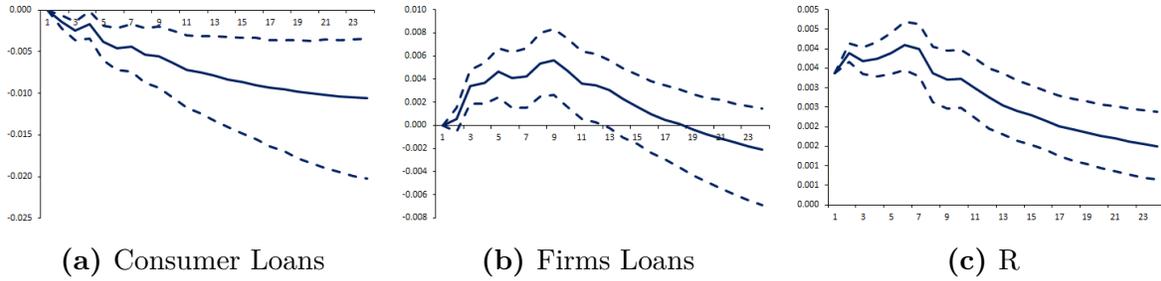
(b) INPC



(c) R

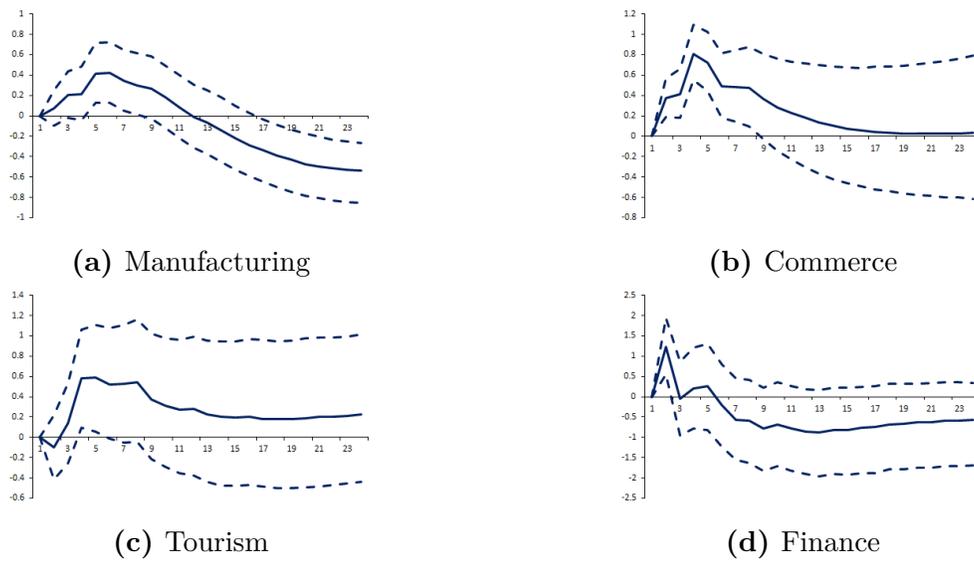
**Figure 7: Responses to a One Standard Deviation Increase in the Short-Term Interest Rate.**

Note: Time in months (horizontal axis) and units in percent (vertical axis).



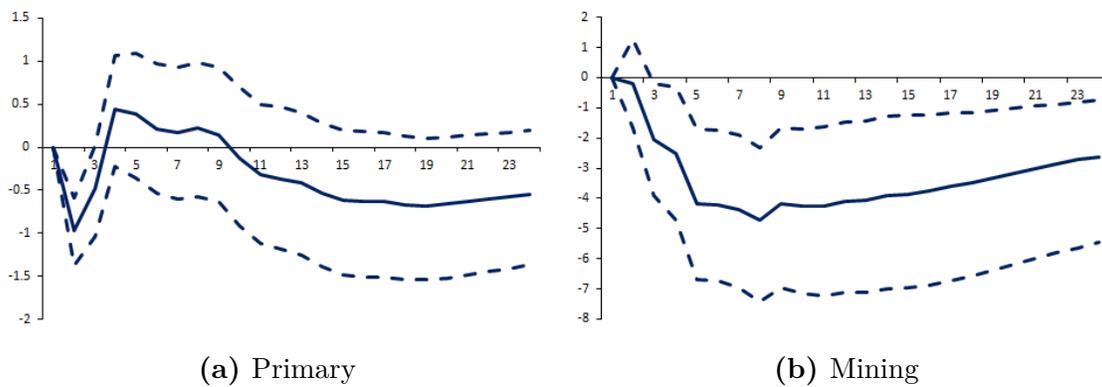
**Figure 8: Responses to a One Standard Deviation Increase in the Short-Term Interest Rate.**

Note: Time in months (horizontal axis) and units in percent (vertical axis).



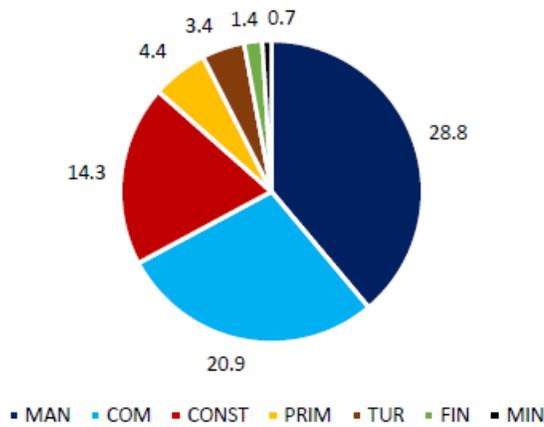
**Figure 9: Responses to a One Standard Deviation Increase in the Short-Term Interest Rate.**

Note: Time in months (horizontal axis) and units in percent (vertical axis).



**Figure 10: Responses to a One Standard Deviation Increase in the Short-Term Interest Rate.**

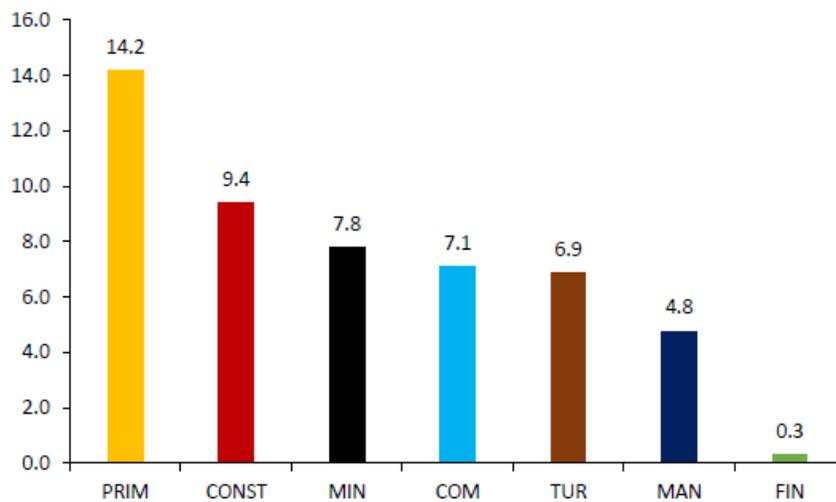
Note: Time in months (horizontal axis) and units in percent (vertical axis).



**Figure 11: Credit Participation by Economic Sector**

**Source: Banco de México.**

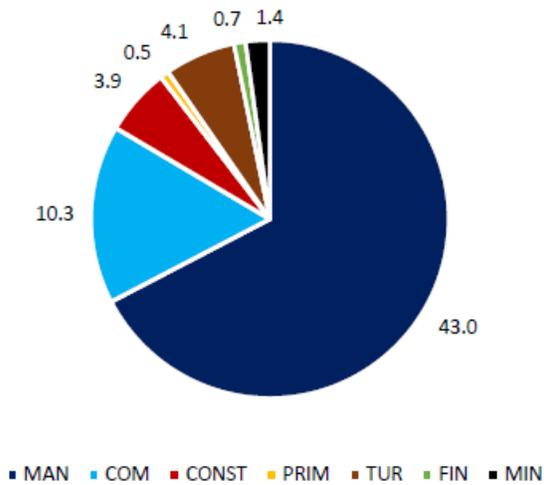
Note: Average values for the period July-2001 to December-2019. PRIM = Primary Sector. MIN = Mining Sector. MAN = Manufacturing Sector. CONST = Construction Sector. COM = Commerce Sector. TUR = Tourism Sector. FIN = Finance Sector.



**Figure 12: Loan Delinquency Rate by Economic Sector**

**Source: Banco de México.**

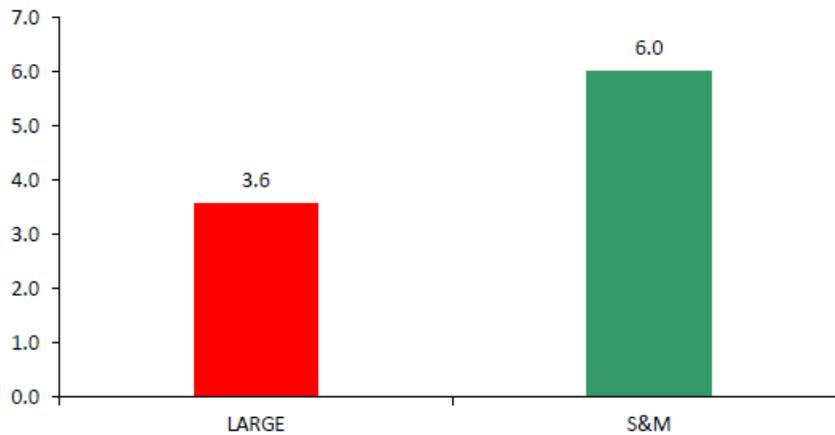
Note: Average values for the period July-2001 to December-2019. PRIM = Primary Sector. MIN = Mining Sector. MAN = Manufacturing Sector. CONST = Construction Sector. COM = Commerce Sector. TUR = Tourism Sector. FIN = Finance Sector.



**Figure 13: Large Firms Distribution by Economic Sector**

**Source: Economic Census, 2019 (INEGI).**

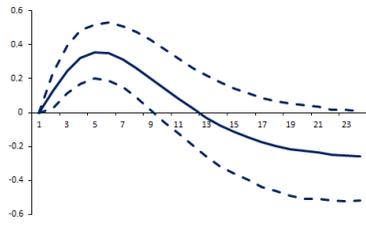
Note: PRIM = Primary Sector. MIN = Mining Sector. MAN = Manufacturing Sector. CONST = Construction Sector. COM = Commerce Sector. TUR = Tourism Sector. FIN = Finance Sector.



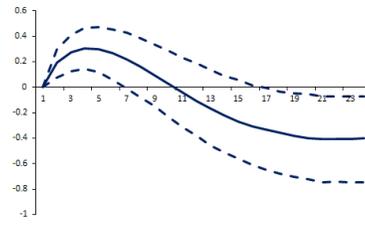
**Figure 14: Loan Delinquency Rate by Firm Size**

**Source: CNBV.**

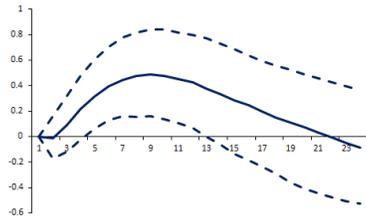
Note: Average values for the period January-2007 to December-2019. LARGE= Large Firms. S&M= Small and Medium sized Firms.



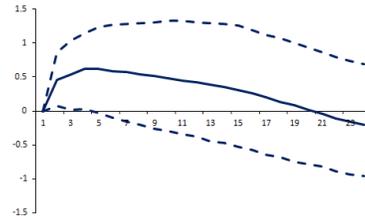
(a) Manufacturing



(b) Commerce



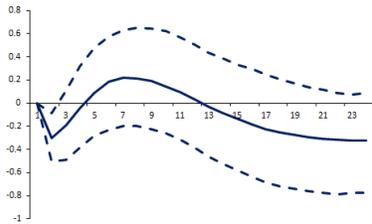
(c) Tourism



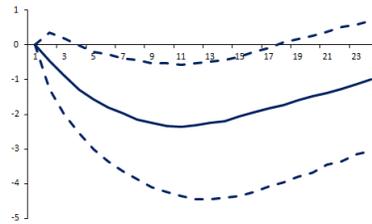
(d) Finance

**Figure 15: Responses to a One Standard Deviation Increase in the Short-Term Interest Rate.**

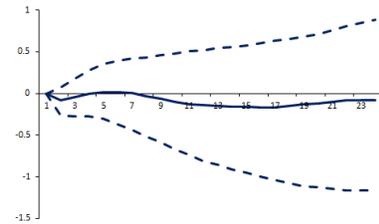
Note: Time in months (horizontal axis) and units in percent (vertical axis).



(a) Primary



(b) Mining



(c) Construction

**Figure 16: Responses to a One Standard Deviation Increase in the Short-Term Interest Rate.**

Note: Time in months (horizontal axis) and units in percent (vertical axis).

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