Regional and Industry Effects of Monetary Policy in Mexico*

Luis F. Colunga-Ramos[†‡]

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Abstract

Regions and industries are not homogeneous economic units. There are differences in the firms size and the degree of openness and exposure to markets, which can generate different reactions to common monetary policy shocks. My hypothesis is that for the Mexican case, regions and industries that have a stronger relationship with the financial sector are more sensitive to monetary policy shocks. Results show that after a monetary policy shock there are heterogeneous effects on economic activity in the Mexican regions and industries. Specifically, production in regions located in the north of the country tends to be more negatively affected by increases in the short-term rate. While the most sensitive sectors are those that are highly related to the credit market and durable goods production, such as manufacturing and finance. My results are explained in a context in which those regions and industries have a greater integration with the financial sector.

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[†]Economics Political and Policy Sciences, University of Texas at Dallas, LuisFernando.ColungaRamos@utdallas.edu
[‡]University of Texas at Dallas.

1 Introduction

Seminal work done by Sims (1980), Cushman David and Zha (1997), Sims and Zha (1998), Christiano et al. (1999) and others has suggested that monetary policy shocks can have a unique effect on the economy at the national level. However, a country is composed of different regions and different industries, whose economic variables might respond differently to monetary policy shocks shocks. Most of the literature centers on responses of economic variables at the national level. Regions and industries are not homogeneous economic units. There are differences in the size of firms and degree of openness and exposure of economies, among other factors, which can generate heterogeneous reactions in different regions and industries in response to common macroeconomic shocks, Zuccardi-Huertas (2002). For example, in the Mexican case, with the recent oil prices reduction during January 2020 to April 2020, the economic activity of the Southern region[1] and the mining sector has been affected the most compared with other Mexican regions and industries production due to its strong link with the oil extraction sector[2]. Moreover, there is evidence supporting the idea that the impact of economic shocks and monetary policy may differ among regions within a country (for the United States, Carlino and DeFina (1998); for Spain, De Lucio and Izquierdo (1999); for Chile, García et al. (2003); for Colombia, Zuccardi-Huertas (2002); for Canada, Georgopoulos (2009) and Potts and Yerger (2010); and for Indonesia, Ridhwan et al. (2014)).

And there is also some other evidence that supports the idea that following a monetary tightening the industry effects are not uniform, for example: for the United States, Bernanke and Gertler (1995) and Raddatz and Rigobon (2003); for Australia, Lawson et al. (2008); for the United Kingdom, Ganley and Salmon (1997); for Germany, Hayo and Uhlenbrock (2000); for France, Germany, Italy, UK and USA, Dedola and Lippi (2005); for Chile, García et al. (2003); for Malasya, Ibrahim (2005); for Israel, Ribon (2009); and for India, Sengupta (2014). However, for the Mexican economy there is no similar research on this topic. As a result, this paper is on the impact of the monetary policy at the sectoral and regional level on the Mexican economy contributes to this body of work.

[1] According to INEGI, the average annual participation during the 2013-2019 period in national oil production between the different regions is as follows, Northern: 2.29 percent; North Center: 0.01 percent; Center: 0.45 percent and Southern: 97.2 percent. That means that an oil prices reduction affects mainly the southern region economic activity.

[2] Banco de México. Regional Economic Report, January-March 2020. Downlowadable at https://www.banxico.org.mx/publications-and-press/regional-economic-reports/regional-economic-reports-sta.html.

The economic literature suggests different channels[3] through which monetary policy could have an impact on sectoral and regional economic activity. One of these channels is the interest rate channel since elasticities with respect to this variable might be different between different industries in each region. That may suggest for example, that a contractionary monetary policy that increases the cost of money will derive in a reduction in investment and aggregate demand. However, the investment response will be different across regions and industries depending on how sensitive their economic activity is to interest rates shocks.

Khan (2011), Mehrotra and Nadhanael (2016) and Yetman et al. (2018) point out that there exists a positive relationship between financial inclusion and the power and effectiveness of monetary policy. That is, in economies in which the access to bank loans is high, an interest rates reduction could stimulate the demand for credits so that business owners can fund their investment projects, which would represent a stimulus for aggregate demand. But if a large proportion of consumers and firms are financially excluded, then the monetary policy tools may have a lower impact on the economy.

According to the National Banking and Securities Commission[4] (2018) and INEGI[5] (2018), the southern states of the country have the lowest degree of financial inclusion compared to the rest of the states. In other words, in the southern states of the country, the indicators referring to financial infrastructure and access to banking system products (savings and credit accounts) are lower than those observed for the rest of the country's regions. As a result, I would expect that in those states in which the financial inclusion is relatively low, the transmission mechanism of monetary policy could be weak.

Why is it important to know whether the Central Bank monetary policy has distinct sectoral and regional effects? According to Ramos et al. (2000), from a theoretical point of view:

[3]The Banco de Mexico Law, in its second article states that:

> *The Banco de México's purpose shall be to provide the country's economy with domestic currency. In pursuing this purpose, its primary objective shall be to seek the stability of the purchasing power of said currency. The Bank shall also have the purpose of promoting the sound development of the financial system and fostering the proper functioning of payment systems.*

To achieve its objective, the monetary authority (Central Bank) has certain instruments that directly or indirectly influence economic activity. Usually, the instrument that a central bank uses to implement its monetary policy is the interest rate, also known as the reference rate. For the purposes of this paper I only analyze the interest rate channel. However, Beyer et al. (2017) point out that changes in the reference rate of the Central Bank affects the economy through some other channels, for instance: the credit channel, other asset prices channel, exchange rate channel and expectations channel.

Figure 1 shows how the different monetary policy channels affect the aggregate demand and finally the inflation.

[4]National Financial Inclusion Report (2018) downloadable at https://www.cnbv.gob.mx.

[5]National Survey of Financial Inclusion Results (2018) downloadable at https://www.inegi.org.mx/programas/enif/2018/.

If there is a set of regions or industries in which production is more sensible to a common monetary policy shock, when the monetary policy is expansionary, it is expected that their production experience a higher growth rate compared to the other regions and industries. While when the monetary policy is contractionary, the production growth rate of those regions and industries will be lower.

Therefore, the costs in terms of economic activity, for example, of a program to reduce inflation, would not be shared by all industries and regions in the same proportion, leading some sectors and regions to experience higher or lower costs versus the others. In addition, monetary policy could become a source of economic inequality in regional and sectoral economic cycles, widening the development gap between advanced and lagging regions[6] and industries.

In the last 14 years, average annualized GDP growth in Mexico has been 2.4 percent per year. According to the National Council for the Evaluation of Social Development Policy (CONEVAL), in 2008 the percentage of the population in Mexico living in poverty was 44.4 percent, while in 2016, that percentage was only reduced to 43.6 percent. Moreover, although the average growth of the economy has been low and insufficient to significantly reduce poverty levels, when analyzing economic growth by geographic regions, a great disparity can be observed. GDP of the northern region of the country had an average growth of 2.8 percent during the period 2004-2017, while the GDP of the southern region barely grew on average 0.4 percent. On the other hand, in addition to the different dynamism of the economic activity of the country regions, according to data coming from INEGI, historically the states located in the south have faced more unfavorable economic conditions. For example, while the annual GDP per capita in the northern region of the country has been on average 13,262 dollars, the GDP per capita of the southern region has been almost 30 percent lower than that of the northern region (9,464 dollars). Moreover, if we excluded the oil production sector from the southern region, the GDP per capita of that region would be the lowest among the regions. The scenario is still unfavorable when analyzing the average GDP per capita growth between regions. While the GDP per capita in the northern region of the country has grown on average 2.2 percent during 2004 to 2017, the GDP per capita of the Southern region has decreased 4 percent during the same period.

[6]For the purposes of this research, the states of Mexico are grouped into the following regions (Figure2): Northern: Baja California, Chihuahua, Coahuila, Nuevo León, Sonora and Tamaulipas. North-Central: Aguascalientes, Baja California Sur, Colima, Durango, Jalisco, Michoacán, Nayarit, San Luis Potosí, Sinaloa and Zacatecas. Central: Ciudad de México, Estado de México, Guanajuato, Hidalgo, Morelos, Puebla, Querétaro and Tlaxcala. Southern: Campeche, Chiapas, Guerrero, Oaxaca, Quintana Roo, Tabasco, Veracruz and Yucatán.

In this context, in which there has persisted an environment of wide inequality in economic activity between the different regions of the country, I consider that a better understanding of the monetary policy impact on regional and sectoral economic activity is important. For example, a contractionary monetary policy aimed to contain inflation could have a different impact, reducing economic activity mostly in regions and industries which are more sensitive to monetary shocks.

In order to investigate how different regional and industry economic activity can respond to a common monetary shock, my approach involves estimating a SVAR with an exogeneity block through the use of quarterly and monthly data that I collect from the National Institute of Statistics (INEGI) and the US Federal Reserve. Then, I argue for some anecdotal reasoning to explain these differences.

To my knowledge, this paper is the first to analyze the effects of monetary policy on economic activity at the regional and sectoral level in Mexico. The main findings show that economic activity in northern regions, where the financial inclusion[7] and degree of openness[8] are high, is more sensitive to monetary policy. In the same line, following a monetary tightening, manufacturing and finance sectors that have a strong linkage with the banking sector are more negatively affected.

This document is organized as follows: Section 2 describes the transmission of monetary policy on economic activity as explained by Banco de Mexico; Section 3 presents a literature review; Section 4 describes the data sources of information; Section 5 explains the methodology used for the purposes described above; Sections 6 and 7 presents preliminary results; while Section 8 discusses some final remarks.

2 Regional and Industry Effects of the Monetary Policy

This section describes first the literature reviewed for the case of monetary policy impact on regional economic activity. And second, it presents some research documents regarding the impact of monetary policy at the sectoral level. The international literature reports that monetary policy shocks has different effects at the regional or state level within different countries.

Carlino and DeFina (1998) examine whether monetary policy has similar effects across regions in the United States during the 1958–1992 period. They estimate impulse response functions from SVARs for each of the following regions: New England, Mideast, Plains, Southeast, and the Far West. They report that each region responds to a monetary policy

[7]Results consistent with Khan (2011), Mehrotra and Nadhanael (2016) and Yetman et al. (2018).
[8]Results consistent with Carlino and DeFina (1998) and García et al. (2003).

shock in a quantitatively similar way to that of the U.S. average. However, they find that the Great Lakes region is considerably more sensitive to monetary policy shocks, and the rest (Southwest and Rocky Mountains) were found to be much less sensitive. Then, they extend their investigation to a state-level analysis to draw inferences on the channels for monetary policy. State-level impulse responses to monetary policy shocks displayed noticeable variation both within and across major BEA regions. They conclude that the manufacturing-intensive states are more responsive to changes in monetary policy shocks when compared to the more industrially diverse states.

Georgopoulos (2009) studies the impact of monetary policy on economic activity at the regional level for Canada for the period 1976 to 2000. The author finds that following a monetary tightening, the most sensitive regions tend to be those that are more exposed to international trade, as well as those whose economic activity is mainly based in the manufacturing sector.

Potts and Yerger (2010) adds to the existing literature on Canadian-U.S. macroeconomic linkages by estimating the dynamic response of Canadian regional employment to shocks in both the Canadian Bank Rate and the U.S. Fed Funds Rate. They find that each Canadian region, except for Prairie, has a negative and statistically significant employment response to positive innovations in the Canadian Bank Rate with Ontario and Quebec being more interest-sensitive than other regions. This is to be expected given that Ontario and Quebec are the primary provincial hubs of Canadian manufacturing activity. Of particular note is the finding that each Canadian region, other than the West, exhibits very similar responses to changes in the Fed Funds Rate as to changes in the Canadian Bank Rate. The West is the only Canadian region that appears to be decidedly more sensitive to Canadian monetary policy than U.S. monetary policy. They also find that positive economic activity shocks in adjacent cross-border U.S. states have a positive impact on Canadian regional employment for all regions but not Quebec.

De Lucio and Izquierdo (1999) analyze the impact of a monetary policy shock on the economic activity of different regions in Spain. The authors find that in almost all Spanish regions an expansionary monetary policy generates increases in regional employment.However, the authors point out that the magnitude of employment responses is different between regions. The highest magnitudes of the responses on employment are associated with regions where the manufacturing sector and the degree of commercial openness are more relevant.

On the other hand, Ridhwan et al. (2014) analyze whether monetary policy had symmetric effects across the 26 Indonesian provincial economies during the 1990:1–2007:4. Their models reveal considerable regional differences in policy responses. West Java, the largest manufacturing-based province, tends to be the most affected by an unanticipated 1 percent

point increase in the monetary policy rate, while Bali's economy appears to be the least affected province. Notably Sulawesi and Eastern Indonesia, which are both highly dependent on the agricultural sector, are also less affected by the policy shocks, while Java Island, which is predominantly manufacturing based is more sensitive to monetary policy actions. Consistent with theory, they find that a contractionary monetary policy will be followed by the temporary fall of regional output and, after reaching the maximum (the lowest) point, the output tends to return to its equilibrium position. This suggests the relevance of the interest rate channel of monetary policy.

García et al. (2003) study the impact of monetary policy on regional economic activity in Chile. Their main findings were that the impact of monetary policy on regional unemployment is greater in those regions with commercial and industrial orientation than in regions whose economic activity is mostly associated with mining or agriculture.

Finally, Zuccardi-Huertas (2002) analyzes the regional effects of monetary policy in Colombia. The author divides the country into seven regions: Bogota, Medellin, Cali, Barranquilla, Bucaramanga, Manizales and Pasto. The author uses quarterly data for the metropolitan areas during the 1984-2000 period. Results show that there is no statistical evidence in the case of Colombia to reject the null hypothesis of equal regional reactions following a common monetary shock, despite the regional differences in industrial specialization, in company size, and degree openness. The author finds that these responses are not statistically different between regions and respond the same way to a common monetary policy shock.

These results mean that in Colombia the actions of the monetary authority are not a source of divergence in the economic cycles of the regions. Therefore, for example, costs in terms of economic activity of a program to reduce inflation will be shared by all regions in the same proportion, but none of them have to pay a higher or lower price compared with others. It also means that all regions would benefit similarly from monetary expansion. Therefore, plans for economic stabilization through monetary policy would not lead to different results between regions of the country.

From this first section of the literature review, I can conclude that in general, monetary policy in advanced and emerging economies have different effects on economic activity at the regional level. Note that regions mainly linked to the manufacturing sector and more export oriented are the most sensitive to monetary policy shocks. However, in the case of Colombia, no differences between regions were found, which could be due to the degree of homogeneity of the regions of the country.

Regarding the literature on the impact of monetary policy at the sectoral level, there are some research documents worth mentioning.

The essence of this research on the industry effects of the monetary policy relies on the contributions made by Bernanke and Blinder (1992), Bernanke and Gertler (1995) and Bernanke and Mihov (1998). These research papers explore the impact of monetary policy over economic activity, in part, through the use of VAR models in which variables of economic activity, price indices, and a monetary policy indicator are incorporated.

In some of the aforementioned research documents, the variable of economic activity is a measure of aggregate production at the national level, such as the national GDP or through a proxy variable for the national GDP (e.g. US Industrial Production). In measuring economic activity in this way, it is assumed that the impact form a tight monetary policy is the same among the different sectors of the economy.

I incorporate the ideas of Bernanke and Gertler (1995) who analyze the impact of monetary policy at the sectoral level for the United States case during the period January 1965 to December 1993. The authors find that durable consumer goods and residential investment tend to be the most sensitive sectors during periods of the interest rate tightening.

Raddatz and Rigobon (2003) analyze the impact of monetary policy at the sector level for the United States case during 1955-2003. The authors find that the industry responses to the monetary policy shock are heterogeneous. In particular, durable goods and residential investment were the most sensitive sectors to a monetary tightening. While sectors such as services and structures were the least sensitive to increases in the interest rate.

Lawson et al. (2008) analyzes the impact of monetary policy at the industry level in Australia during 1983 to 2007. The authors find that the most sensitive sector (measured from the expenditure perspective) to an interest rate shock was investment in machinery and equipment, while the most sensitive sectors measured from the production perspective were construction and retail.

In addition to Bernanke and Gertler (1995), Raddatz and Rigobon (2003) and Lawson et al. (2008), other authors also addressed the impact of monetary policy at the sectoral level but from another perspective. Under this other approach instead of including all the different GDP components simultaneously, a different VAR model is estimated for each sector. According to Raddatz and Rigobon (2003), this strategy is debatable since it implies variation both in the parameters and in the set of information available to the Central Bank when making monetary policy decisions. That is, by estimating an individual VAR it would be assumed that, for example, the impact of monetary policy on the price level would be different for each estimated sectoral VAR model. This leads to the difficulties in making comparisons from the impact of monetary policy across sectors. In contrast, the strategy of Raddatz and Rigobon (2003) provides a methodological framework that allows industry comparisons on the sectoral effect in the face of a common monetary policy shock.

Ganley and Salmon (1997) study the impact of monetary policy at the sectoral level for the United Kingdom case during the period 1975 to 1991. The authors find that the effects between industries are quite heterogeneous. Construction and manufacturing sectors are among the most sensitive to interest rate shocks. The services sector is the least sensitive. The authors find that within the manufacturing industries, the food and beverages and tobacco industries respond less to changes in the interest rate.

Hayo and Uhlenbrock (2000) analyze the impact of monetary policy on the production of 28 German industries. The authors find that the effects of monetary policy at the industry level are asymmetric. Among their main findings is that the most sensitive industries to the monetary policy are the non-ferrous metal industry, chemical industry, iron and steel industry, electrical engineering industry and manufacturers of machinery. The vehicle production industry had a response more similar to that of the manufacturing industry at the aggregate level.

Dedola and Lippi (2005) analyze the impact of monetary policy on the economic activity of 21 manufacturing industries for the case of France, Germany, Italy, UK and USA. They find that the impact of monetary policy is different across countries and between industries within the same country. In addition, some industries, such as, durable goods (motor vehicle) were more sensitive to interest rates. In contrast, other industries (non-durable goods), such as the food industry are less sensitive to monetary policy.

García et al. (2003) study the impact of monetary policy at the sectoral level for the case of Chile during the period 1986-2003. The authors find that in general, durable goods consumption and investment in machinery are the most sensitive sectors to changes in the interest rate, while non-durable consumption goods almost did not respond to a monetary policy shock. In the case of the impact of monetary policy at the sectoral level from the production perspective, the authors estimate a VAR model for each economic sector and find that the most sensitive sectors to an interest rate shock are commerce and construction. On the other hand, the least sensitive sector is that of primary activities.

Ibrahim (2005) analyze the impact of monetary policy at the sectoral level for the case of Malaysia. The author finds that the most sensitive industries to a monetary policy shock were: manufacturing, construction, finance, insurance, real estate and the business services sector. On the other hand, the least sensitive sectors to monetary policy shocks were agriculture, mining, electricity, water and gas.

Ribon (2009) analyze the impact of monetary policy at the sectoral level (16 industries) for the case of Israel during the period January 1997 to June 2006. In general terms, Ribon (2009) find that the industries that produce durable goods are the most sensitive to the interest rate, while those that are more concentrated in large size companies tend to have a

lower response to shocks in the interest rate, in part, because they have a greater capacity to increase prices, that is, they have greater market power.

Sengupta (2014) analyze the impact of monetary policy at the sectoral level for the case of India during 1996:Q1 to 2011:Q4. In particular, the author is interested in finding how sensitive are 8 sectors of the economy to an interest rate shock. Sengupta (2014) find that the most sensitive sectors to monetary policy are Construction, Mining and Commerce, which are mostly linked to the export sector and the credit market.

The literature suggest a consensus on the sectors of economic activity that are usually the most affected by a contractionary monetary policy. The sectors clasified from the expenditure perspective that are more sensitive to interest rate shocks are the durable goods consumption (Bernanke and Gertler (1995), Raddatz and Rigobon (2003), Dedola and Lippi (2005), García et al. (2003), Ribon (2009)); residential investment (Bernanke and Gertler (1995), Raddatz and Rigobon (2003)); and investment in machinery and equipment(Lawson et al. (2008), García et al. (2003)). While the sectors classified from the production perspective which are more sensitive to the interest rate are: construction (Lawson et al. (2008), Ganley and Salmon (1997), García et al. (2003), Ibrahim (2005), Sengupta (2014)), finance (Ibrahim (2005)); commerce (Lawson et al. (2008)), García et al. (2003), Sengupta (2014)); and manufacturing (Ganley and Salmon (1997), Ibrahim (2005)).While the least sensitive sectors are non-durable goods (Bernanke and Gertler (1995), Dedola and Lippi (2005)); food and beverages and tobacco (Ganley and Salmon (1997), Dedola and Lippi (2005)); services (Ganley and Salmon (1997), Raddatz and Rigobon (2003)); mining (Ibrahim (2005)).

Some of the reasons why these sectors are the most affected by a contractionary monetary policy are because their economic activity is strongly linked to the credit market, in which interest rates play a crucial role.

To sum up, having analyzed some literature regarding the industry effects of monetary policy, it is evident that there is no empirical evidence for the Mexican case with respect this topic. Therefore, it is my interest to reinforce the results derived from the regional effects analysis by considering also the sectoral effects.

3 Data

I consider quarterly and monthly frequency data on regional and industry production, an indicator of monetary policy, as well as other variables that the literature suggests for identifying monetary shocks in small open economies. The variables and sources of information are described below.

Time period of analysis goes from July 2001 to December 2019. The reasoning behind starting the analysis in 2001[9] 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, according to Chiquiar et al. (2010), inflation rate began to show a more stable behavior from 2001.

In the case of Mexico, I consider a set of four variables $(Y, P, EXCH, R)$, which correspond to those commonly used in the identification of a monetary shock for a small open economy. First, I have production (Y), which is disaggregated both at the regional and industry level. In the case of production at the regional level, I employ the Quarterly Indicator of State Economic Activity (ITAEE) since there is no quarterly production data available by state. However, given that this indicator is a production index by state and not regional, a regional indicator was calculated using the regionalization [10] of the Banco de Mexico, weighted by the relative participation of each state in the annual GDP of each region. I assume constant relative participations during each year, since the information of INEGI on national accounts by state is only of annual frequency. Note that this methodology is similar to that used by Banco de México in the Report on Regional Economies. Information on ITAEE and state GDP comes from INEGI. Regarding sectoral production data at the national level, this was obtained directly from INEGI, through the Global Index of Economic Activity (IGAE).

Regarding the second variable for Mexico, which refers to the price level (P), this was obtained directly from INEGI and corresponds to the National Consumer Price Index.

The third variable is the nominal exchange rate $(EXCH)$, which 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.

The fourth variable refers to the monetary policy indicator(R), which in this case is 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

[9]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).

[10]I have to mention that even though there are some other country regionalization's, I decided to work with the Banco de Mexico's regionalization in order to be consistent with the way in which the Central Bank carries out the analysis of the economic activity for its corresponding monetary policy stance.

(1996), De Mello and Moccero (2009), Cermeño et al. (2012), Cortés Espada (2013) and Carrillo and Elizondo (2015).

The information on the exchange rate and the short-term interest rate comes from Banco de México.

The United States variables, US Industrial Production (Y^*), US Consumer Price Index (P^*) and the US Federal Funds Rate (R^*) were obtained from the Federal Reserve Bank of St. Louis.

Data on production for Mexico and United States is seasonally adjusted. All variables, except for interest rates, were transformed to indices based on 2008 equal to 100, and then the logarithms[11] of the variables were obtained.

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 and Zha (1997) point out that recursive VAR models to identify monetary policy shocks make sense for relatively large and closed economies, such as the United States. Since monetary policy decisions in the United States are unlikely to have any influence from foreign smaller economies. By contrast, in the case of small open economies, shocks from some larger economies are more likely to have some impact on monetary policy decisions. This is important since in the seminal work done by Cushman David and Zha (1997) using recursive identification models applied to small open economies, after a monetary contraction, leads to increases in the price level ("price puzzle") as well as a depreciation of the domestic currency ("exchange rate puzzle"), which is not consistent with the theory. These findings are documented in Cushman David and Zha (1997) in relation to the work done by both Sims (1992) -price puzzle- and Grilli et al. (1995) -exchange rate puzzle-.

Taking into account these anomalies, possibly due to a wrong identification of the monetary policy models, Cushman David and Zha (1997) estimate a SVAR in which they take into account that the domestic variables of a small open economy can respond contempora-

[11]Note that the estimation of the SVAR models is by 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), in addition to other works on the effect of monetary policy on regional and sectoral economic activity, namely García et al. (2003) and Ridhwan et al. (2014). As well as other studies regarding the impact of monetary policy, Brandt and Freeman (2009). The idea is that if all the variables are integrated in the same order and there are cointegrating equations, then, the estimation of the SVAR models is appropriate.

neously and with a lag to variables of a larger economy, but not vice versa. In other words, they analyze the case of the United States (large economy) and Canada (SOE), which is considered a small open economy compared to the United States. Thus, the variables of the United States are considered exogenous with respect to the set of variables of Canada. Cushman David and Zha (1997) find that under this SVAR Model with an Exogeneity Block, after a monetary contraction in Canada, an increase in the interest rate is observed, as well as an appreciation of the domestic currency, which is consistent with the theory. In such a way, by using this alternative specification –the SVAR Model with Block Exogeneity-, "puzzling responses" are avoided.

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 countries, considered relatively smaller than the United States (Germany, Japan, United Kingdom, France, Italy and Canada). Kim and Roubini (2000) estimate a SVAR model in which they assume that the variables of these six countries may have an influence of variables from the United States, but not vice versa. Kim and Roubini (2000) find that by employing this specification after a monetary policy contraction, the presence of puzzling responses is not observed in the price level and 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 in Mexico), for this research document, the methodology is in the spirit of Cushman David and Zha (1997) and Kim and Roubini (2000), although with some modifications. More important, my approach allows me to identify differences in the dynamics of the regional and industries production behavior after a monetary and external shocks. To my knowledge this is the first paper that describes this phenomenon. In my opinion, this analysis allows identifying the regions and industries in which monetary policy is effective and, therefore, anticipating which regions and sectors of economic activity would be most affected by a contractionary monetary policy. In the same line, this paper also allows me to identify the regions and industries that benefit the most from an economic expansion in the United States. For which, initially I consider the use of a VAR model. The representation of this model is described below:

$$z_t = B_1 z_{t-1} + ... + B_q z_{t-q} + u_t \tag{1}$$

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 Equation 2, we have that the variance-covariance matrix is full ($E\left[u_t {u_t}' \mid y(t-s), s>0\right] = V$). Having

considered the contemporaneous relationship of the variables by identifying A_0, it is possible to rewrite the previous model in its structural form as follows:

$$A_0 z_t = A_1 z_{t-1} + \ldots + A_q z_{t-q} + \varepsilon_t \tag{2}$$

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, we can rewrite the Equation 2 as follows:

$$A(L)z(t) = \varepsilon(t) \tag{3}$$

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

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 United States variables. $\varepsilon_1(t)$ and $\varepsilon_1(t)$ are vectors of the residuals of dimensions $m_1 \times l$ and $m_2 \times l$, respectively. The dimensions of A_{11} are $m_1 \times m_1$, dimensions for A_{12} are $m_1 \times m_2$, dimensions for A_{21} are $m_2 \times m_1$ and dimensions for A_{22} are $m_2 \times m_2$, where $m_1 + m_2 = m$.

I also assume that:

$$E\left[\varepsilon(t)\varepsilon(t)' \mid y(t-s), s > 0\right] = I, E\left[\varepsilon(t) \mid y(t-s), s > 0\right] = 0 \tag{5}$$

The restriction that A_{21} is equal to zero implies that the variables of the United States are not affected by the variables of Mexico both 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: $Y, P, EXCH, R$ -in that order-. And for simplicity a recursive order is assumed. The order of the variables is similar to Carrillo and Elizondo (2015) in the sense that Banco de México can react contemporaneously to a production shock, but production reacts with a lag to monetary policy shocks.

However, to understand the possible heterogeneity in the response of economic activity at the regional level, I decompose variable Y into an index of economic activity for each region (Northern, North-Central, Central and Southern). Given that the mechanism in which the level of economic activity is contemporaneously related among different regions is unknown, I assume that the there is not a contemporaneous relationship between regional production levels. This assumption is similar to the one made by seminal work of Carlino and DeFina (1995). In a similar way to the case of Mexico, I assume a lower triangular order for the United States variables (Y^*, P^*, R^*), this assumption is consistent with Cushman David and Zha (1997). Regarding block A_{12}, given that 80 percent of Mexican exports go to the United States and this represents more than a third of domestic production, the national level of Mexico production is related to the US Industrial Production and consequently, regional production as well. Similarly, I assume that the price level in Mexico may be influenced by the international prices of goods and services, so the price level of the United States 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 may respond simultaneously 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, the three US variables may be taken into account by Banco de México prior to its monetary policy stance. The following matrix shows in a general form the identification of the SVAR Block Exogeneity Model that is 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.

$$A(L) = \begin{array}{c} \\ Y \\ P \\ EXCH \\ R \\ \\ Y^* \\ P^* \\ R^* \end{array} \begin{pmatrix} a_{11} & 0 & 0 & 0 & . & a_{15} & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 & . & 0 & a_{26} & 0 \\ a_{31} & a_{32} & a_{33} & 0. & & a_{35} & a_{36} & a_{37} \\ a_{41} & a_{42} & a_{43} & a_{44} & . & a_{45} & a_{46} & a_{47} \\ . & . & . & . & . & . & . & . \\ 0 & 0 & 0 & 0 & . & a_{51} & 0 & 0 \\ 0 & 0 & 0 & 0 & . & a_{61} & a_{62} & 0 \\ 0 & 0 & 0 & 0 & . & a_{71} & a_{72} & a_{73} \end{pmatrix} \tag{6}$$

The following expression $A(L)$ is similar to the previous one. It shows national production (Y) disaggregated at the regional level. Where S, CN, N, C refers to the production index for each of the four regions in which the Mexican territory is composed. The part of the model identification in which production is disaggregated at the regional level and therefore I include a production index for each of the regions within the SVAR is consistent with the strategy followed by Carlino and DeFina (1995), Georgopoulos (2009), Potts and Yerger (2010) and García et al. (2003).

$$A(L) = EXCH \begin{array}{c} \\ S \\ NC \\ N \\ C \\ P \\ \\ R \\ \\ Y^* \\ P^* \\ R^* \end{array} \begin{pmatrix} a_{11} & 0 & 0 & 0 & 0 & 0 & 0 & . & a_{18} & 0 & 0 \\ 0 & a_{22} & 0 & 0 & 0 & 0 & 0 & . & a_{28} & 0 & 0 \\ 0 & 0 & a_{33} & 0 & 0 & 0 & 0 & . & a_{38} & 0 & 0 \\ 0 & 0 & 0 & a_{44} & 0 & 0 & 0 & . & a_{48} & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & 0 & 0 & . & 0 & a_{59} & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} & 0 & . & a_{68} & a_{69} & a_{610} \\ a_{71} & a_{72} & a_{73} & a_{74} & a_{75} & a_{76} & a_{77} & . & a_{78} & a_{79} & a_{710} \\ . & . & . & . & . & . & . & . & . & . & . \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & & .a_{88} & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & & .a_{98} & a_{99} & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & . & a_{1008} & a_{1009} & a_{1010} \end{pmatrix} \tag{7}$$

Regarding the analysis of the impact of monetary policy at the industry level, the analysis is similar to that carried out by region. In such a way that the production variable is disaggregated by sector instead of by region. That is, production (Y) is disaggregated into the following 8 sectors: Tourism (TUR), Mining (MIN), Primary (PRIM), Financial

(FIN), Wholesale (WHOLS), Retail (RETAIL), Construction (CONST) and Manufacturing (MANUF). It is possible to have a higher level of disaggregation, since national production can be decomposed into 14 sectors, however, given that the previous 8 sectors represent more than 70 percent of total production and including more sectors in the VAR Model would reduce even more the degrees of freedom, I consider the 8 most relevant sectors[12]. The decomposition of (Y) and the inclusion of production indices by industry is consistent with Bernanke and Gertler (1995) and García et al. (2003). I also assume, as I do for the regional analysis, that since I do not know how is the contemporaneous intersectoral relationship, such a relationship exists but with a lag. This assumption is similar to the one made by Carlino and DeFina (1995) in their analysis of the impact of monetary policy but at the regional level.

For the regional and sectoral analysis, it should be noted that the literature suggests two options for one part of the identification of the SVAR Model. The first option implies including one regional or sectoral (for one region or one sector) production index and another one at the national level. Under this option it is assumed that there is no explicit relationship (contemporaneous and lagged) between regions and sectors, which is a strong assumption of which there is no evidence to support it for the Mexican case. The second option suggests an explicit relationship between regions and sectors, and consequently it is required to include all regional or sectoral production indices simultaneously inside the SVAR Model. Although the form of the contemporaneous relationship between regions and sectors is unknown, it makes enough sense to assume that there exists at least a lagged relationship between regions and sectors given the interregional migration[13] and interregional and intersectoral productive relationships documented by Callicó López et al. (2000), Fuentes (2005), Chapa Cantú et al. (2009), Dávila Flores (2015), Albornoz Mendoza et al. (2012), Ayala et al. (2015) and Haddad et al. (2019). As a result, along this document, I decide to work with the second option.

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

[12]These sectors have the highest shares on the national production.

[13]Interregional migration has been documented by Varela Llamas et al. (2017) and for Banco de México at The Regional Economic Report, October-December 2018 in the Box: Interregional Labor Mobility of Skilled and Unskilled Workers in Mexico, 2000–2015. Downlowadable at https://www.banxico.org.mx/publications-and-press/regional-economic-reports/regional-economic-reports-sta.html.

test (See Table 3), while all variables are stationary in first differences. And I proceeded to estimate the VAR[14] models by using the variables in log-levels.

5.1 The Regional Effects of Monetary Policy Shocks in Mexico

According to Figure 4, it can be seen that following a monetary tightening (increase of one standard deviation[15] of the monetary policy indicator (the short-term interest rate)) the economic activity of the northern regions, Northern (N) and North-Central (NC) respond negatively and fall until reaching the minimum point during the first 5 and 7 quarters, respectively. On the other hand, economic activity in the central region takes approximately 2 quarters to fall, and it declines up to 7 quarters after the monetary shock. Interestingly, economic activity in the southern region does not respond to monetary policy over the 15-quarter horizon. This contrast in these results is interesting, and subject to analysis, since it shows a differentiated response from regional economic activity with respect to monetary policy.

Note that the data analyzed is of quarterly frequency, period of analysis 2001:Q2 to 2019:Q4 is short and consequently, the number of observations is reduced. Taking this concern into account, a similar analysis [16] is made, where formal employment is used as a measure of economic activity. The use of formal employment could be considered as a good proxy variable for economic activity since the correlation between these two variables during the analysis period is 98.9 percent. In addition to the fact that the formal employment has been widely used as a measure of economic activity, for example: De Lucio and Izquierdo (1999), García et al. (2003) and Potts and Yerger (2010).

By using formal employment as a measure of economic activity, it can be shown that according to Figure 5, results are similar to those found using the regional production indices. In other words, the economic activity (measured through formal employment) in the southern region is the least sensitive to the monetary policy shock, since although in this case,

[14]The number of optimal lags according to the Schwarz criterion (SC) was obtained for each VAR model (regional and sectoral).The reason because I prefered not using AIC criterion to select the lags number is due to AIC tends to overestimate that number, and since the sample size that I am using is relatevly small, I think SC is the best option. 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.

[15]One standard deviation of the short term interest rate during the time period is equivalent to approximately 194 BPS.

[16]Under this identification, instead of using Industrial Production for the United States case, I use total nonfarm payroll employment to keep consistency with the fact of using formal employment in Mexico as a measure of economic activity.

formal employment falls in the first six months, it is subsequently not observed a statistically significant response, contrary to what happens in the rest of the country's regions.

As a result, it can be concluded that the economic activities of the regions located in the north of the country are more sensitive to monetary policy shocks. And therefore, the natural question is: what are the reasons for this heterogeneity?

Table 6 shows that northern regions tend to have a greater participation in the industry sector, specifically in the manufacturing sector, which can be further corroborated by Figure 7.

Figure 7 shows how in the northern states there is a strong specialization of economic activity in the manufacturing sector, particularly, in the automotive sector. In all the states located in the northern border, except Tamaulipas, there is at car-making company.

Additionally, Figure 8 and Figure 9 show that regions whose sensitivity to monetary policy shocks is lower, economic activity is more oriented to the services and oil extraction sectors. That is, economic activity in states like Veracruz, Tabasco and Campeche may be more sensitive to exogenous variables that affect oil extraction, like for example international oil prices.

Figure 8 shows that the states on the coasts of the country, specifically those located in the southeast tend to have a greater specialization in the services sector, such as tourism, so the economic activity of these sectors are expected to be more sensitive to exogenous variables that influence the flow of tourists to those states. Therefore, a lower impact of the domestic monetary policy in these states could be expected since a large part of the tourists come from abroad. According to the Ministry of Tourism, during the first two months of 2019, the arrival of national tourists to hotel rooms reached 8.5 million tourists (70.4 percent of the total); while 3.6 million were international tourists (29.6 percent of the total). Moreover, approximately 50 percent of the total international travelers stayed at the states located in the south of the country.

On the other hand, Figure 6 and Figure 10 show that financial penetration[17] tends to be greater in the northern regions of the country than in the south. In the central region, financial penetration is also high, which is not the case of the southern region. Moreover, the banking sector relevance in the southern region is the lowest among the rest of the regions. Furthermore, Figure 11 shows that according to INEGI[18], the southern states of the country have lower financial inclusion indicators in comparison with the states of the northern regions of the country. These indicators include: Automated teller machines (per 100,000 adults),

[17]Financial penetration is defined as Banking Credit/GDP.

[18]National Survey of Financial Inclusion Results (2018) downloadable at https://www.inegi.org.mx/programas/enif/2018/.

Commercial bank branches (per 100,000 adults), Credit cards (per 100,000 adults) and Debit cards (per 100,000 adults).

Given that the industrial activity in the northern regions of the country relies in large part on commercial banks credits, this is one likely reason why economic activity in the northern regions is very sensitive to increases in short-term interest rates. Furthermore, Figure 11 shows that according to INEGI[19], the southern states of the country have lower financial inclusion indicators in comparison with the states of the northern regions of the country. These indicators include: Automated teller machines (per 100,000 adults), Commercial bank branches (per 100,000 adults), Credit cards (per 100,000 adults) and Debit cards (per 100,000 adults).

In addition, note is that in the northern regions of the country, which I find to be more sensitive to monetary policy shocks, trade openness is very high, as indicated in Figure 12. Figure 12 shows that the share of exports with respect GDP of each state is larger in the northern regions than in the central and southern regions.

This result is consistent with the Mundell-Fleming-Dornbush model for a small open economy. That is, following a monetary tightening, one would expect that ceteris paribus, there would be capital inflows into Mexico, which would imply an appreciation of the Mexican peso (reduction in the exchange rate pesos/dollar) and, therefore, that may produce a cost increase of the domestic products, which would generate a negative impact on net exports.

Moreover, according to Banco de Mexico[20] (2018), exchange rate pass through over the consumers price level is higher in the regions located in the north of the country, which, as already mentioned, are the most exposed to international trade and in which the manufacturing sector has a greater participation.

The previous results are consistent with the literature claiming that regions in which the nature of economic activity is more oriented to the manufacturing industry, in which financial penetration is high and the degree of commercial openness is high, there is an observed larger impact from monetary policy on economic activity. While in regions whose economic activity is more oriented to mining or tourism, the effect of monetary policy is lower, Carlino and DeFina (1998) and García et al. (2003).

[19]National Survey of Financial Inclusion Results (2018) downloadable at https://www.inegi.org.mx/programas/enif/2018/.

[20]Regional Economic Report, October-December 2018 in the Box: Exchange Rate Pass-through on Prices in Mexico: A Regional Analysis. Downloadable at https://www.banxico.org.mx/publications-and-press/regional-economic-reports/regional-economic-reports-sta.html.

5.2 The Industry Effects of Monetary Policy Shocks in Mexico

Figure 13 shows that following a monetary tightening the production of the tourism sector (TUR) has a delayed negative response. Particularly the economic activity of this sector falls after the first quarter to reach a minimum point around the fifth quarter post-shock. One possible reason could be that if as a result of an interest rates increase, there is a reduction in investment plans, and consequently this could discourage business tourism. In this regard, the OECD[21] (2017) points out that bank credit is a powerful factor that has contributed to the growth of the tourism sector in Mexico. However, because some small and medium-sized tourism companies may face certain restrictions to obtain bank loans, the OECD (2017) reveals that, in such a case, public banks and government interventions that finance tourism companies at subsidized interest rates have played an important role in the development of the tourism industry.

Regarding the mining sector (MIN)[22], it can be observed that the response of economic activity of this sector is not statistically significant for all the horizon period analyzed. Mining is highly related to the oil extraction, an activity that is itself highly linked to the international oil market. Therefore, one would expect that the impact of domestic monetary policy would have a low influence on the production of this sector.

We can also observe that following a monetary tightening, the economic activity of the primary sector (PRIM) quickly responds in a negative fashion. In fact, the minimum point of this response is reached in the quarter after the monetary shock and it stabilizes in the eight subsequent quarters. The reasons why the economic activity of this sector responds quickly and prolonged are not clear, but they are probably related to a lower availability of credit to small business owners, with which the growth of the sector is weakened.

With respect to the financial and real estate services sector (FINANC), it can be observed that the production of this sector has a negative and statistically significant response following an interest rate increase. The response of this sector lasts until three years. The reasons why this sector is significantly affected by a contractionary monetary policy should be clear since in this industry the banking sector is included. Therefore, increases in the funding cost for financial institutions implies a lower capacity for issuing loans. This finding is consistent with the literature, Ibrahim (2005) and Sengupta (2014).

[21] Tourism Policy Review of Mexico Report downloadable at: https://www.oecd.org/mexico/tourism-policy-review-of-mexico-9789264266575-en.htm.

[22] According to INEGI (2020), the mining sector production considered in the national accounts is classified into oil and non-oil mining production. Being the oil mining production the one that on average from 2003 to 2018 has represented 86.3 percent of the total mining production.

According to Figure 14 it can be seen that the construction sector and wholesale have a delayed negative and barely statistically significant response given an interest rate increase. This result is consistent with Ganley and Salmon (1997), Bravo et al (2003), Ibrahim (2005) and Sengupta (2014). Some of the reasons for the sensitivity of the construction sector can be attributed to the fact that the production of the sector is closely linked to the credit markets. That is, the acquisition of real estate (e.g. houses, buildings, apartments, production plants and infrastructure) is usually accomplished through long-term credits. As a consequence, if there was an increase in the cost of money, one would expect a reduction in the construction sector.

The response to a monetary shock on wholesale trade (WHLSL) is also negative and the logic of this result relies on the fact that retail companies usually stock up on inventories through bank loans. Consequently, an increase in the interest rate affects the purchases of retail companies and, therefore, wholesale sales.

It is interesting that retail trade (RETAIL) does not respond to a contractionary monetary policy, nevertheless, it should be noted that the bulk of retail sales (63 percent according to INEGI (2015)) is related to the sale of non-durable goods, such as: food, fuel and health care items. Therefore, a low impact of monetary policy on retail sales of basic goods is expected. This finding is consistent with Bernanke and Gertler (1995), who argue that the consumption of durable goods will be the most affected.

On the other hand, following a monetary tightening, the economic activity of the manufacturing sector (MANUF) negatively responds quickly and in a prolonged manner. This is probably attributed to the fact that a large proportion of the goods produced in this industry are durable and exported. What in the case of durable goods can be linked to their high elasticity with respect to interest rates, while in what refers to export products it could be derived from an appreciation of the domestic currency.

The results derived from both regional and sectoral analysis are consistent with the literature. That is, the economic activity of the regions located in the north of the country is more sensitive to the monetary policy shock. In these regions, the sectors of construction, manufacturing of durable goods, commerce and finance have a high participation within the regional GDP. These results derived from the regional analysis are consistent with the sectoral analysis at the national level. On the other hand, the geographic region in which economic activity does not respond to changes in the interest rate is also that in which the mining sector have a high participation in its production.

Figure 15 and Figure 16 show that by employing monthly frequency data for the industry analysis, results are similar to the previous ones (with quarterly data). However, in this case the response of the tourism sector is not statistically significant.

6 The Effects of External Shocks in Mexico

Figure 17 shows that following an expansion of the industrial production of the United States, the production of all the Mexican regions shows a positive and statistically significant response. In fact, the production of the southern region shows the longest duration. Some of the reasons why the economic activity of the southern region has a longer lasting time response after an economic expansion in the United States could be the following. First, according to PEMEX[23] (2020), almost all of Mexico's oil production is generated in the southern region of the country, of which approximately 60 percent is exported to the United States. Second, according to Banxico[24] (2018), remittances from the United States to the states of the southern region have the second highest share of GDP compared to the rest of the country's regions. In addition, remittances have one of the highest contributions to GDP in the southern region. And, thirdly, according to the Secretary of Tourism[25] (2020), approximately more than half of the international visitors to the southern region come from the United States. These three factors together make an economic expansion in the United States become an important source of resources for economic activity in the southern region of the country.

In the same way, the Figure 18 shows that, if employment in the United States increases, the level of employment in the different Mexican regions shows an expansionary response. This result is understandable given that 80 percent of Mexican exports go to the United States. That is, it happens that, if the United States is doing well, Mexico too. On the other hand, Figure 19 shows that after a positive monetary shock in the United States (increase in the Federal Funds Rate), this contributes to an expansion of employment in all the Mexican regions, which probably occurs because after a monetary contraction in the US, that may motivate a Mexican peso depreciation and as a result, it positively contributes to the exports value and consequently regional economic activity increases.

Similarly, Figure 20 and Figure 21 show that sectoral economic activity responds positively to an increase in industrial production in the United States, that is the case of the tourism, mining, wholesale, retail, and manufacturing sectors. While the least sensitive sectors to US industrial production are construction and the banking sector. Regarding possible spillover effects of the US monetary policy on production at the sectoral level in Mexico,

[23]Petroleum statistics (may, 2020) available at https://www.pemex.com.

[24]Regional Economic Report January-March 2017 in the Box: Impact of International Remittances on Regional Economic Activity. Downloadable at https://www.banxico.org.mx/publications-and-press/regional-economic-reports/regional-economic-reports-sta.html.

[25]International arrivals statistics (april,2020) available at https://www.datatur.sectur.gob.mx.

Figure 22 and Figure 23 show that there is not generalized statistical evidence among the different industries.

7 Concluding Remarks

The main conclusions of this paper suggest that the effects of monetary policy on economic activity among the different Mexican regions and industries are heterogeneous. Through the estimation of SVAR Models with block exogeneity following Cushman David and Zha (1997) and Kim and Roubini (2000) it is found that the northern Mexican regions are more sensitive to monetary policy shocks. Some of the possible reasons are a high vocation of the economic activity related to the industrial sector and specifically, the manufacturing sector. While southern regions more oriented to tourism or mining sectors are less sensitive to monetary policy shocks. In the same way, regions whose commercial openness is greater will be more sensitive to changes in the monetary policy stance of the Central Bank. The previous results are similar to those found by Carlino and DeFina (1998) and García et al. (2003). Results at the regional level are confirmed through the analysis of the industry effects of monetary policy, since the most sensitive sectors to the interest rate are manufacturing and finance which are also those that have the greatest participation in the production of the northern regions of the country. Some of the reasons why these sectors are the most sensitive to shocks in the interest rate are due in the first place to their close relationship with the credit market. However, according to Dedola and Lippi (2005) other reasons could be a high capital intensity of production or the size of the companies that compose the industries (the smaller the companies or the higher leverage ratio, the lower their capacity to obtain external funding). This document contributes to a better understanding of the impact from monetary policy since it suggests that increases in the reference interest rate will have a greater negative impact on the northern regions of Mexico as well as in the manufacturing and finance sectors. In addition, this document is the first effort to provide evidence of the existence of heterogeneity in the effects of monetary policy at the sectoral and regional level within Mexico.

These results confirm that the impact of monetary policy is not homogeneous across economic regions within a county and across different industries, and also seem to suggest that the monetary policy may not work in areas where financial channels are weak. For example, in the case that Banco of Mexico would adopt an expansionary monetary policy that could enhance the economic growth of the states located in the south of the country, which are in more unfavorable economic conditions, probably the effectiveness of monetary policy would be limited or even null, in part, because the financial inclusion in that part of the country is the lowest compared to the rest of the regions. As a result, an expansionary monetary policy would imply an even greater gap between the states of the north and south of the country. Finally, more research needs to be done in order to strengthen these results. Future research

avenues that I intend to analyze is to study the impact of monetary policy by analyzing production since the expenditure perspective that is non-durable goods consumption, durable goods consumption, residential investment and investment in equipment and in machinery. Given that the literature for the Mexican case is quite limited, although other studies have been carried out for the case of Canada and Chile.

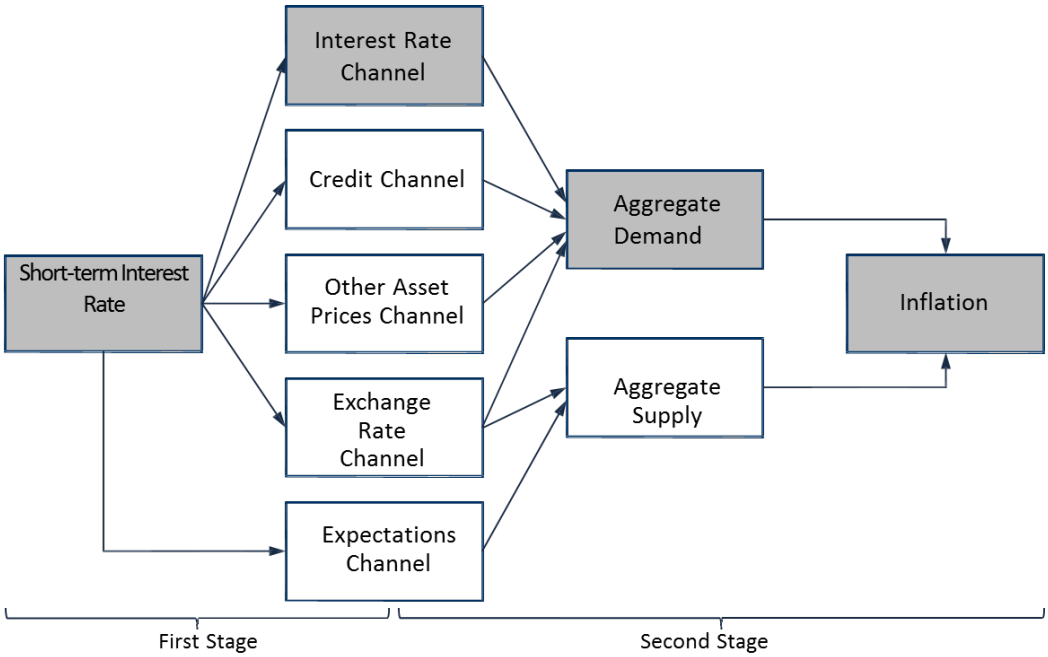


Figure 1: Transmission Mechanism of Monetary Policy.

Figure 2: Mexican states grouped by Region.

	Variables in Levels			First Differences		
	ADF Test			ADF		
Variable	t-Statisitc	C.V.	Result	t-Statisitc	C.V.	Result
R	-1.8282	-2.9024	Unit Root	-4.8835	-2.9024	Stationary
P	-1.1000	-2.9024	Unit Root	-2.6554	-2.9024	Unit Root
Y	-0.9841	-2.9024	Unit Root	-5.8274	-2.9024	Stationary
EXCH	-0.7319	-2.9024	Unit Root	-7.6023	-2.9024	Stationary
N	-1.0575	-2.9024	Unit Root	-5.5096	-2.9024	Stationary
NC	-0.3390	-2.9024	Unit Root	-6.0746	-2.9024	Stationary
C	-0.0372	-2.9024	Unit Root	-6.8448	-2.9024	Stationary
S	-3.1822	-2.9024	Stationary	-7.9829	-2.9024	Stationary
Y*	-2.7580	-2.9024	Unit Root	-4.1252	-2.9024	Stationary
P*	-1.7521	-2.9024	Unit Root	-6.2108	-2.9024	Stationary
FFR*	-3.0278	-2.9024	Stationary	-3.4731	-2.9024	Stationary
TUR	0.5504	-2.9024	Unit Root	-7.9523	-2.9024	Stationary
FIN	0.3336	-2.9024	Unit Root	-3.6874	-2.9024	Stationary
MIN	1.1313	-2.9024	Unit Root	-11.4809	-2.9024	Stationary
PRIM	-0.8575	-2.9024	Unit Root	-16.2707	-2.9024	Stationary
CONST	-1.8104	-2.9024	Unit Root	-1.8607	-2.9024	Unit Root
WHOLS	-0.5841	-2.9024	Unit Root	-7.6476	-2.9024	Stationary
RETAIL	-0.9088	-2.9024	Unit Root	-8.5716	-2.9024	Stationary
MANUF	-0.7929	-2.9024	Unit Root	-5.7333	-2.9024	Stationary

Figure 3: 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 11), 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 P is stationary at the 90 percent confidence level (C.V equal to -2.5926). While first difference of variable CONST was stationary at the 95 percent confidence level when including not only an intercept but also a trend variable in the ADF Test.

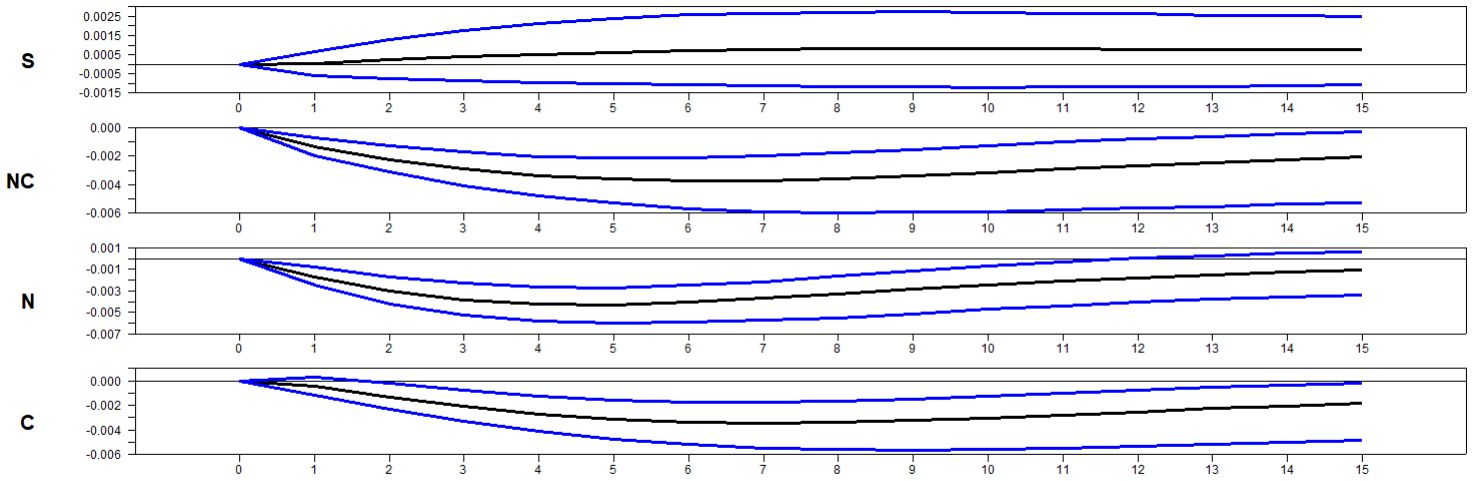


Figure 2(a)

Figure 4: Regional Production Responses to a One Standard Deviation Increase in SOFR (Quarterly Data).

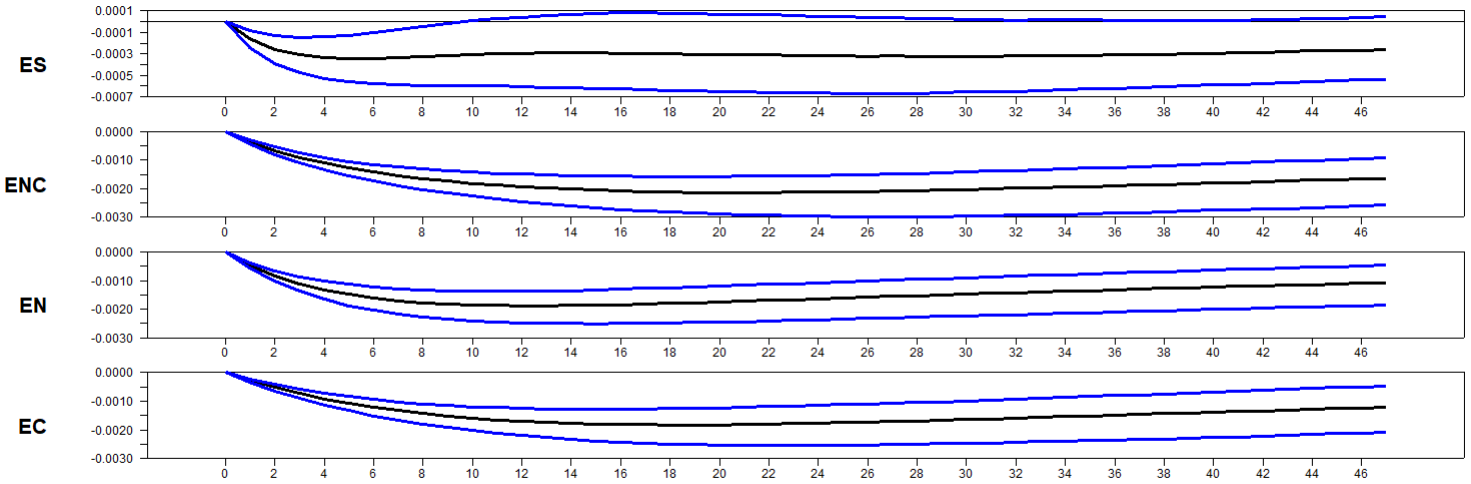


Figure 2(a)

Figure 5: Regional Employment Responses to a One Standard Deviation Increase in SOFR (Monthly Data).

REGION	GDP BY ECONOMIC SECTOR/REGIONAL GDP												CREDIT BY SECTOE/REGIONAL GDP					EXP/GDP
	AGRO	IND	CONST	MAN	MIN	PETR	SERV	RET	WHL	TRAN	FIN	TUR	CRE	AGRO	IND	SERV	HOU	EXP
Northern	3.1	43.1	9.3	28.7	2.9	0.4	53.8	7.3	7.0	6.1	3.2	1.4	12.3	0.5	4.0	3.7	3.0	75.7
North-Central	7.5	30.1	9.0	17.4	2.0	0.0	62.3	9.4	8.9	4.9	2.9	2.7	7.7	0.6	2.0	3.2	1.3	20.2
Central	1.6	22.9	6.0	15.7	0.3	0.0	75.5	8.7	8.1	6.7	6.4	1.6	23.7	0.3	7.1	8.9	5.9	17.0
Southern	4.1	35.6	9.1	9.0	15.6	14.9	60.3	8.2	6.7	5.3	2.2	3.6	4.9	0.2	0.9	1.8	1.1	12.6
National	3.6	31.4	7.9	18.0	3.9	2.6	65.0	8.4	7.8	6.0	4.2	2.1	14.6	0.4	4.3	5.3	3.5	31.1

Figure 6: Economic Activity Composition and Credit Relevance by Sector.

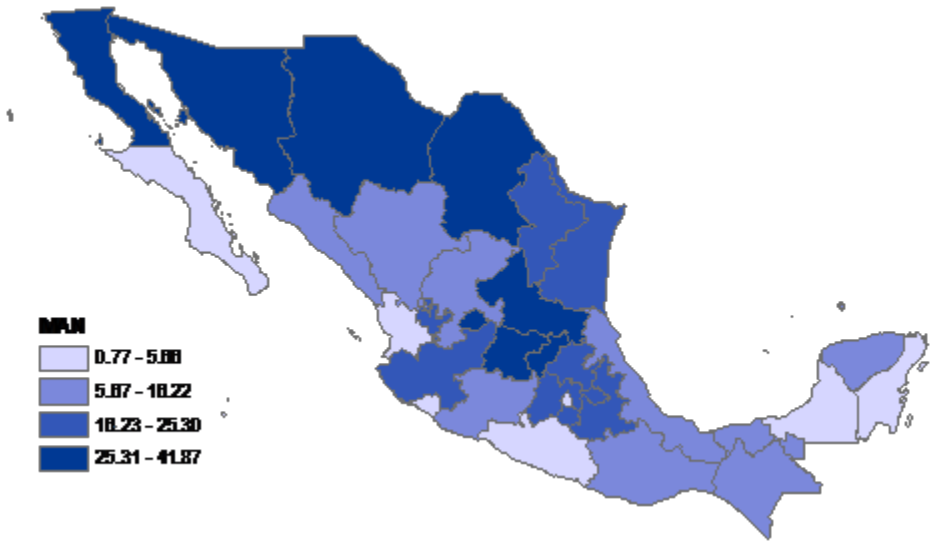


Figure 7: Percentage of Manufacturing GDP with respect Total GDP by State.

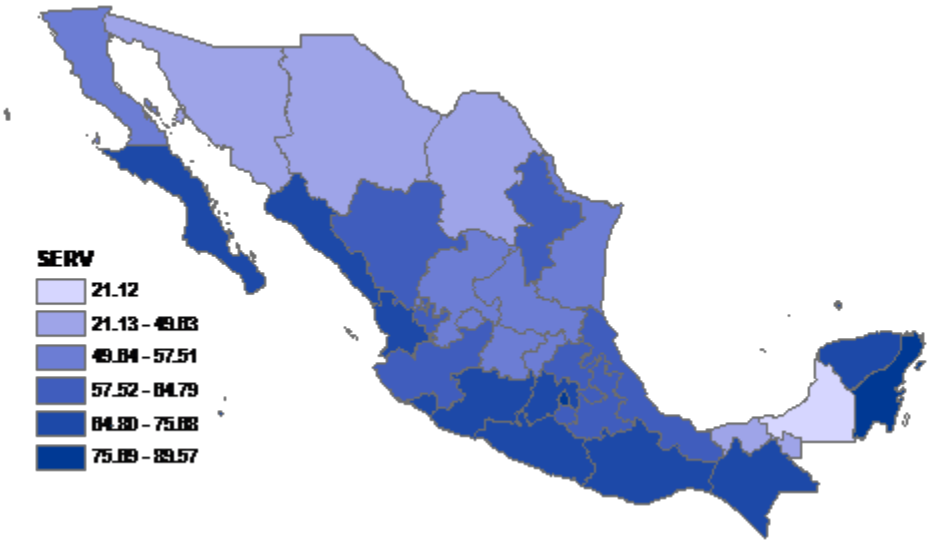


Figure 8: Percentage of Services GDP with respect Total GDP by State.

Figure 9: Percentage of Oil Extraction GDP with respect Total GDP by State.

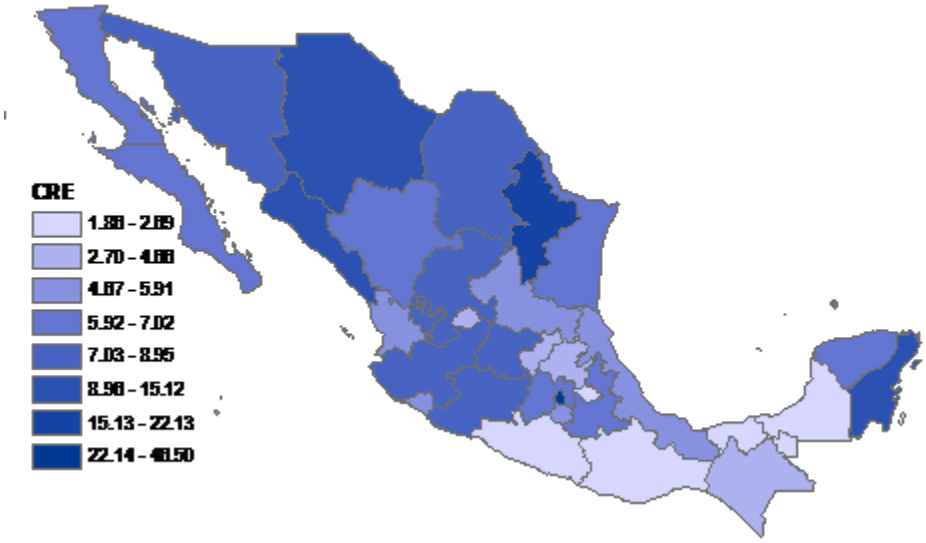
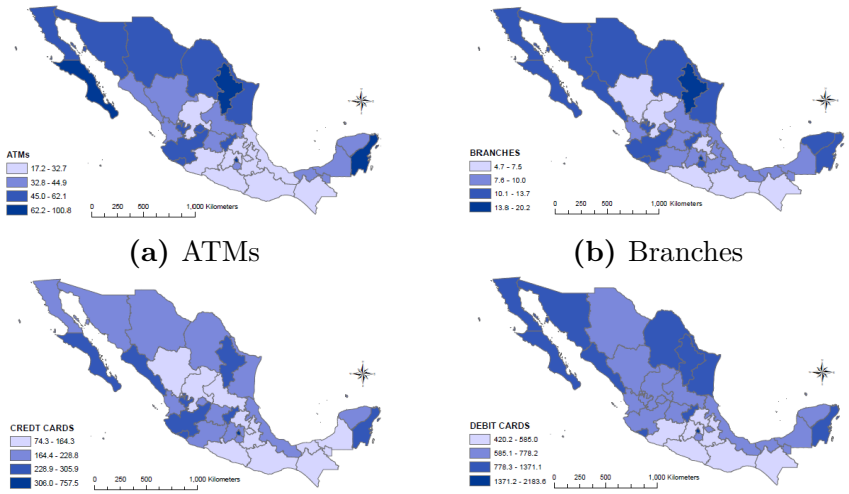


Figure 10: Percentage of Commercial Banks Credit with respect Total GDP by State.



(a) ATMs **(b)** Branches

(c) Credit Cards **(d)** Debit Cards

Figure 11: Other Financial Inclusion Indicators by State. Note: a) Automated teller machines (per 100,000 adults). b) Commercial bank branches (per 100,000 adults). c) Credit cards (per 100,000 adults). d) Debit cards (per 100,000 adults)

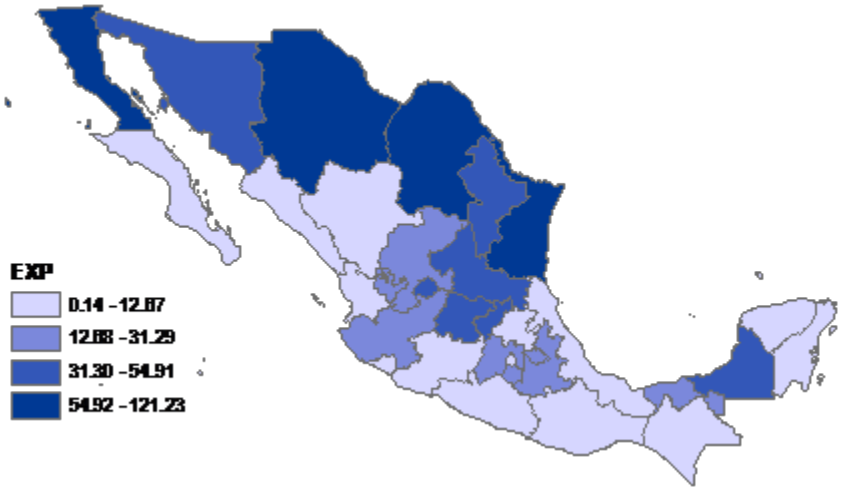


Figure 12: Percentage of Exports with respect Total GDP by State.

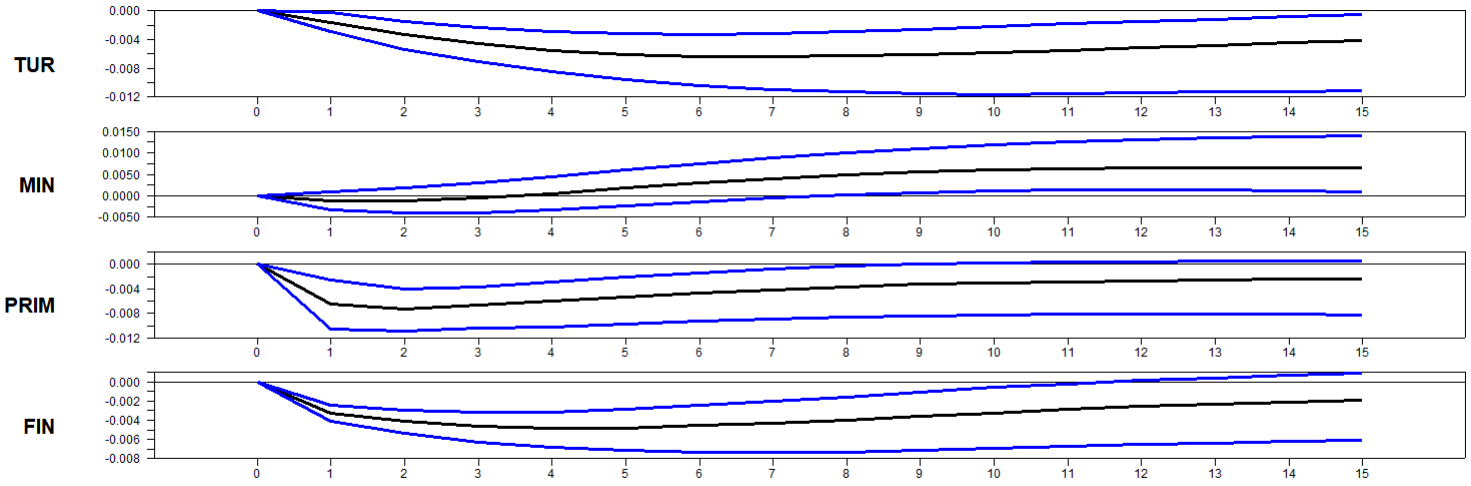


Figure 2(a)

Figure 13: Sectoral Production Responses to a One Standard Deviation Increase in SOFR (Quarterly Data).

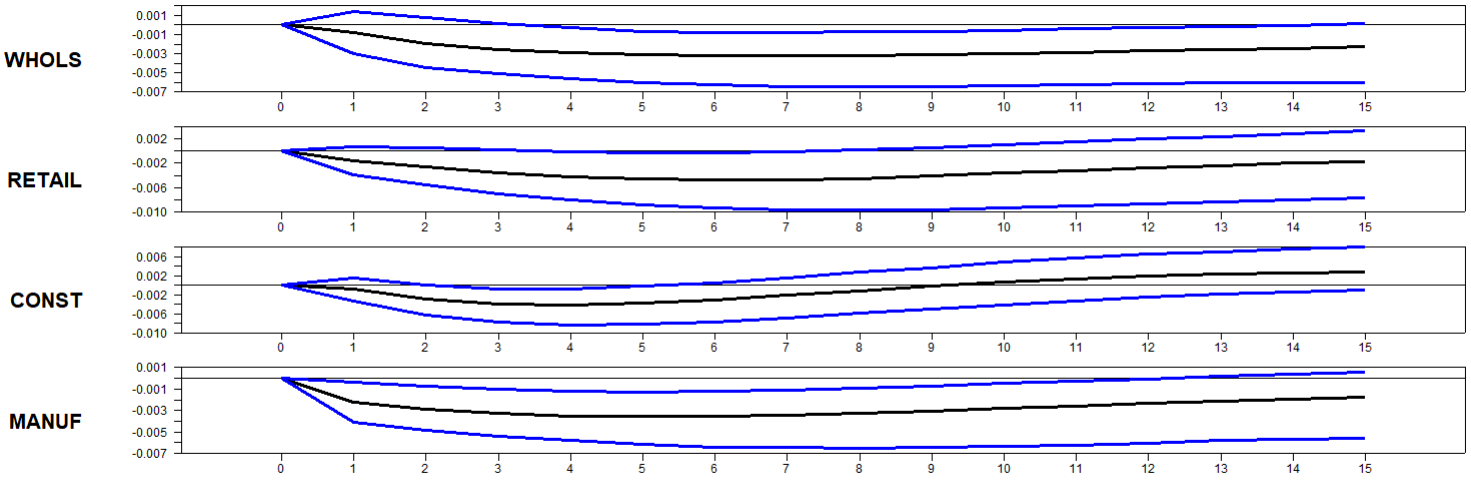


Figure 2(b)

Figure 14: Sectoral Production Responses to a One Standard Deviation Increase in SOFR (Quarterly Data).

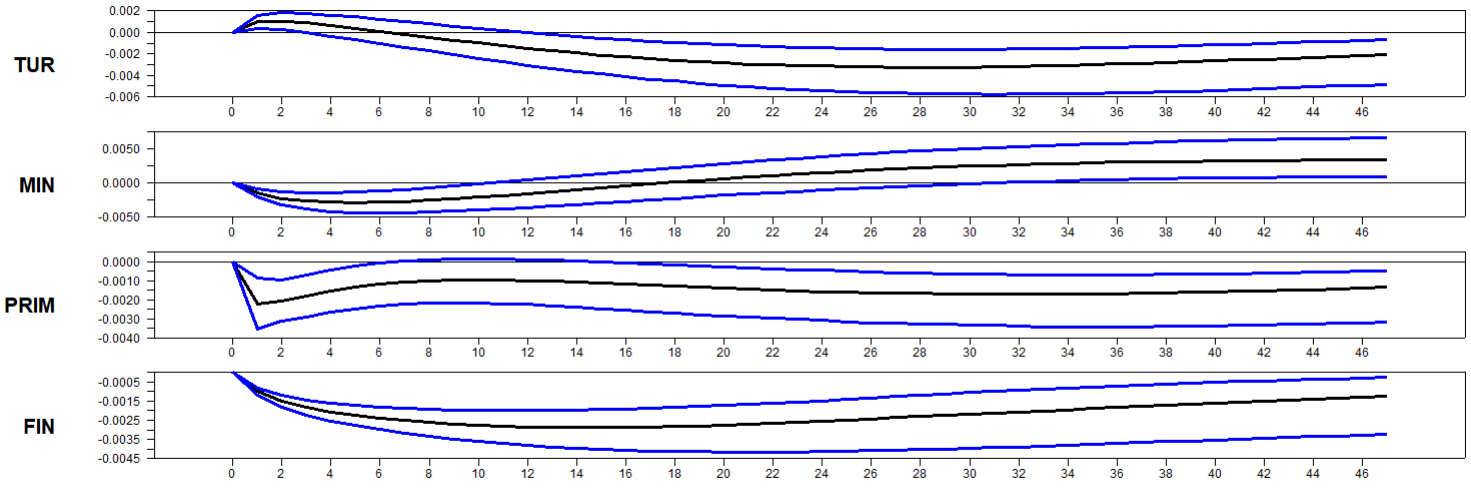


Figure 2(a)

Figure 15: Sectoral Production Responses to a One Standard Deviation Increase in SOFR (Monthly Data).

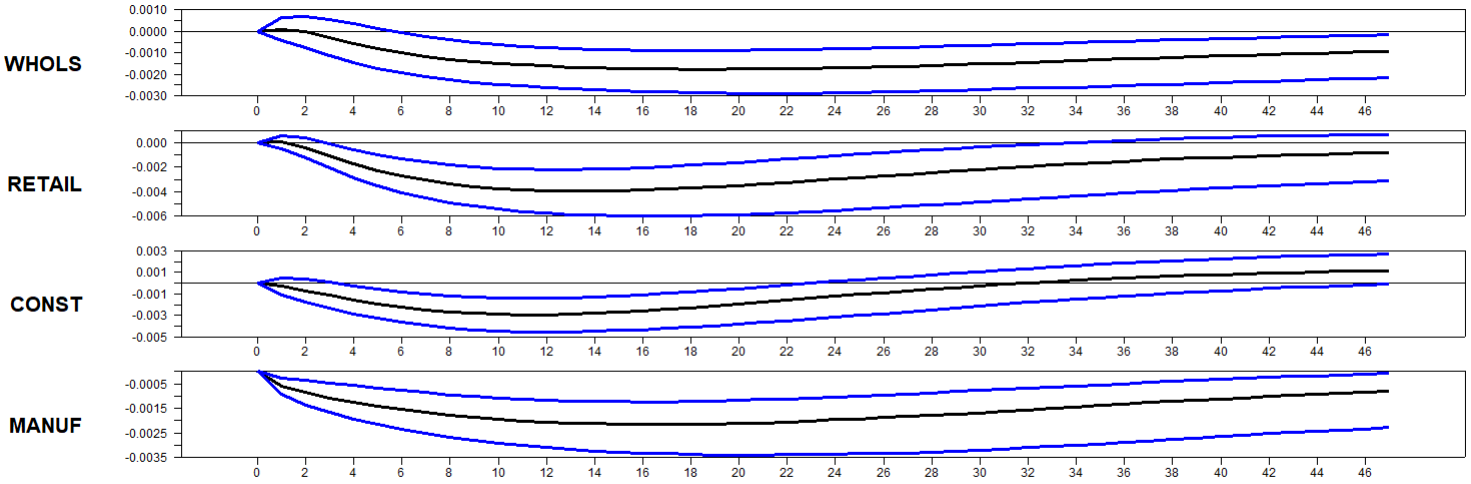


Figure 2(b)

Figure 16: Sectoral Production Responses to a One Standard Deviation Increase in SOFR (Monthly Data).

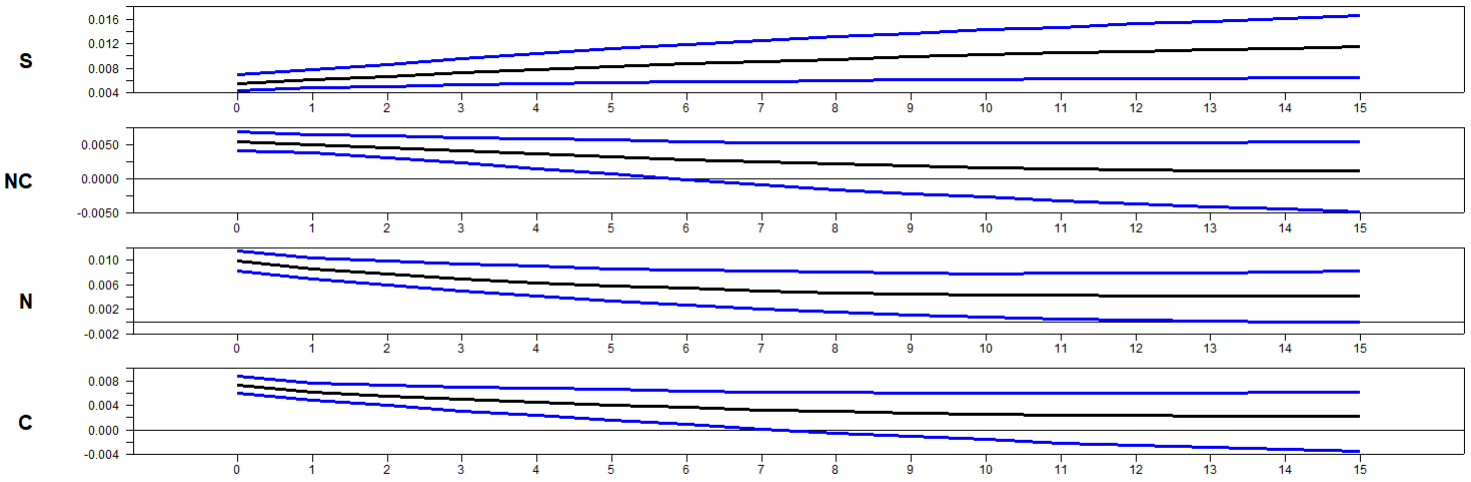


Figure 2(a)

Figure 17: Regional Production Responses to a One Standard Deviation Increase in US Industrial Production(Quarterly Data).

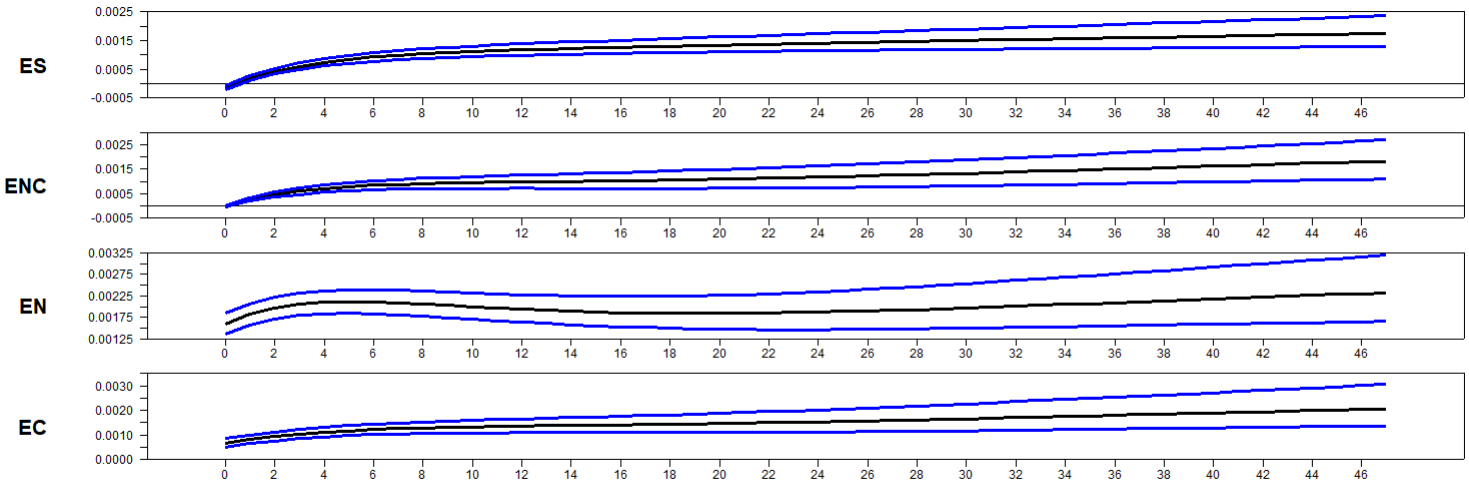


Figure 2(a)

Figure 18: Regional Employment Responses to a One Standard Deviation Increase in US Employment(Monthly Data).

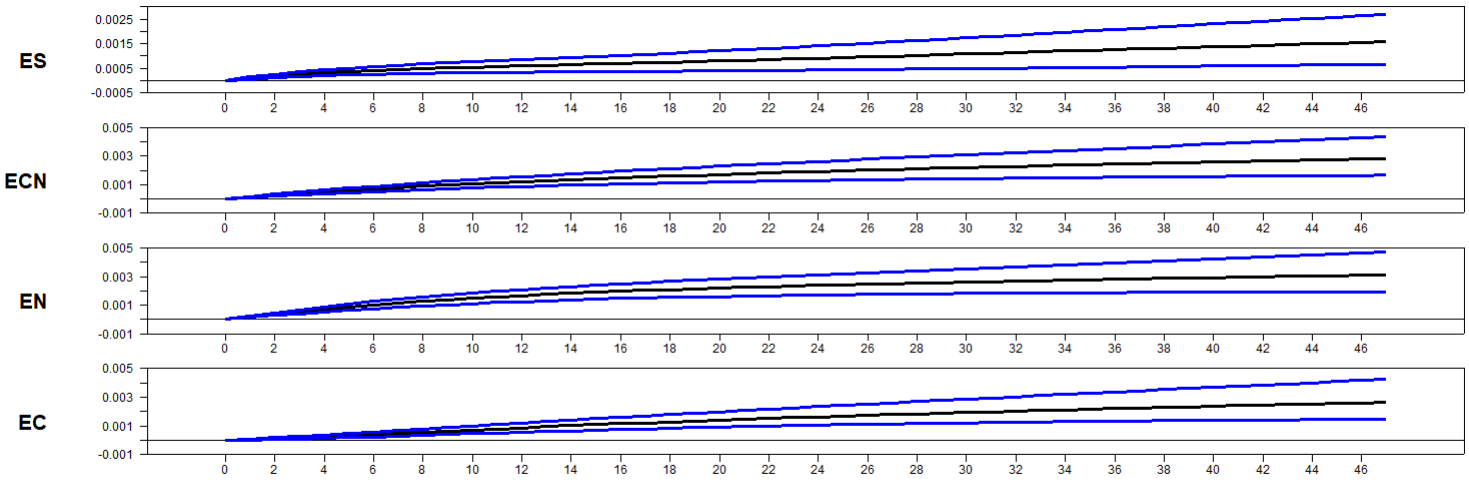


Figure 2(a)

Figure 19: Regional Employment Responses to a One Standard Deviation Increase in the US Federal Funds Rate(Monthly Data).

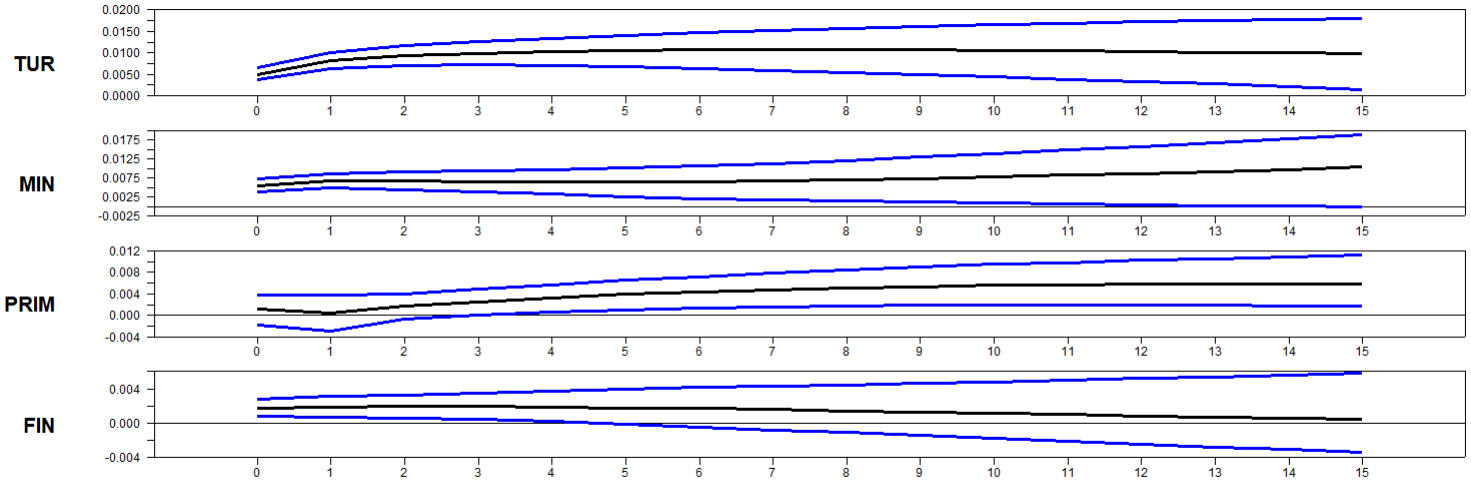


Figure 2(a)

Figure 20: Sectoral Production Responses to a One Standard Deviation Increase in the US Industrial Production(Quarterly Data).

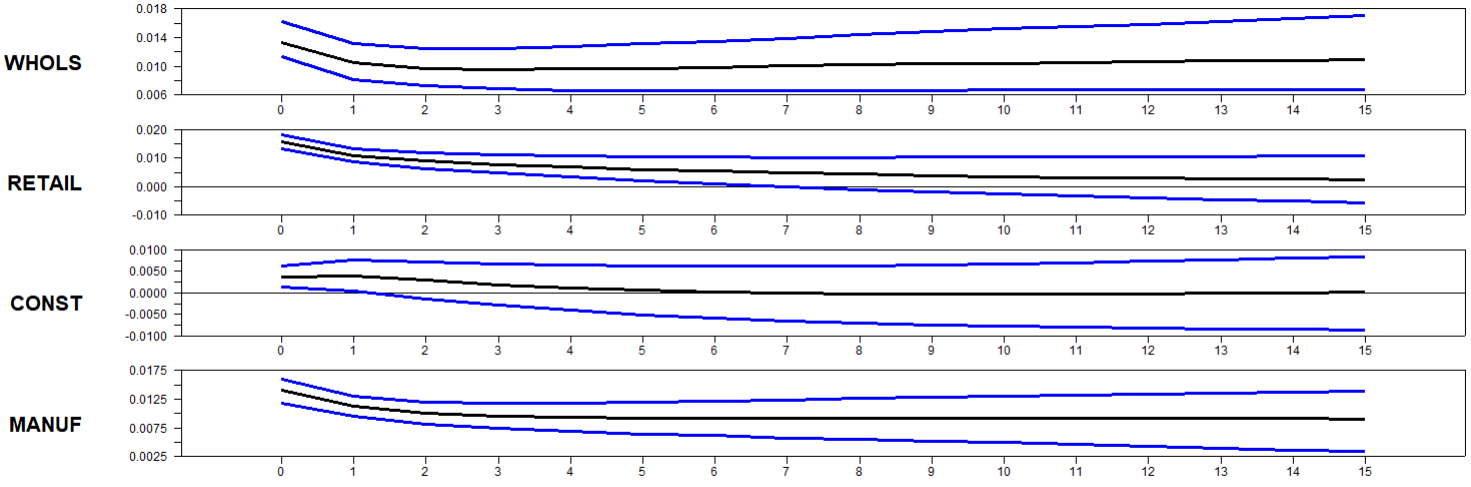


Figure 2(b)

Figure 21: Sectoral Production Responses to a One Standard Deviation Increase in the US Industrial Production(Quarterly Data).

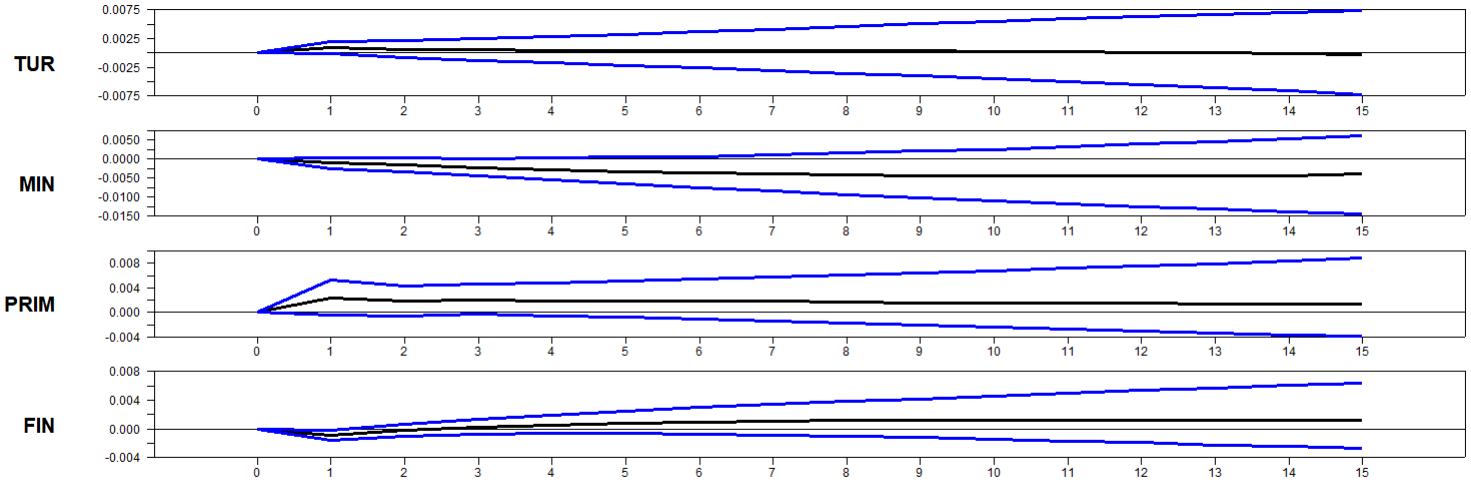


Figure 2(a)

Figure 22: Sectoral Production Responses to a One Standard Deviation Increase in the US Federal Funds Rate(Quarterly Data).

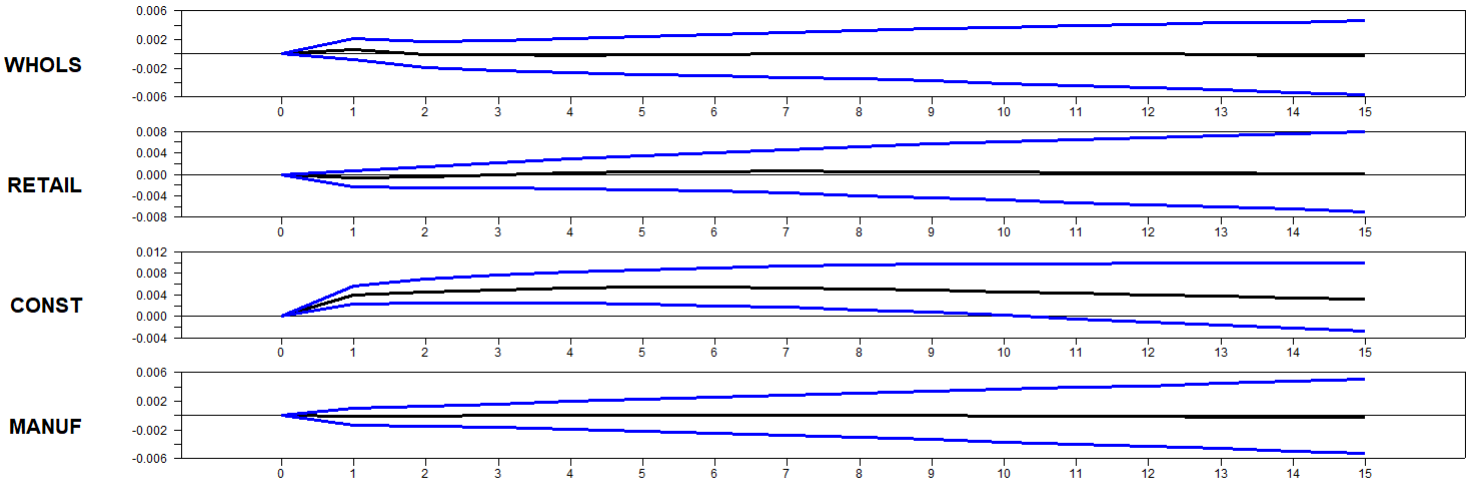


Figure 2(b)

Figure 23: Sectoral Production Responses to a One Standard Deviation Increase in the US Federal Funds Rate(Quarterly Data).

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