Effects of Supply and Demand Shocks on the Production and Inflation of Manufactured Goods at the Regional Level in the Context of the COVID-19 Pandemic*

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Abstract

Existing evidence suggests that supply and demand shocks associated with the COVID-19 pandemic affected Mexican sectoral production growth heterogeneously. While this evidence is available for the Mexican economy at the national level, a similar analysis has yet to be done for the production growth and inflation of manufactured goods from a regional perspective. This paper aims to fill this gap by analyzing the contribution of supply and demand shocks on regional production and inflation dynamics of consumer manufactured goods, and investigates the effects of labor market shocks on the recent evolution of regional inflation. Under a sign-restricted Structural Bayesian Vector Autoregression (SBVAR) identification, we find that starting in 2021, external demand shocks have increased their contribution relative to that of local shocks to explain production growth and inflationary pressures of manufactured goods mainly in the Northern, North-Central, and Central regions.

Keywords: External Shocks, Inflation, Manufacturing, SVAR

JEL classification codes: E31, F41, R11

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1 Introduction

The COVID-19 pandemic has exposed the Mexican economy to a series of supply and demand shocks. For instance, disruptions in global supply chains reduced the supply of tradable goods produced locally while simultaneously increased their prices. Additionally, the positive external shock stemming from the fiscal incentives delivered in the United States during the toughest stages of the pandemic (2020 and 2021), translated into a higher demand for Mexican manufacturing goods, fueling increases in their output and prices.[1] Also, output and prices were affected by internal supply shocks, such as the closure, at the beginning of the second quarter of 2020, of non-essential activities ordered by health authorities; and by internal demand shocks, such as households' measures of self-confinement, which reduced their consumption of specific goods and services.

Given the variety of internal and external supply and demand shocks that economies worldwide experienced during the pandemic, there has been an increasing interest in identifying how much each type of shock has contributed to the dynamics of output and prices. On this issue, Chavarín et al. (2023) estimate, using a sign-restricted Structural Bayesian Vector Autoregression (SBVAR), the contributions of internal and external demand and supply shocks to output growth at the aggregate and sectoral levels in Mexico. Their main conclusions indicate, in the first place, that before the pandemic, the weak performance of the Mexican economy can be linked to a combination of demand and supply factors. Second, that during the 2020-Q2, the main factors affecting growth derived from internal demand factors, as well as from internal and external supply conditions. Additionally, they report that since 2021-Q2, external supply shocks have contributed negatively to growth, "particularly in manufacturing, while domestic and external demand factors, have contributed positively".[2]

In this paper we use monthly data from January 2007 to September 2022 to extend the analysis of Chavarín et al. (2023) in order to answer two research questions. First, we set out to determine to what extent local and external supply and demand shocks have contributed to the evolution of the regional production and inflation dynamics of manufactured goods in the context of the COVID-19 pandemic.[3] Second, we evaluate the contribution of labor

[1] The link between the Mexican economy and the United States economy at the aggregate level has been widely documented. See, for instance, Chiquiar and Ramos-Francia (2004), Hernández (2004), Sosa (2008), Mejía-Reyes and Campos-Chávez (2011), Delajara (2012), and Chavarín et al. (2023).

[2] Chavarín et al. (2023), p.2.

[3] In this paper we employ the regions defined in the Reporte sobre las Economías Regionales by Banco de México. 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,

market shocks to the recent evolution of regional inflationary pressures of manufactured goods. In estimating the shock contributions, we use a historical decomposition analysis. For this purpose, we employ a structural vector-autoregressive model (SVAR) estimated with state-of-the-art techniques, including sign restrictions.

In its Quarterly Reports, Banco de México acknowledges the significance of internal and external supply and demand shocks on the evolution of economic activity and inflation. Given that monetary policy primarily affects internal demand factors, it is crucial to identify the extent to which inflation drivers are associated with supply or demand factors. To the best of our knowledge, we are the first to analyze the contribution of supply and demand shocks over the regional production and inflation dynamics of consumer manufactured goods, and also investigate the effects of some labor market shocks on the recent evolution of regional inflation.

Among the main findings of our paper stand out that, starting in 2021, external demand shocks have fostered manufacturing goods output growth, mainly in the North, North-Central and Central regions. Along the same time period, it is identified that there have been substantial upward pressures in consumer prices of manufacturing goods excluding transport equipment across all regions. It is also found that consumer prices of manufacturing goods excluding transport equipment underwent similar upward pressures in all regions, although explained by heterogeneous contributions of supply and demand shocks. For instance, in the North, such pressures are mostly explained by external supply shocks, while in the South are accounted for, to a greater extent, by local demand shocks.

The paper is organized as follows. Section 2 describes some relevant literature regarding the effects of supply and demand shocks on production growth, inflation, and some labor market variables in the context of the COVID-19 pandemic. Section 3 presents the econometric methodology and describes the data used for the empirical analysis. Sections 4 to 6 present the estimation results, while Section 7 concludes.

2 Literature Review

The analysis of the effects of supply and demand shocks on the evolution of production and inflation during the COVID-19 pandemic has been centered on a few economies. In Mexico, Chavarín et al. (2023) utilize an SBVAR model with sign restrictions to examine the sources of heterogeneity in the evolution of economic activity during the pandemic. The authors find that demand shocks were the primary driver of the decline in production across

Morelos, Puebla, Querétaro, and Tlaxcala. Southern: Campeche, Chiapas, Guerrero, Oaxaca, Quintana Roo, Tabasco, Veracruz, and Yucatán.

most economic sectors during the second quarter of 2020. They also observe that external supply shocks have negatively impacted the evolution of economic activity, particularly in the industrial production sector, since the beginning of 2021. However, internal and external demand shocks have contributed positively to the evolution of sectoral production during this time.

In the United States, Shapiro (2022) proposes a methodology that breaks down headline inflation into supply and demand shocks. Using the price and production time series of more than 100 goods and services to calculate the personal consumption expenditures (PCE) index, he finds that, at the onset of the pandemic, demand shocks contributed to the decline in headline PCE inflation. However, these shocks began to contribute positively since the second quarter of 2021, coinciding with the economy's reopening and the implementation of the American Rescue Plan. Shapiro (2022) also finds that supply-driven inflation emerged in early 2022, likely due to the economic disruptions associated with the armed conflict in Ukraine.

In another work, Brinca et al. (2021) use a Bayesian structural vector autoregression approach to measure the contribution of supply and demand shocks to the evolution of labor market variables using monthly data on hours worked and real wages for a set of economic sectors in the United States. The authors report that aggregate hours worked were heterogeneously affected by labor market supply and demand shocks at the beginning of the pandemic. Specifically, they find that the manufacturing sector, particularly the food industry, was the least affected by the drop in hours worked during this period.

Consolo et al. (2021) estimate a Bayesian mixed frequency VAR model for the aggregate Euro area labor market, featuring a structural identification via sign restrictions. The authors find that the decline in the employment rate observed during the pandemic was mainly induced by supply and demand shocks. The former may have been associated with the lockdowns imposed by national governments during the pandemic, forcing many firms to close or temporarily reduce their operations, while the latter may have reflected constraints on the demand for services due to confinement measures and other factors, such as an increase in uncertainty during the pandemic, which reduced private consumption.

In this context, this paper contributes to the literature by analyzing the impact of internal and external supply and demand shocks on the production and inflation of manufactured goods at the regional level in Mexico. To the best of our knowledge, this study is the first to examine these effects in the Mexican case.

3 Empirical Framework and Data

In order to identify the contribution of the different supply and demand shocks that may have influenced the evolution of regional production and consumer prices of manufactured goods in Mexico, we follow Chavarín et al. (2023). Using data spanning January 2007 to September 2022, we estimate two SBVAR models for each region: one for the manufacturing sector excluding transportation equipment, and another for the transportation equipment industry.[4] The reduced-form representation of each SBVAR model is described below:

$$y_t = C + B_1 y_{t-1} + ... + B_p y_{t-p} + u_t \tag{1}$$

where y_t is an $N \times 1$ vector of N endogenous variables, C is an $N \times 1$ vector of constants, B is an $N \times N$ matrix of coefficients for lagged variables, p is the number of lags, u_t is a vector of residuals for each equation with $u_t \sim N(0, \Sigma)$, where Σ is the $N \times N$ variance-covariance matrix of residuals.[5] Given the large number of parameters to be estimated, we use Bayesian methods to deal with the dimensionality issue and assume a Gaussian-Wishart prior distribution to derive the posterior distribution of the VAR coefficients.[6] To map the structural supply and demand shocks in which we are interested from the reduced-form estimated shocks, we need to impose some restrictions on the estimated variance–covariance matrix. As a a result, the error term u_t can be written as a linear combination of structural shocks:

$$u_t = A\epsilon_t \tag{2}$$

[4] Data availability for Mexico motivates our use of monthly data for this period.

[5] The Schwarz information criterion (SC) and the Hannan-Quinn information criterion (HQ) both selected $p = 1$ for most of the VAR models. For more direct comparability, we maintained the same number of lags for the VAR specifications. As a robustness check, results remain qualitatively similar when increasing the number of lags. We also considered that the estimates may be affected by the inclusion of the COVID-19 pandemic in the period of analysis. On an alternative specification of Equation 1, following Kang et al. (2016), Carriero et al. (2022), and Hartwig (2022), we included an exogenous dummy variable set equal to 1 for Mar-2020 and Apr 2020, and 0 otherwise. Our analysis suggests that the historical decomposition estimates at the monthly frequency remain qualitatively similar for most of the time span, regardless of the inclusion of the dummy variable.

[6] We choose the set of hyperparameters to compute the mean and variance of the prior distribution for the VAR coefficients based on the combination that optimizes the marginal likelihood function. In particular, we allow for the auto-regressive coefficient to vary between 0 and 1, the overall tightness hyperparameter (λ_1) to vary between 0.05 and 0.2 and the lag decay hyperparameter (λ_3) to vary in a range between 1 and 2. These values are standard in the literature, see for instance, Dieppe et al. (2016). The total number of iterations is 20,000, and the number of burn-in iterations is 19,000.

with $\epsilon_t \sim N(0, I)$, where I is an $N \times N$ identity matrix and where A is a nonsingular parameter matrix. The variance-covariance matrix has the following structure: $\Sigma = AA'$.[7] Therefore, in order to identify A we impose some sign restrictions. Our identification scheme relies on the restrictions imposed on impact on the sign of the endogenous variable's response to each structural shock by Chavarín et al. (2023).

In Equation 1, y_t refers to the monthly variations of the log-levels of the following endogenous variables: regional real manufacturing production; regional consumer price index for manufactured goods excluding fuel prices; real manufacturing production in the United States; producer price index for the manufacturing sector in the United States, and the bilateral real exchange rate between Mexico and the United States.[8] The sources of information are Banco de México, the National Mexican Institute of Statistics (INEGI), and the Federal Reserve of St. Louis.

It must be emphasized that the SBVAR methodology allows the identification of the structural shocks in which we are interested. For the estimation of these models, and in order to identify the supply and demand shocks, we impose sign restrictions on the response on impact of the endogenous variables. For the case of the endogenous variables in which we do not impose a sign restriction, we allow them to freely respond on impact.[9] In what follows, we provide a description of the structural shocks' identification, while Table 1 summarizes this identification scheme.

- **Local supply shock:** We assume that following a local supply shock, production increases and local prices decrease. As Mexico is considered a small open economy, we propose that local variables do not affect United States production and prices.

[7] To understand how each identified shock affects the deviation of annual variations in the corresponding variable from its long-term mean, please refer to Appendix A for technical details on historical shock decompositions.

[8] All variables, except for the real exchange rate, are seasonally adjusted using the X-12 monthly adjustment method.

[9] In estimating the VAR model for the manufacturing sector excluding transportation equipment, and in order to identify local shocks, we use the information on the production value in real terms and on the prices of a set of goods that, according to the North American Industry Classification System (NAICS) 2018 classification, correspond to manufactured goods from sectors 31-33, excluding the transportation equipment industry (subsector 336) and the petroleum and coal products manufacturing industry (subsector 324). On the other hand, to estimate the VAR model for transportation equipment, we only consider information on the real production value and prices of manufactured goods from industry 336 from the NAICS classification. Hence, the price index for manufactured goods excluding transportation equipment is a weighted price index that includes the prices of 182 groups of goods used for the calculation of core inflation and five groups of goods used in the calculation of non-core inflation (pork, beef, lard, chicken and beef viscera). We exclude transportation equipment and fuel prices from that index. The weights to build that index are those of the INPC, while the transportation equipment price index considers only the prices of new cars and auto parts, also weighted with the INPC weights.

Therefore, given a reduction in domestic prices and no effect on United States prices, we should also observe a real depreciation of the Mexican peso.[10]

The assumption that Mexico is a small open economy is supported by the fact that, according to the World Bank, Mexico's Gross Domestic Product represented 10.8 percent of the United States GDP in 2021. Additionally, approximately 80 percent of Mexico's exports are sent to the United States, which represents around 40 percent of Mexico's GDP. Consequently, the identification strategy presented in Table 1 imposes zero restrictions on impact on the United States variables following local shocks, forming an exogeneity block similar to the approach proposed by Cushman and Zha (1997) and Kim and Roubini (2000). However, following Kim and Roubini (2000), we only impose restrictions on the contemporaneous relationships of the variables without further restrictions on the lagged structural parameters.

The exogeneity block implies that, within the model's endogenous variables, the United States variables cannot be affected on impact by the Mexican variables. To support this assumption, we estimate Granger causality tests, as shown in Table 2, and provide statistical evidence that the United States variables help predict production growth and inflation in Mexico. However, the lagged values of the Mexican variables do not help predict economic variables for the United States, which further supports the block exogeneity assumption in the shocks' identification strategy.

- **Local demand shock:** Following a local demand shock, we assume that local production increases without inducing firms to adjust their production capacity immediately, which pushes prices up. As in the case of the local supply shock, we also assume that the local demand shocks do not influence the dynamics of the United States variables. The domestic inflationary pressures and null effects on United States prices would lead to an appreciation of the real exchange rate.

- **External supply shock:** Following an external supply shock, we assume that on impact, in the United States and Mexico, production increases, and prices go down. This happens because we impose that the external supply shock stimulates both the supply of the manufacturing sector in the United States and the Mexican regions, given

[10] The Bilateral Real Exchange Rate Index (RER) is calculated is calculated as the product of the nominal exchange rate times the price relationship between the two countries. Specifically, the RER index is equal to: $RER = e_t * (p_t^*/p_t)$, where p_t is the National Consumer Price Index of Mexico (INPC) in month t; p_t^* is the US consumer price index in month t; and e_t is the average nominal exchange rate index in Mexican pesos for one US dollar in month t. The interpretation of the index is as follows: an increase in the RER index represents a depreciation of the Mexican peso relative to the US dollar, while a decrease in the index represents an appreciation of the peso.

that the value chains of both economies are highly integrated. We let the response of the real exchange rate following an external supply and demand shock be determined by the data.[11]

- **External demand shock:** We assume that following an external demand shock, United States production and prices of manufactured goods go up. Regarding the impact of an external demand shock on local variables, we maintain a narrow approach by refraining from imposing any restrictions on their contemporaneous response.

In terms of what we may expect from the results, we perform a visual analysis using Figures 1 and 2. In panel a) of Figure 1, we can observe that the Northern and Central states of the country are more manufacturing-intensive producers than the Southern states. In particular, for some of the Northern states, manufacturing production represents around one-third of their GDP, while for some Southern states that proportion is, at most, 6 percent. In line with that, Northern states are more export-intensive, with some of them reaching exports as a fraction of their GDP exceeding 50 percent.

According to Figure 2, many Southern states are more service-intensive producers, especially in the tourism industry. Naturally, those states benefit from visitors, many of them from the United States. Thus, production and prices of manufactured goods in the country's Northern states may have a significant influence from external factors, given their higher exposure to the United States economy.

For Southern states, we expect an important contribution from local supply and demand shocks in explaining the dynamics of both production and prices of manufactured goods, given their high service intensity orientation. However, external demand shocks may also drive Southern states' variables, given their high dependence on international tourists.

In addition to the visual analysis, we conducted a reduced-form analysis to explore the relationship between local and United States variables. We started by calculating the correlation coefficients between local and lagged United States variables, and the results are presented in Table 3. The table shows that the annual growth rate of regional economic activity and the lagged annual growth rates of industrial production in the United States are positively correlated with coefficients around 0.44 and 0.53 across regions, with stronger correlations observed mainly contemporaneously and with the first lag of the United States industrial production. Moving to Table 4, we observe that the correlation between the annual

[11] One crucial aspect of our analysis is the implementation of an alternative identification strategy inspired by Barišić et al. (2022). In this approach, we omit the sign restrictions on impact of local variables following a United States supply shock, and we allow the data to speak freely by remaining agnostic about the effects of an external supply shock at the local level. Surprisingly, the results obtained using this alternative strategy are qualitatively similar to those obtained under the strategy presented in Table 1.

growth rate of manufacturing production in the Mexican regions and the United States is higher than that of industrial production, with slightly higher contemporaneous correlation coefficients for the country's Northern regions.

We also examined the correlation between the United States and regional inflation rates, and the results are presented in Table 5. We find that inflation rates in the four regions of Mexico are positively correlated with the United States inflation rates, with correlation coefficients ranging from 0.48 to 0.61 across regions. The Northern regions show the highest correlation with the contemporaneous inflation rate in the United States, while the Central and Southern regions have the highest correlation with the six-month lag of the United States inflation.

Finally, Table 6 shows that the inflation rate of manufactured goods in the four Mexican regions is correlated with the lagged United States inflation of manufactured goods up to 6 months. In both cases, we observe persistent correlations with the United States inflation rates for general regional inflation and for manufactured goods.

Secondly, we estimate some Granger causality tests to analyze the relationship between Mexican and United States variables. Table 7 shows that lagged values of United States manufacturing production help predict manufacturing production of the four Mexican regions. Hence, the reduced-form evidence suggests a weak relationship between regional economic activity and United States industrial production. The previous finding captures the fact that regional economic activity considers non-tradable goods and the services industry with a high weight, which could be more associated with domestic factors. Table 8, in turn, shows that the United States lagged inflation rate Granger causes inflation rates only for the Northern and Southern regions.

Thus, using these correlation coefficients and the two-sided Granger causality tests, we find that by using reduced-form evidence, the United States variables affect the dynamics of local variables. Although we do not observe patterns across regions, we hope that once we consider more variables within the analysis, we can identify the effects of external shocks on local variables more precisely.

4 Effects of Local and External Shocks on Regional Manufacturing Production

Figures 3 and 4 show each region's estimated contribution of each identified shock to the deviation of the annual variation of manufacturing production excluding transportation equipment from its long-term mean.[12] It can be seen that, at the beginning of the pandemic, external demand shocks were the most important in explaining the negative growth rate of this industry in the North. The previous finding could be attributed to the high export orientation of that region.

At the beginning of the pandemic, we also find that local and external supply shocks had a modest negative contribution to the production growth of these manufactured goods. Among these products, a significant proportion corresponds to the food industry, considered in the group of essential productive activities in Mexico and the United States. Hence, it seems that this industry experienced fewer operational limitations at the beginning of the pandemic.

Figures 3 and 4 also suggest that, more recently, external demand shocks have been the most important in accounting for the favorable evolution of this class of manufactured goods, mainly in the Central, Northern, and North-Central regions, in that order. This finding could be associated with the reopening of some productive sectors and the massive fiscal stimulus granted in the United States, which stimulated Mexican exports. It stands out that, in the Central region, the positive relative contribution of local demand shocks observed at the beginning of 2021 was less important when comparing it with the rest. In the case of the South, the contribution of external demand shocks could be associated with the dynamism of basic metal and chemical industries exports. In addition, during the last months of 2022, local demand shocks in the Southern region account for an important contribution to the recovery of manufacturing production, excluding transportation equipment. This finding may be explained in the context, for instance, of high public investment levels and the impulse of demand for some processed goods, such as food and beverages, derived from the gradual increase in domestic and foreign tourists.

However, across all regions, it can be observed that during the third quarter of 2022, external demand shocks have decreased their positive contribution to the growth of manufacturing production, excluding transportation equipment, especially in the Northern and North-Central regions. This could be attributed to the decrease in economic activity in the United States. During this period, local supply shocks have increased their negative contribution, particularly in the Northern, North-Central, and Central regions, while the negative

[12] For additional details on the estimation of the historical decomposition of the variables in deviations from their long-term mean based on Equation 1, please refer to Dieppe et al. (2016), p.89. It is worth noting that the point estimates of the historical decompositions correspond to the median of each posterior distribution. Dieppe et al. (2016) argues that, in practice, the median is typically preferred over the mean as a point estimate for two reasons. First, the median is less sensitive to extreme values than the mean. Second, as the median corresponds to the 50th percentile, it is guaranteed to be included within the bounds of a credibility interval. Appendix B shows the Impulse Response Functions (IRFs) of the endogenous variables to the identified structural shocks.

contribution of external supply shocks has decreased. In the Southern region, local supply shocks have been the main contributor to the negative impact on production growth.

Figure 5 shows, in turn, that the deep contraction in transportation equipment output at the beginning of the pandemic was mainly driven by external demand shocks, and local and external supply shocks, in the different regions. The supply shocks would be related to the temporary closure of operations by automakers in Mexico and the United States. As of 2021, in the North, North-Central, and Central regions, external demand shocks contributed positively to the deviation of the real annual variation in the production of transportation equipment from its historical mean. This finding could be associated with the fact that, after the reopening, global demand for vehicles recovered rapidly (Banco de México, 2021a).[13] It also highlights that, in the Northern region, local demand shocks contributed positively and over a longer period to the evolution of the production of transportation equipment compared to the rest of the regions. This finding could be associated with the greater recovery of its labor market.

Figure 5 also indicates that, since the start of the pandemic, the contribution of external supply shocks has been negative and very persistent in the evolution of the production of transportation equipment. This result could be explained in an environment in which the global installed capacity for the production of semiconductors was insufficient to simultaneously meet, since the beginning of 2021, the high demand of the sectors with linkages to industries such as vehicles, and the manufacture of electrical goods and electronics. In addition to the shortage of semiconductors, the automotive industry has also faced logistics and supply problems for other inputs (Banco de México, 2021a).

5 Effects of Local and External Shocks on Inflation of Manufactured Goods

Figures 6 and 7 show that, at the beginning of the pandemic, demand shocks contributed significantly to the downward deviation from the mean of consumer price inflation of manufactured goods excluding transportation equipment, in the North-Central and Central regions. As of 2021, significant inflationary pressures have been observed in all regions. Although they have registered relatively similar behavior, the contribution of supply and demand shocks to these pressures has been heterogeneous across regions. We also find that external factors mostly explain these pressures in the Northern, North-Central, and Central regions; while in the South, inflationary pressures are mainly explained by local demand shocks.

[13] Banco de México. Quarterly Report, April-June 2021, Box 3: Estimation of the Impact of Disruptions in Inputs' Supply on Automotive Production and Economic Activity. Downloadable at https://www.banxico.org.mx/publications-and-press/quarterly-reports/quarterly-reports-prices-banc.html.

On the supply side, external factors could be associated with global supply chain disruptions and the military conflict between Russia and Ukraine that started in February 2022; while from the demand side, external factors could be related, for instance, to the high demand generated by the massive fiscal stimulus in the United States. The growing contribution of external supply shocks has been more evident in the North, finding which could be attributed to the greater integration of the productive chains of this region with the United States. On the other hand, in the South, unlike the other regions, local demand shocks have shown a positive and more persistent contribution in explaining the inflationary pressures of these products. For this region, local demand shocks and external factors have generated a higher inflation rate for these products when comparing with the other regions. In the Central region, the contribution of local demand shocks in explaining the inflationary pressures of these products has been lower relative to the other regions.

Regarding the contribution of local demand shocks to regional inflationary pressures, it is likely that in the North these could be associated with a more robust recovery of its labor market and consequently, of increases on households disposable income and consumption. In the case of the Central and North-Central regions, on the other hand, these inflationary pressures could be associated with the sustained increase in the flow of remittances received by households in such regions (Banco de México, 2021b). It should be mentioned that these two regions concentrate approximately two-thirds of remittances at the national level.[14] In the South, the positive contributions of local demand shocks could be attributed to the recovery of domestic tourism and high levels of public investment, which by increasing households' disposable income, end up in higher expenditure in, for instance, sectors such as food, beverages, and other manufactured products.

With respect to the recent contributions of local supply shocks, these could be attributed, in all regions, to the locally produced raw materials and skilled workers shortages and to labor and transportation costs increases. In addition, in the North, local supply shocks could also be linked to the recent drought and to some power outages, while in the South, these shocks could be attributed to the local contraction in the supply of grains for the food industry.

Figure 8 shows that, since the outset of the pandemic, the annual change in the consumer price index for transportation equipment goods has shown a positive deviation from its long-term mean in all regions. However, since 2021, this gap has been relatively higher in the North. In particular, we find that the inflation of these products in this region is distinguished

[14] Banco de México. Regional Economic Report, October-December 2020, Box 2: Remittances and its Impact on Households' Consumption in Mexican Regions in the Context of the COVID-19 Pandemic. Downloadable at https://www.banxico.org.mx/publications-and-press/regional-economic-reports/regional-economic-reports-sta.html.

by a positive and more persistent contribution of local demand shocks, probably associated with a greater recovery in its economic activity than in the rest of the regions. It is also observed that, since the onset of the pandemic, local supply shocks have shown a positive contribution to the inflationary pressures of these goods. However, the incidence of these factors was more relevant in 2020 and 2021. Since 2021, external supply shocks have shown an upward contribution to explain these inflationary pressures. The supply shocks could be attributed to the technical stoppages in Mexico and the United States due to the global shortage of semiconductors, as well as to the difficulties in obtaining other inputs, among others. On the other hand, although to a lesser extent, it is estimated that, in all regions, external demand shocks contributed to the hike in transportation equipment inflation.[15]

6 Effects of Local, External and Labor Market Shocks on the Inflation of Manufactured Goods

In this section, we aim to estimate the impact of labor market shocks on inflationary pressures in the manufacturing sector. Our motivation for this analysis is derived in part from the insights provided in Figure 9. Figure 9a shows a significant reduction in the unemployment rate across all regions since the beginning of the sanitary crisis period. Figure 9b shows, on the other hand, that the average compensation per employee in the manufacturing sector has shown substantial growth in real terms across all regions in 2022 compared to 2021.

Following Consolo et al. (2021), we add two labor market shocks to the identification strategy described in Section 3.[16] The first shock we consider is a labor supply shock, which assumes that following a positive exogenous shock, households reduce their disutility of working and become more active in the labor market. This leads to an increase in job seekers, making it easier for firms to fill vacancies and reduce hiring costs. Faced with lower wage pressures, firms may respond by increasing their production levels, resulting in lower marginal costs and sales prices.

The second labor market shock we incorporate is a wage bargaining shock, which assumes that workers have more bargaining power to achieve wage increases. Thus, following a positive shock of this nature, we impose that compensation per employee increases on impact. However, since firms would face higher production costs, they would be forced to increase

[15] Our results are qualitatively robust to the inclusion and exclusion of inter-regional shocks. They are also robust when using industrial production and the US CPI instead of manufacturing sector variables when identifying external shocks.

[16] Other references in which labor market shocks are implemented in a similar fashion are Brinca et al. (2021) and Foroni et al. (2018).

their sales prices and reduce their vacancy postings to hire. As a result, we expect production to decrease and unemployment to increase.

Foroni et al. (2018) suggests that an exogenous increase in labor supply may result in some of the new participants transiting through unemployment during the first few months, although many may find a job within the period. Conversely, an increase in workers' bargaining power may lead to higher wages, causing firms to reduce vacancy posting and fire employees, ultimately resulting in a higher unemployment rate. The response of the unemployment rate is useful in disentangling the two labor market shocks.

On the other hand, a positive shock to local demand boosts output and prices, leading to a decrease in the unemployment rate. Conversely, a local supply shock increases firms' efficiency, leading to an expansion of production and a reduction in unemployment. In the case of both labor market shocks, we assume they do not have significant effects on the United States variables. It is worth noting that the identification of external shocks remains unchanged from the previous identification strategy. The identification strategy which incorporates the labor market shocks is summarized in Table 9.

We leverage information from INEGI regarding the unemployment rate and compensation per employee in order to identify labor market shocks, using data from January 2013 to September 2022.[17]

Figures 10 and 11 illustrate that external supply and demand shocks have caused significant inflationary pressures on manufactured goods across all regions during the most recent period of analysis. However, according to the alternative identification strategy, wage bargaining shocks have gained relative importance in explaining inflation dynamics in all regions, particularly in the Central region, since 2021. These findings align with the significant minimum wage increases implemented by the federal government since 2018. Additionally, a new regulation on outsourcing was implemented in 2021, leading to a significant reallocation among the jobs affiliated with the IMSS. In July 2021, more than 3 million workers changed employers, resulting in wage increases relative to other workers, as reported by Banco de México (2021c).[18] It should be noted that the contribution of labor supply shocks to the evolution of consumer prices for manufactured goods is negligible in the Central and South-

[17] Data availability on labor market variables for Mexico motivates our use of monthly data starting in January 2013. We use a regional unemployment rate since an unemployment rate by economic sector is not available. We calculate the regional unemployment rate using the 100-state employment-to-population ratio. To obtain the regional unemployment rate, we weigh each state's unemployment rate by its participation in the economically active population of the region to which it belongs.

[18] Banco de México. Quarterly Report, April-June 2022, Box 3: Recent Evolution of Nominal Wages of IMSS-insured Workers. Downloadable at https://www.banxico.org.mx/publications-and-press/quarterly-reports/quarterly-reports-prices-banc.html.

ern regions, whereas these shocks have had a more significant impact on the Northern and North-Central regions.

7 Concluding Remarks

This document identifies the impact of local and external supply and demand shocks on the evolution of production growth and inflation of manufactured goods across regions in Mexico. The main results of this paper suggest that, as of 2021, there has been an increasing contribution of external factors in explaining the dynamics of production and prices of manufactured goods excluding transportation equipment, mainly in the North, North-Central, and Central regions.

Also, external demand shocks have contributed positively to the evolution of transportation equipment production, while negative external supply shocks have counteracted those positive contributions. These negative external supply shocks may be associated, for instance, with disruptions in global supply chains and shortages of semiconductors, which helps explain the low dynamism of production and inflationary pressures in the transportation equipment industry.

Our results also outline the relevance of enabling local factors, such as actions that create an environment for investment and productivity growth, to foster output and mitigate inflationary pressures. Equally relevant will be external factors, such as a possible reduction in the intensity of the war between Russia and Ukraine, a more effective control of the pandemic that results in the supply chains returning to more efficient operation, as well as a normalization in the availability of inputs required by the manufacturing sector.

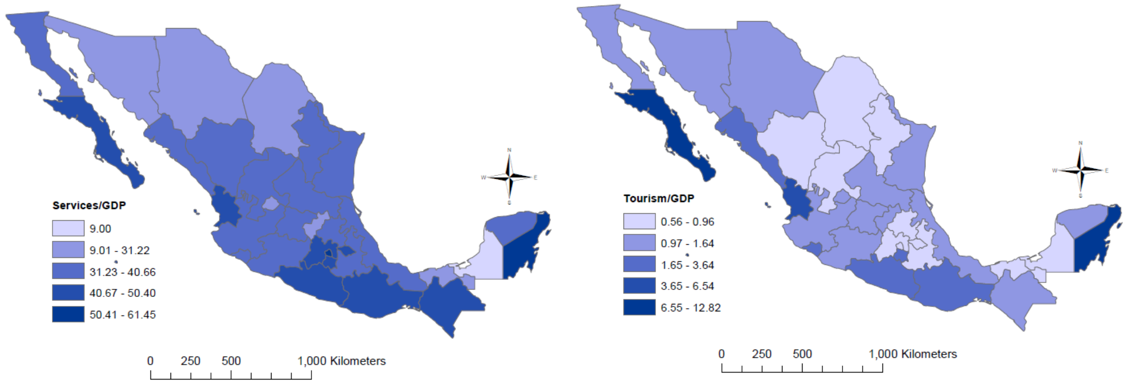
For further research, the methodology employed in this paper could be applied to investigate the effects of supply and demand shocks at the regional level in other sectors such as tourism, retail or housing. Additionally, We must recognize, on the other hand, that our labor market estimates are based on data available starting in 2013, without being able to disaggregate by type of industry (manufacturing excluding transportation equipment and transport equipment). To the extent that new data comes on hand, these models should be re-estimated.

	Local Supply	Local Demand	External Supply	External Demand
Local Manufacturing Production	+	+	+	
Consumer Prices Index of Manufactured Goods	-	+	-	
US Manufacturing Production	0	0	+	+
US Manufacturing Producer Price Index	0	0	-	+
Real Exchange Rate	+	-		

Table 1: Identification Strategy.

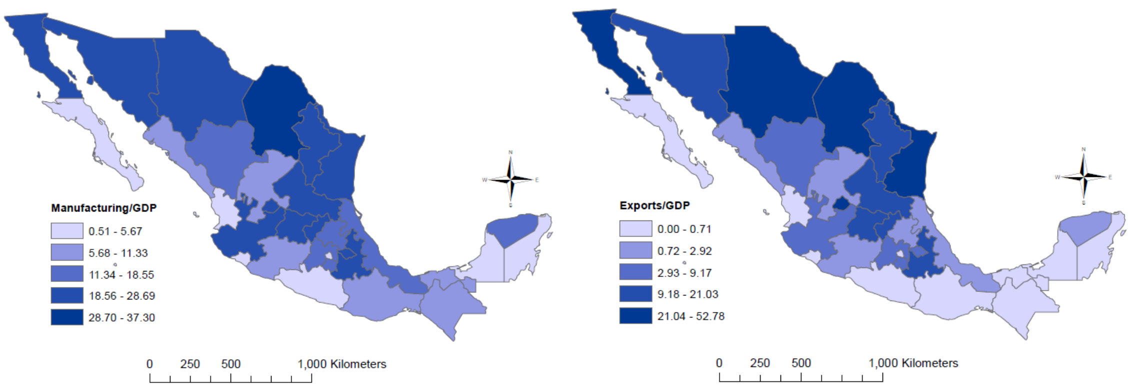
Dependent Variable	**Independent Variable**	χ^2	$p-value$
US Industrial Production	MX Aggregate Production (IGAE)	1.9	0.168
US Industrial Production	MX Industrial Production	2.9	0.238
US Industrial Production	MX Manufacturing Production	3.6	0.161
US Manufacturing Production	MX Manufacturing Production	2.2	0.330
MX Aggregate Production (IGAE)	US Industrial Production	34.7	0.000*
MX Industrial Production	US Industrial Production	39.6	0.000*
MX Manufacturing Production	US Industrial Production	33.7	0.000*
MX Manufacturing Production	US Manufacturing Production	42.2	0.000*
US CPI	MX INPC	11.3	0.506
MX INPC	US CPI	20.4	0.060

Table 2: Granger Causality Tests for Growth Rates of Economic Variables at the National Level.
Note: * Denotes $p-value$ consistent with 5% statistical significance for testing the hypothesis: H_0 = "Independent Variable Fails to Granger Cause Dependent Variable."
Source: Own calculations using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



(a) Services/GDP **(b)** Tourism/GDP

Figure 2: Production of the Services and Tourism Sectors as a fraction of GDP, by State (in percent).
Source: Own calculations using data from INEGI (2020).



(a) Manufacturing/GDP **(b)** Exports/GDP

Figure 1: Manufacturing Production and Exports as a fraction of GDP, by State (in percent).
Source: Own calculations using data from INEGI (2020).

Regional Economic Activity and US Industrial Production

k	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Northern	-0.03	-0.12	-0.13	-0.18	-0.19	-0.18	-0.20	-0.18	-0.16	-0.19	0.09	0.29	0.53
North-Central	0.03	-0.04	-0.05	-0.10	-0.13	-0.13	-0.17	-0.16	-0.15	-0.21	0.05	0.25	0.47
Central	-0.01	-0.07	-0.07	-0.14	-0.17	-0.16	-0.18	-0.15	-0.13	-0.19	0.07	0.24	0.44
Southern	-0.08	-0.15	-0.16	-0.21	-0.21	-0.22	-0.23	-0.22	-0.22	-0.20	0.10	0.31	0.53

Table 3: Correlation Coefficients Between Regional Economic Activity and United States Industrial Production.

Note: These correlation coefficients consider the correlation between the annual growth rate of regional economic activity and the US industrial production lagged by k quarters. For each row of the table, the lower correlation coefficients are highlighted in red, while those higher are highlighted in green.

Source: Own calculations using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.

Regional Manufacturing Production and US Manufacturing Production

k	**12**	**11**	**10**	**9**	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Northern	-0.31	-0.38	-0.30	-0.16	-0.06	0.00	0.06	0.12	0.18	0.27	0.32	0.40	0.63
North-Central	-0.21	-0.26	-0.18	-0.07	0.00	0.04	0.08	0.11	0.15	0.22	0.28	0.38	0.61
Central	-0.23	-0.26	-0.16	-0.05	0.02	0.06	0.11	0.14	0.17	0.22	0.27	0.37	0.62
Southern	-0.05	0.02	0.06	0.12	0.18	0.25	0.35	0.42	0.45	0.49	0.53	0.55	0.57

Table 4: Correlation Coefficients Between Regional Manufacturing Production and United States Industrial Manufacturing Production.

Note: These correlation coefficients consider the correlation between the annual growth rate of regional manufacturing production and the US manufacturing production lagged by k months. For each row of the table, the lower correlation coefficients are highlighted in red, while those higher are highlighted in green.

Source: Own calculations using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.

Regional Headline Inflation and US Headline Inflation

k	12	11	10	9	8	7	6	5	4	3	2	1	0
Northern	0.21	0.28	0.35	0.41	0.45	0.49	0.51	0.52	0.51	0.51	0.51	0.51	0.52
North-Central	0.16	0.25	0.32	0.38	0.43	0.48	0.53	0.55	0.57	0.59	0.60	0.61	0.61
Central	0.20	0.30	0.38	0.45	0.50	0.54	0.57	0.57	0.56	0.56	0.54	0.52	0.48
Southern	0.30	0.39	0.46	0.51	0.54	0.57	0.59	0.58	0.58	0.57	0.55	0.53	0.51

Table 5: Correlation Coefficients Between Regional Headline Inflation and US Headline Inflation.
Note: These correlation coefficients consider the correlation between the regional headline inflation rate and the US headline inflation rate lagged by k months. For each row of the table, the lower correlation coefficients are highlighted in red, while those higher are highlighted in green.
Source: Own calculations using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.

Regional Inflation of Manufactured Goods and US PPI-Manufacturing Growth

k	12	11	10	9	8	7	6	5	4	3	2	1	0
Northern	0.23	0.29	0.33	0.37	0.40	0.42	0.44	0.44	0.44	0.44	0.44	0.45	0.45
North-Central	0.20	0.26	0.31	0.34	0.37	0.41	0.44	0.46	0.48	0.50	0.52	0.55	0.57
Central	0.34	0.39	0.43	0.45	0.47	0.48	0.49	0.48	0.47	0.47	0.48	0.48	0.48
Southern	0.32	0.37	0.41	0.43	0.46	0.48	0.49	0.49	0.49	0.49	0.49	0.50	0.50

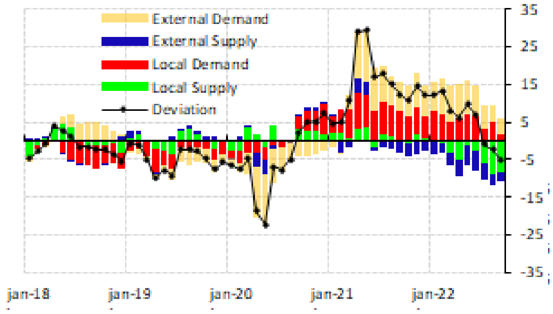
Table 6: Correlation Coefficients Between Regional Inflation of Manufactured Goods and US PPI-Manufacturing Growth.
Note: These correlation coefficients consider the correlation between the regional inflation rate of manufactured goods and the US PPI-Manufacturing annual growth rate lagged by k months. For each row of the table, the lower correlation coefficients are highlighted in red, while those higher are highlighted in green.
Source: Own calculations using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.

Region	Dependent Variable	Independent Variable	χ^2	$p-value$
Northern	Manufacturing Production	US Manufacturing Production	61.9	0.000*
Northern	ITAER	US Industrial Production	5.0	0.071
North-Central	Manufacturing Production	US Manufacturing Production	73.1	0.000*
North-Central	ITAER	US Industrial Production	0.8	0.380
Central	Manufacturing Production	US Manufacturing Production	87.1	0.000*
Central	ITAER	US Industrial Production	2.8	0.092
Southern	Manufacturing Production	US Manufacturing Production	15.0	0.000*
Southern	ITAER	US Industrial Production	9.1	0.002*

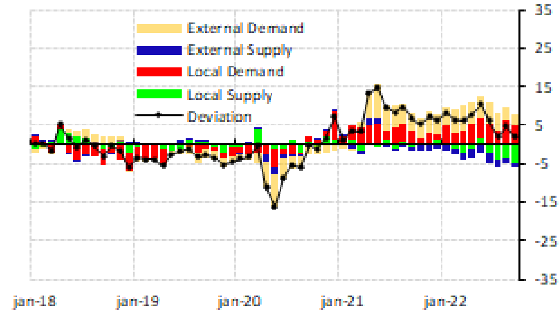
Table 7: Granger Causality Tests for Growth Rates of Economic Activity and Manufacturing Production.
Note: * Denotes $p-value$ consistent with 5% statistical significance for testing the hypothesis: H_0 = "Independent Variable Fails to Granger Cause Dependent Variable."
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.

Region	Dependent Variable	Independent Variable	χ^2	$p-value$
Northern	Manufactured Goods (INPC)	US PPI-Manufacturing	1.0	0.310
Northern	INPC	US CPI	26.3	0.000*
North-Central	Manufactured Goods (INPC)	US PPI-Manufacturing	1.3	0.261
North-Central	INPC	US CPI	1.2	0.265
Central	Manufactured Goods (INPC)	US PPI-Manufacturing	3.2	0.075
Central	INPC	US CPI	1.1	0.289
Southern	Manufactured Goods (INPC)	US PPI-Manufacturing	0.6	0.437
Southern	INPC	US CPI	16.8	0.018*

Table 8: Granger Causality Tests for Inflation.
Note: * Denotes $p-value$ consistent with 5% statistical significance for testing the hypothesis: H_0 = "Independent Variable Fails to Granger Cause Dependent Variable."
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.

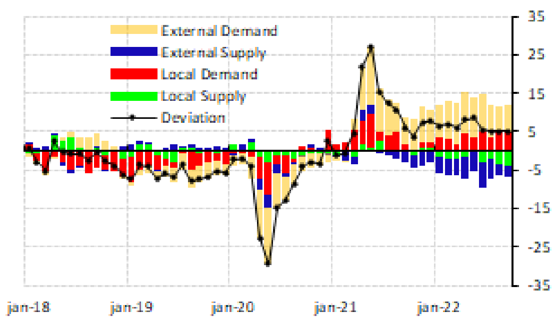


(a) Northern

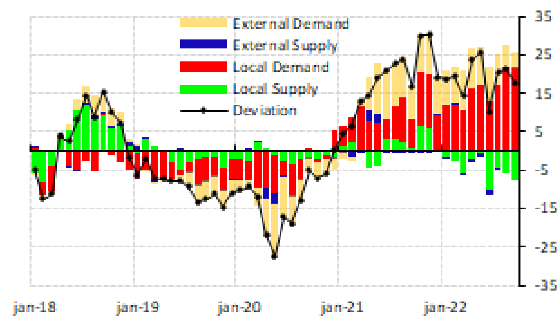


(b) North-Central

Figure 3: Historical Decomposition of the Regional Production of the Manufacturing Sector excluding Transportation Equipment.
Notes: The black line denotes the deviation of the real annual growth rate of the manufacturing production value excluding transportation equipment from its long-term average. The annual variations and shock contributions are calculated from the twelve-month rolling sum of the monthly variations and contributions estimated with the model. The long-term mean corresponds to the period spanning February 2007 to September 2022. Since roots of the characteristic polynomial (modulus) do not lie outside the unit circle, the estimated VAR models satisfy the stability condition.
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.

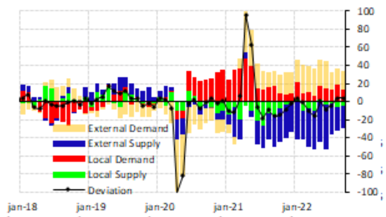


(a) Central

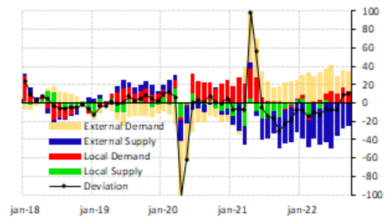


(b) Southern

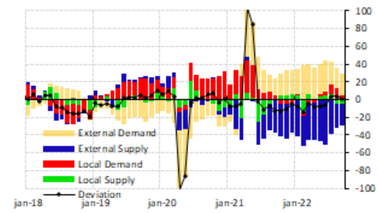
Figure 4: Historical Decomposition of the Regional Production of the Manufacturing Sector excluding Transportation Equipment.
Notes: The black line denotes the deviation of the real annual growth rate of the manufacturing production value excluding transportation equipment from its long-term mean. The annual variations and shock contributions are calculated from the twelve-month rolling sum of the monthly variations and contributions estimated with the model. The long-term mean corresponds to the period spanning February 2007 to September 2022. Since roots of the characteristic polynomial (modulus) do not lie outside the unit circle, the estimated VAR models satisfy the stability condition.
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



(a) Northern

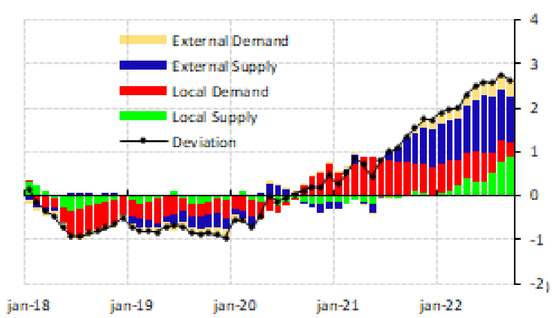


(b) North-Central

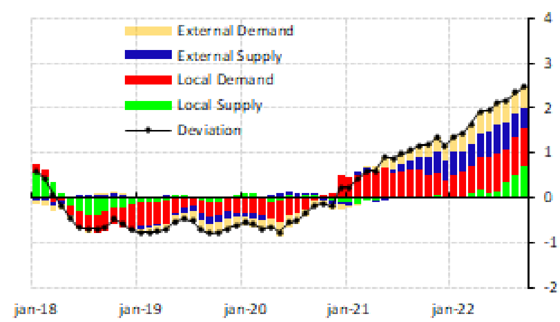


(c) Central

Figure 5: Historical Decomposition of the Regional Production of Transportation Equipment.
Notes: The black line denotes the deviation of the real annual growth rate of the transportation equipment production value from its long-term mean. The annual variations and shock contributions are calculated from the twelve-month rolling sum of the monthly variations and contributions estimated with the model. The long-term mean corresponds to the period spanning February 2007 to September 2022. Since roots of the characteristic polynomial (modulus) do not lie outside the unit circle, the estimated VAR models satisfy the stability condition.
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.

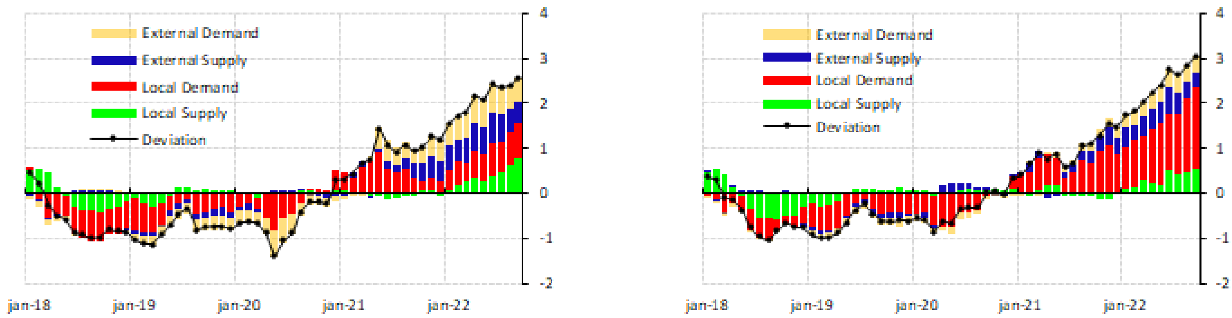


(a) Northern



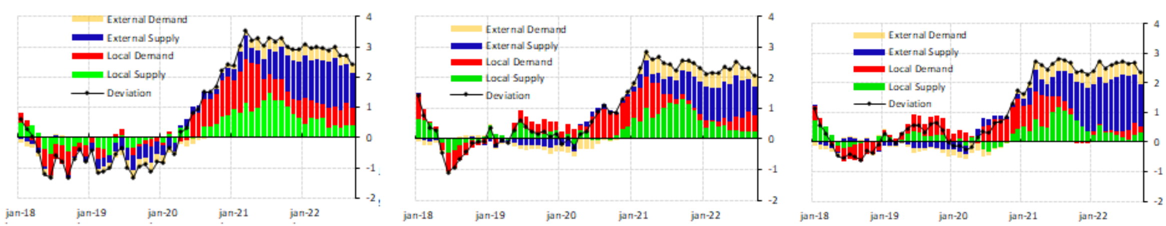
(b) North-Central

Figure 6: Historical Decomposition of the Regional Price Index of Manufactured Goods excluding Cars and Motor Vehicle Parts.
Notes: The black line denotes the deviation of the annual growth rate of the regional price index of manufactured goods excluding cars and motor vehicle parts from its long-term mean. The annual variations and shock contributions are calculated from the twelve-month rolling sum of the monthly variations and contributions estimated with the model. The long-term mean corresponds to the period spanning February 2007 to September 2022. Since roots of the characteristic polynomial (modulus) do not lie outside the unit circle, the estimated VAR models satisfy the stability condition.
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



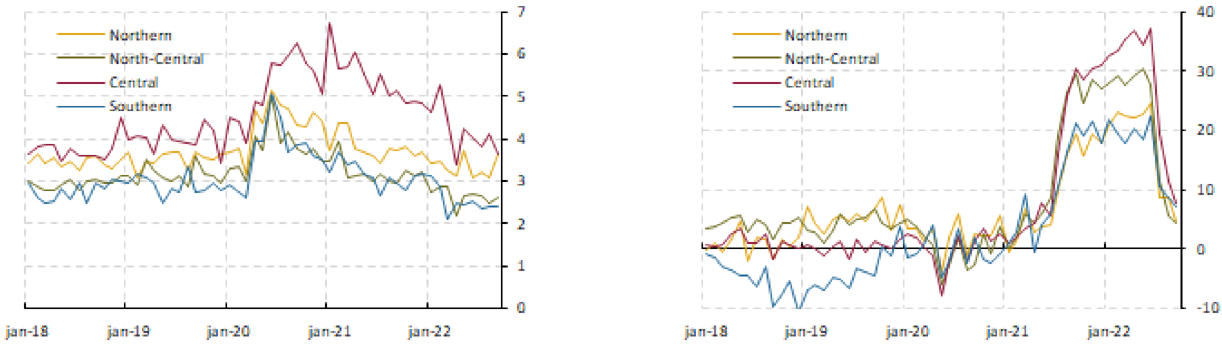
(a) Central **(b)** Southern

Figure 7: Historical Decomposition of the Regional Price Index of Manufactured Goods excluding Cars and Motor Vehicle Parts.
Notes: The black line denotes the deviation of the annual growth rate of the regional price index of manufactured goods excluding cars and motor vehicle parts from its long-term mean. The annual variations and shock contributions are calculated from the twelve-month rolling sum of the monthly variations and contributions estimated with the model. The long-term mean corresponds to the period spanning February 2007 to September 2022. Since roots of the characteristic polynomial (modulus) do not lie outside the unit circle, the estimated VAR models satisfy the stability condition.
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



(a) Northern **(b)** North-Central **(c)** Central

Figure 8: Historical Decomposition of the Regional Price Index of Cars and Motor Vehicle Parts.
Notes: The black line denotes the deviation of the annual growth rate of the regional price index of cars and motor vehicle parts from its long-term mean. The annual variations and shock contributions are calculated from the twelve-month rolling sum of the monthly variations and contributions estimated with the model. The long-term mean corresponds to the period spanning February 2007 to September 2022. Since roots of the characteristic polynomial (modulus) do not lie outside the unit circle, the estimated VAR models satisfy the stability condition.
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.

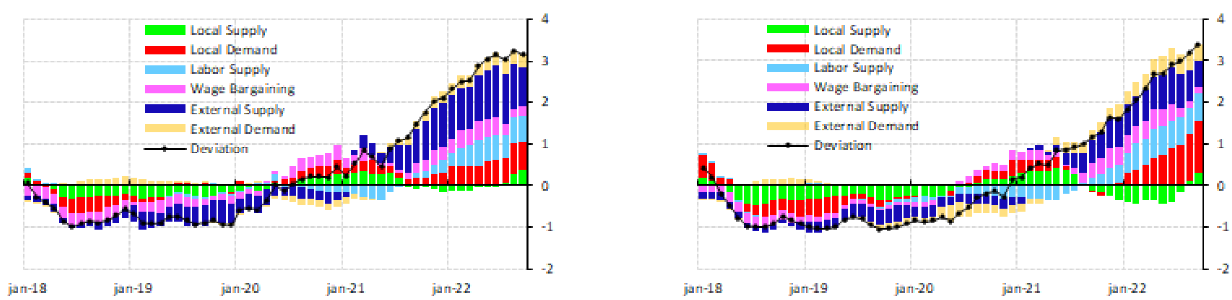


(a) Regional Unemployment Rate **(b)** Compensations per Employee

Figure 9: Annual Growth Rates of Regional Unemployment and Compensations per Employee.
Source:INEGI.

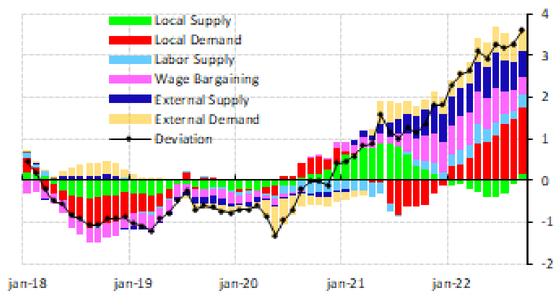
	Local Supply	Local Demand	Labor Supply	Wage Bargaining	External Supply	External Demand
Local Manufacturing Production	+	+	+	-	+	
Consumer Prices Index of Manufactured Goods	-	+	-	+	-	
Compensation per Employee	+		-	+		
Unemployment Rate	-	-	+	+		
US Manufacturing Production	0	0	0	0	+	+
US Manufacturing Producer Price Index	0	0	0	0	-	+
Real Exchange Rate	+	-				

Table 9: Strategy Identification.

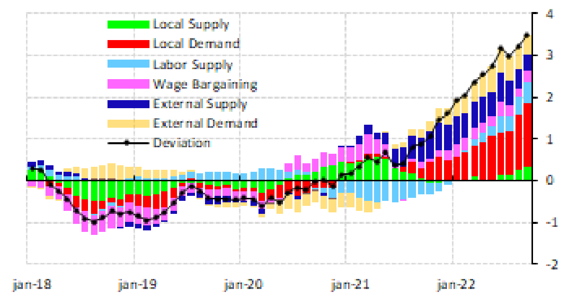


(a) Northern **(b)** North-Central

Figure 10: Historical Decomposition of the Regional Price Index of Manufactured Goods.
Notes: The black line denotes the deviation of the annual growth rate of the regional price index of manufactured goods from its long-term mean. The annual variations and shock contributions are calculated from the twelve-month rolling sum of the monthly variations and contributions estimated with the model. The long-term mean corresponds to the period spanning February 2013 to September 2022. Since roots of the characteristic polynomial (modulus) do not lie outside the unit circle, the estimated VAR models satisfy the stability condition.
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



(a) Central



(b) Southern

Figure 11: Historical Decomposition of the Regional Price Index of Manufactured Goods.

Notes: The black line denotes the deviation of the annual growth rate of the regional price index of manufactured goods from its long-term mean. The annual variations and shock contributions are calculated from the twelve-month rolling sum of the monthly variations and contributions estimated with the model. The long-term mean corresponds to the period spanning February 2013 to September 2022. Since roots of the characteristic polynomial (modulus) do not lie outside the unit circle, the estimated VAR models satisfy the stability condition.

Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.

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Appendix A: *Historical Decomposition Analysis*

The historical decomposition analysis of the shocks and the deterministic part is performed using the following equations:

$$y_t = \mu_t + \sum_{i=1}^{p} B_i y_{t-i} + u_t, \tag{1}$$

where y_t is the $N \times 1$ vector of endogenous variables, μ_t is the $N \times 1$ vector of deterministic terms, B_i is the $N \times N$ matrix of lag coefficients for $i = 1, \ldots, p$, p is the number of lags, and u_t is the $N \times 1$ vector of residuals.

The structural shocks can be expressed as:

$$\epsilon_t = A^{-1} u_t, \tag{2}$$

where A^{-1} is the inverse of the parameter matrix A.

The contribution of each structural shock $\epsilon_{i,t}$ to the endogenous variable j at time t can be calculated as:

$$\Delta y^i_{j,t} = \sum_{k=0}^{p-i} (B_{i+k} - B_k) j, :\epsilon i, t, \tag{3}$$

where $(B_{i+k} - B_k)j,:$ is the j^{th} row of the matrix $(Bi + k - B_k)$.

The total contribution of all structural shocks to the endogenous variable j at time t can be calculated as:

$$\Delta y^{shocks}_{j,t} = \sum_{i=1}^{p} \Delta y^i_{j,t}. \tag{4}$$

The contribution of the deterministic terms to the endogenous variable j at time t can be calculated as:

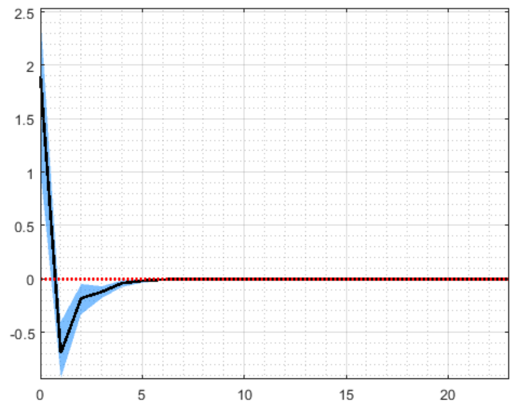
$$\Delta y^{deterministic}_{j,t} = \mu_{j,t} - \mu_{j,t-1}. \tag{5}$$

The total contribution of all shocks and the deterministic terms to the endogenous variable j at time t can be calculated as:

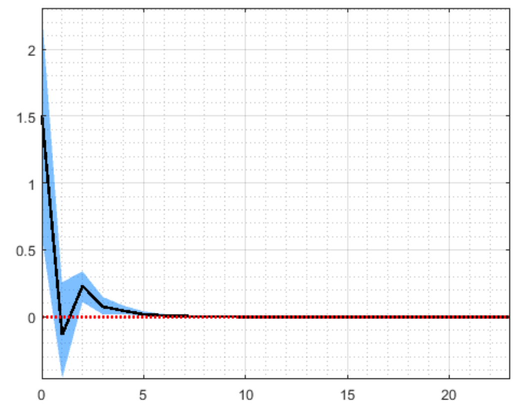
$$\Delta y_{j,t} = \Delta y^{shocks}_{j,t} + \Delta y^{deterministic}_{j,t}. \tag{6}$$

These equations provide the historical decomposition of shocks and the deterministic part, which allows us to analyze the contribution of each structural shock and deterministic term to the behavior of the endogenous variables over time.

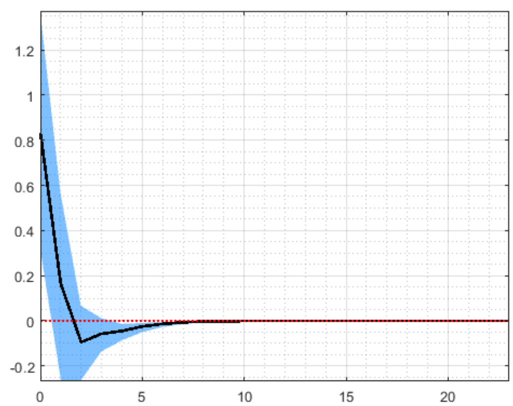
Appendix B: *Impulse Response Functions*



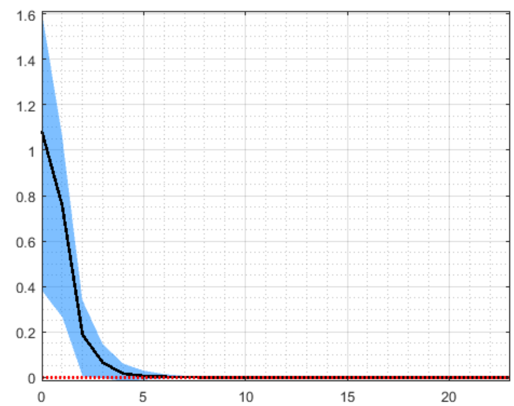
(a) Local Supply



(b) Local Demand

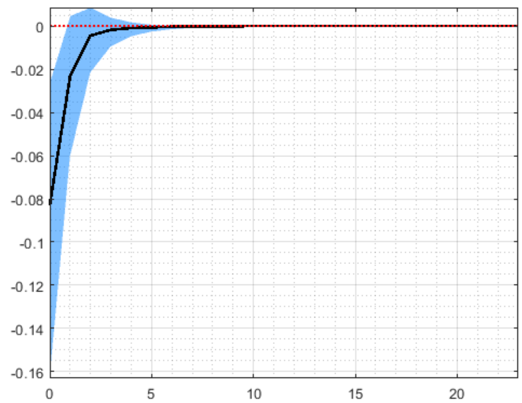


(c) External Supply

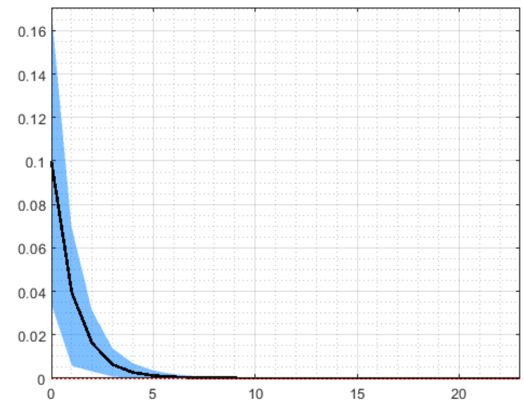


(d) External Demand

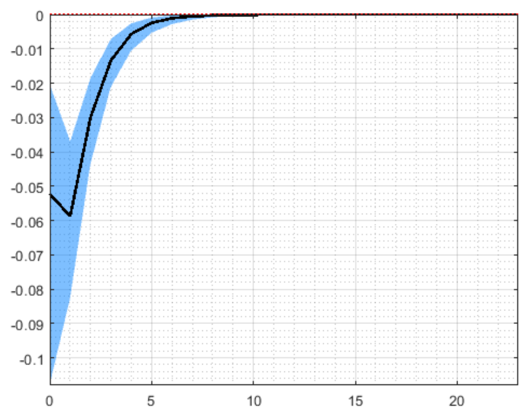
Figure B1: (Northern Region). Impulse Response Functions of the Monthly Growth Rate of the Price Level of the Manufacturing Sector excluding Transportation Equipment to the Indicated Structural Shock.
Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.
Source: Own estimates based on data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



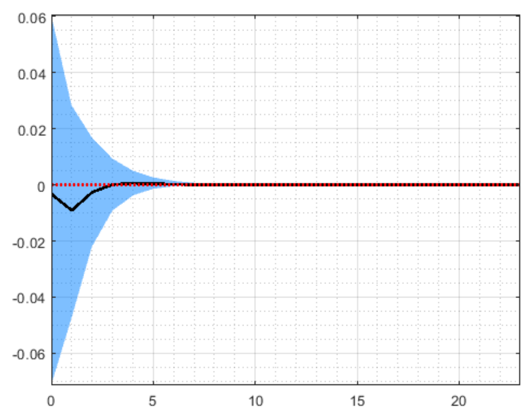
(a) Local Supply



(b) Local Demand



(c) External Supply

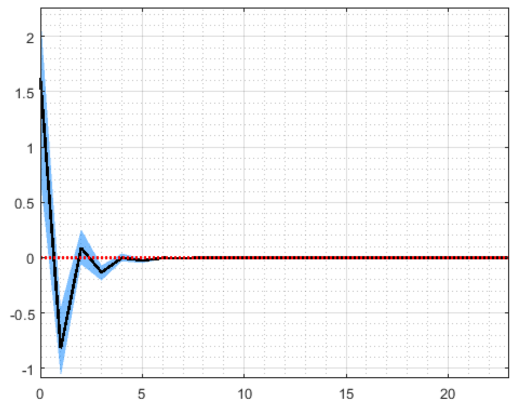


(d) External Demand

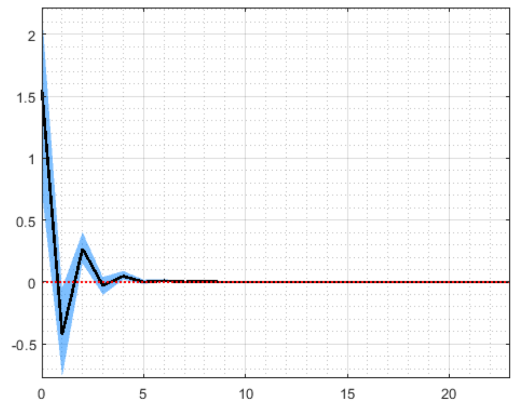
Figure B2: (Northern Region). Impulse Response Functions of the Monthly Growth Rate of the Price Index of Manufactured Goods excluding Cars and Motor Vehicle Parts to the Indicated Structural Shock.

Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.

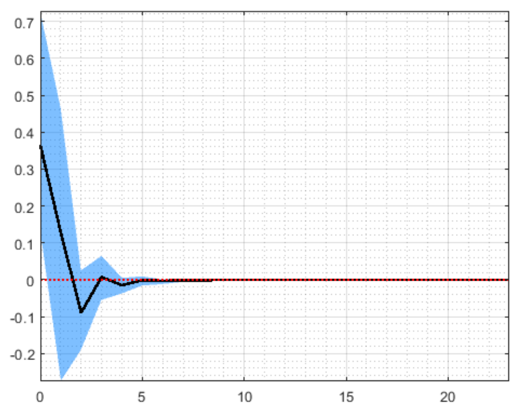
Source: Own estimates based on data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



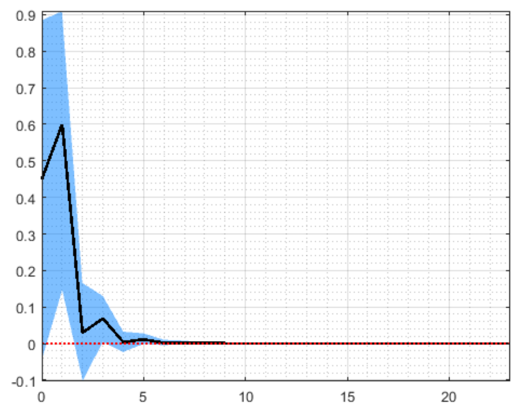
(a) Local Supply



(b) Local Demand

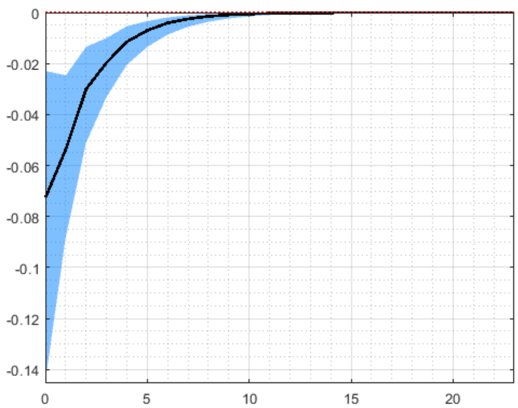


(c) External Supply

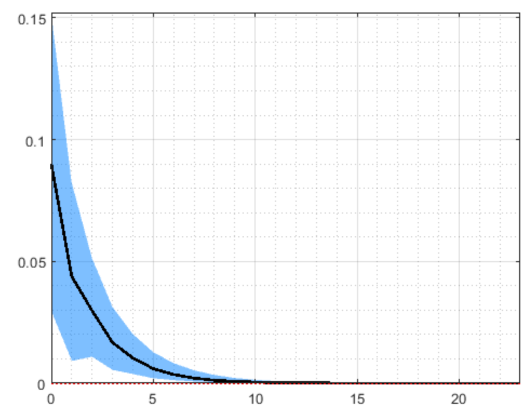


(d) External Demand

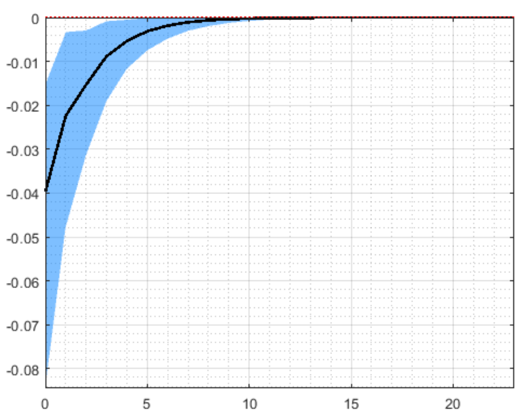
Figure B3: (North-Central Region). Impulse Response Functions of the Monthly Growth Rate of the Production Level of the Manufacturing Sector excluding Transportation Equipment to the Indicated Structural Shock.
Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



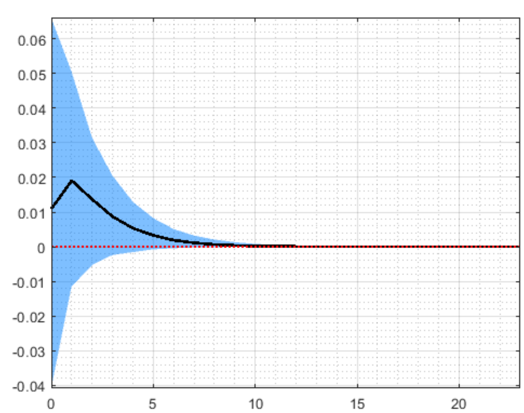
(a) Local Supply



(b) Local Demand



(c) External Supply

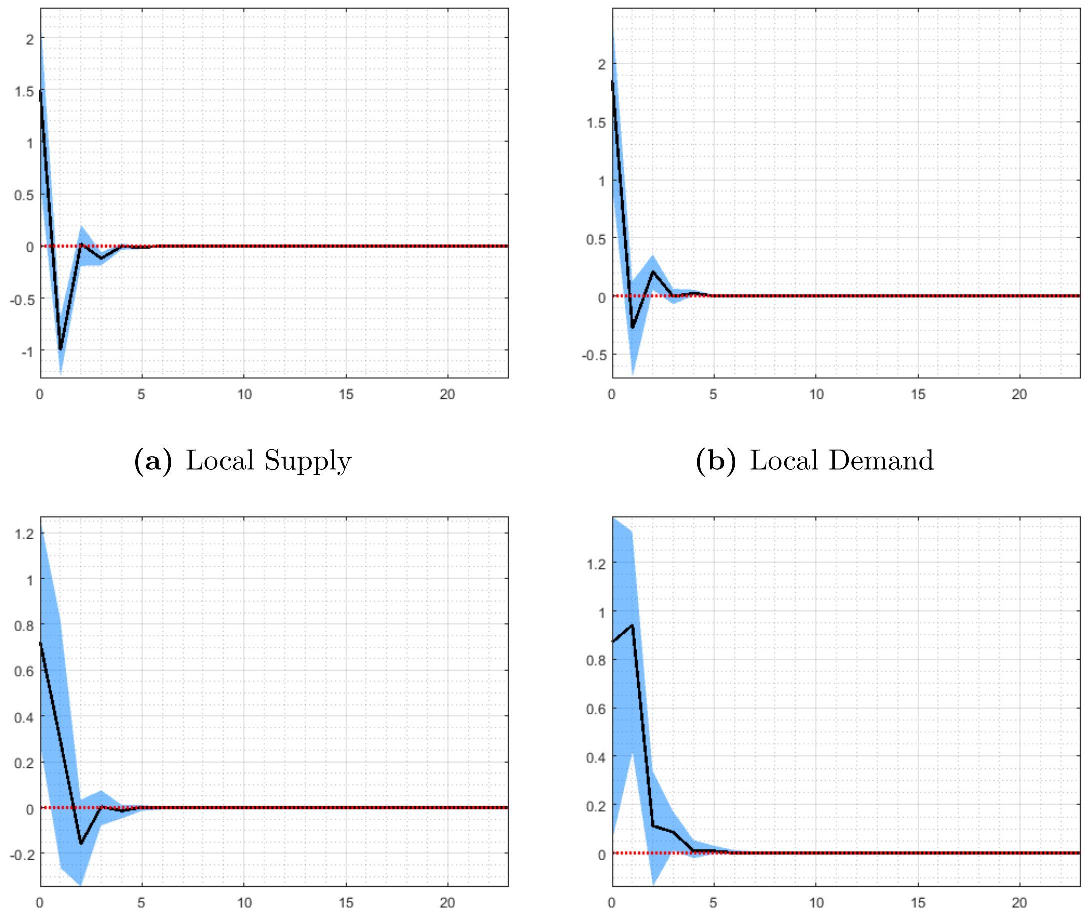


(d) External Demand

Figure B4: (North-Central Region). Impulse Response Functions of the Monthly Growth Rate of the Price Index of Manufactured Goods excluding Cars and Motor Vehicle Parts to the Indicated Structural Shock.

Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.

Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



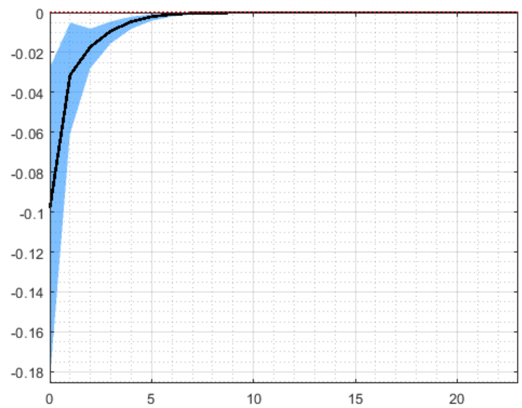
(a) Local Supply

(b) Local Demand

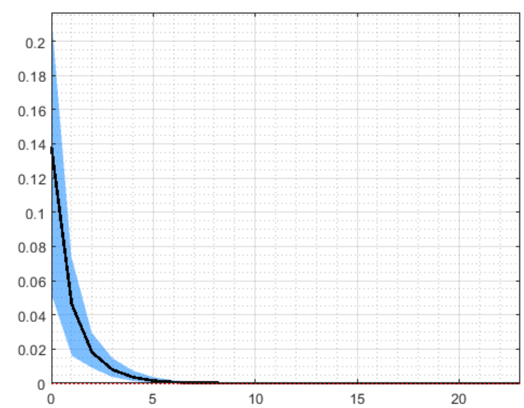
(c) External Supply

(d) External Demand

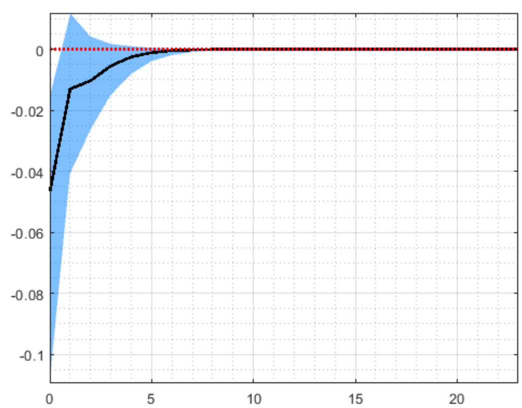
Figure B5: (Central Region). Impulse Response Functions of the Monthly Growth Rate of the Production Level of the Manufacturing Sector excluding Transportation Equipment to the Indicated Structural Shock.
Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



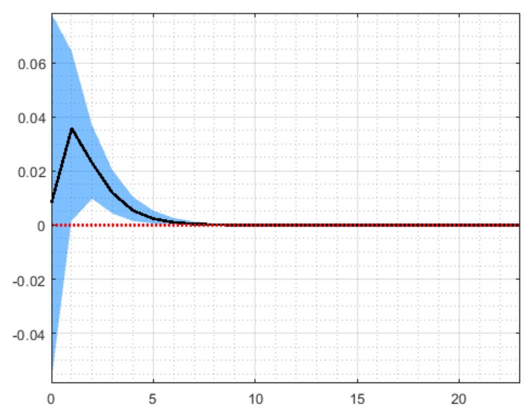
(a) Local Supply



(b) Local Demand

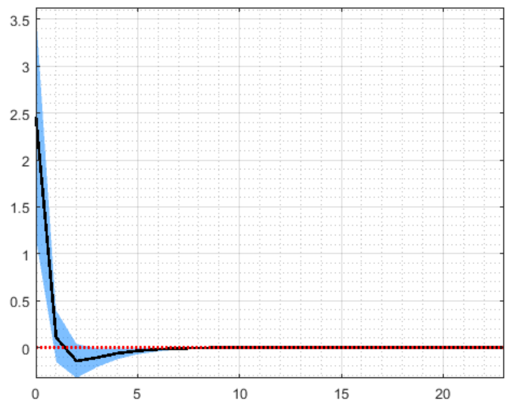


(c) External Supply

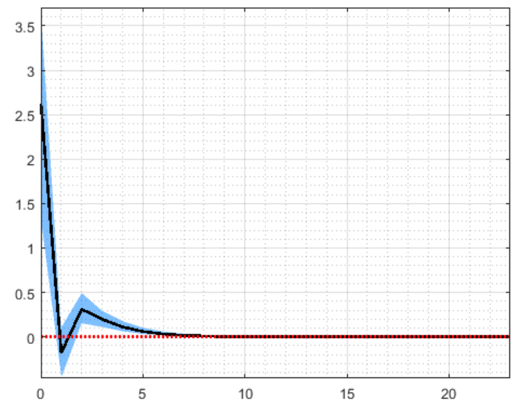


(d) External Demand

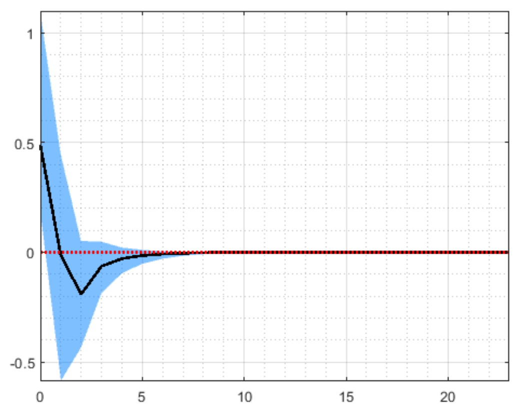
Figure B6: (Central Region). Impulse Response Functions of the Monthly Growth Rate of the Price Index of Manufactured Goods excluding Cars and Motor Vehicle Parts to the Indicated Structural Shock.
Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



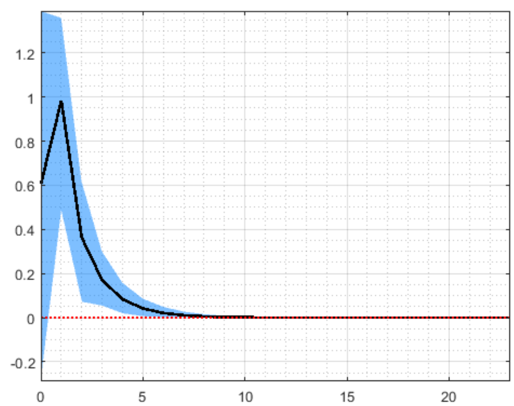
(a) Local Supply



(b) Local Demand

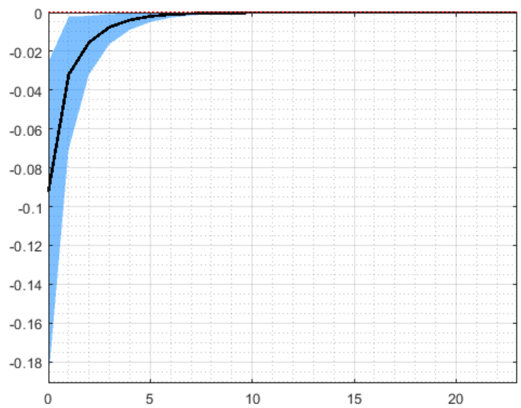


(c) External Supply

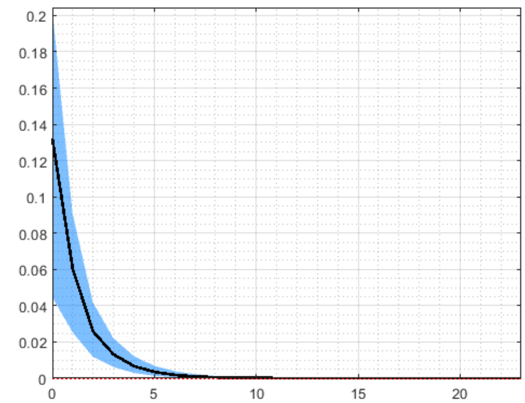


(d) External Demand

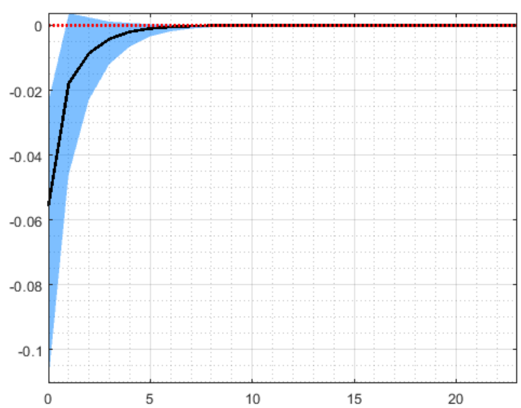
Figure B7: (Souhtern Region). Impulse Response Functions of the Monthly Growth Rate of the Production Level of the Manufacturing Sector excluding Transportation Equipment to the Indicated Structural Shock.
Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



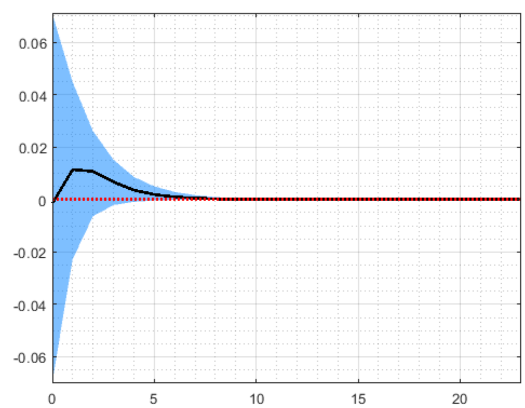
(a) Local Supply



(b) Local Demand



(c) External Supply

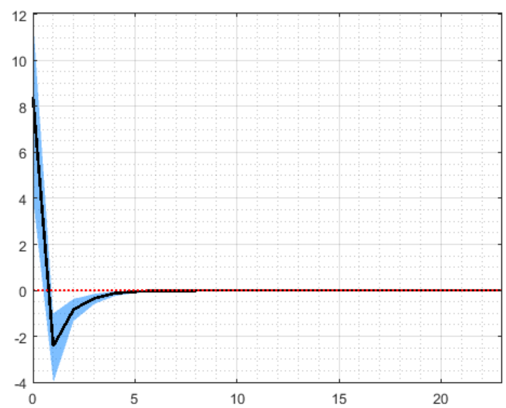


(d) External Demand

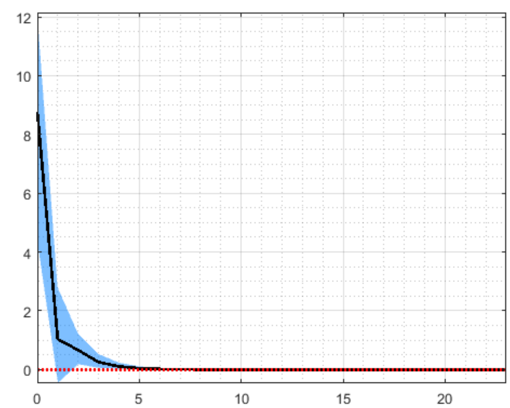
Figure B8: (Souhtern Region). Impulse Response Functions of the Monthly Growth Rate of the Price Index of Manufactured Goods excluding Cars and Motor Vehicle Parts to the Indicated Structural Shock.

Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.

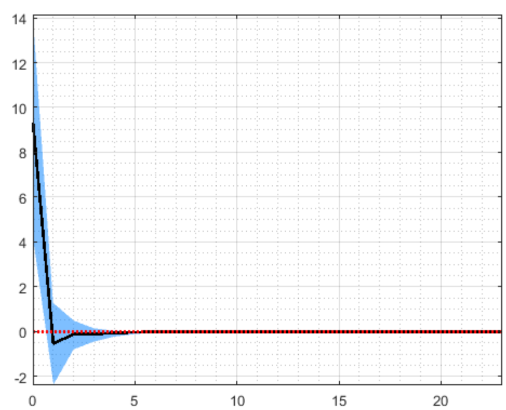
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



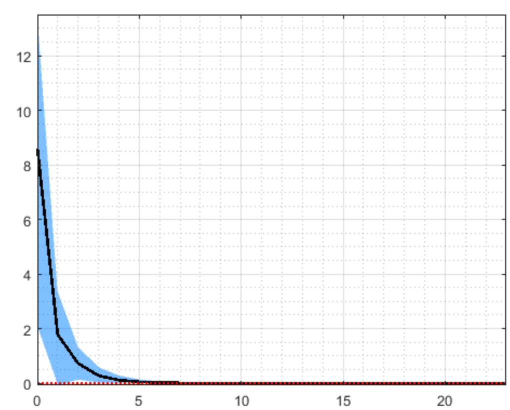
(a) Local Supply



(b) Local Demand



(c) External Supply

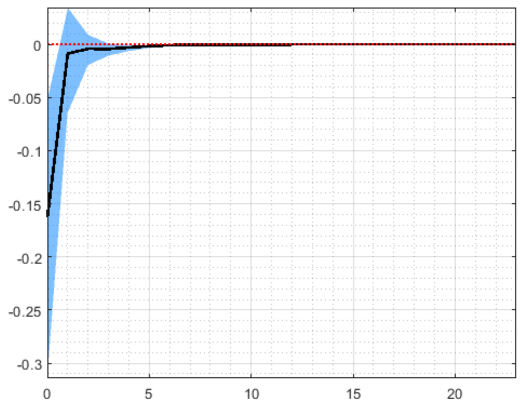


(d) External Demand

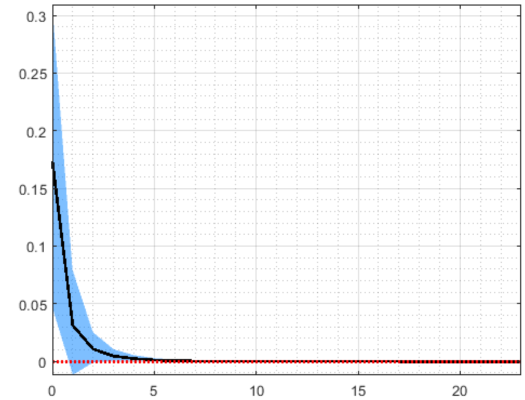
Figure B9: (Northern Region). Impulse Response Functions of the Monthly Growth Rate of the Production Level of Transportation Equipment to the Indicated Structural Shock.

Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.

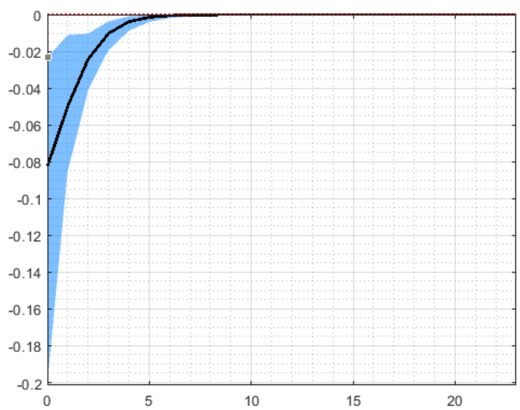
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



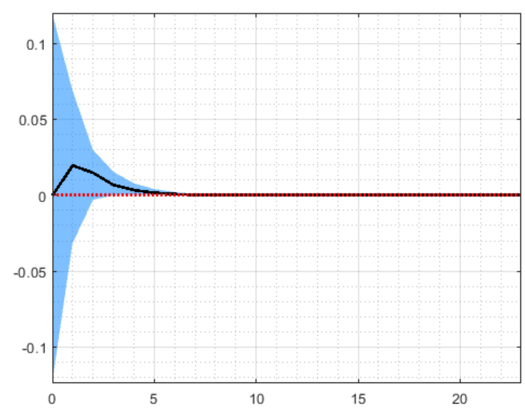
(a) Local Supply



(b) Local Demand



(c) External Supply

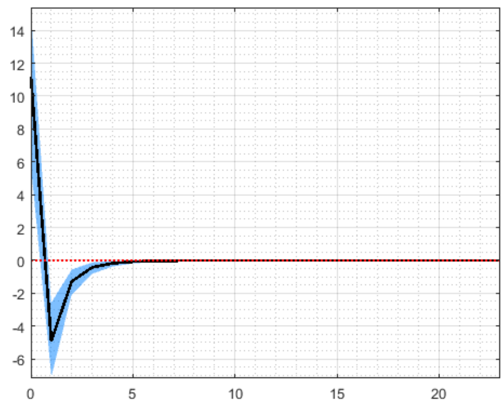


(d) External Demand

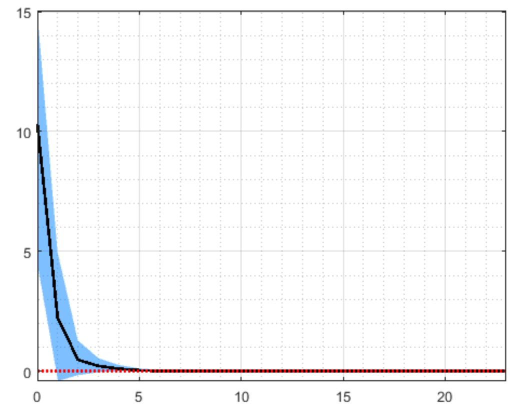
Figure B10: (Northern Region). Impulse Response Functions of the Monthly Growth Rate of the Price Index of Cars and Motor Vehicle Parts to the Indicated Structural Shock.

Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.

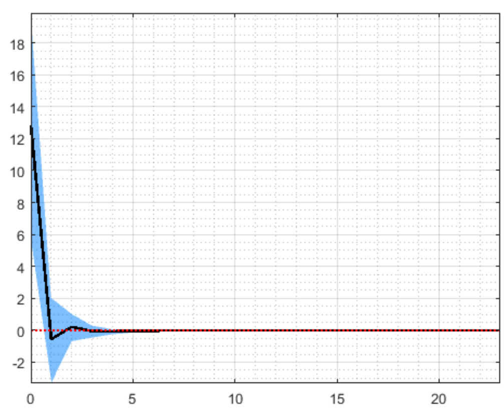
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



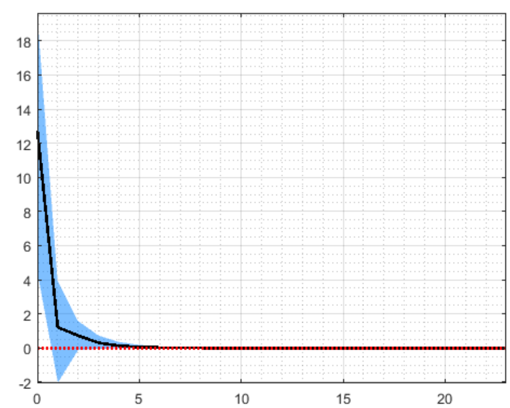
(a) Local Supply



(b) Local Demand

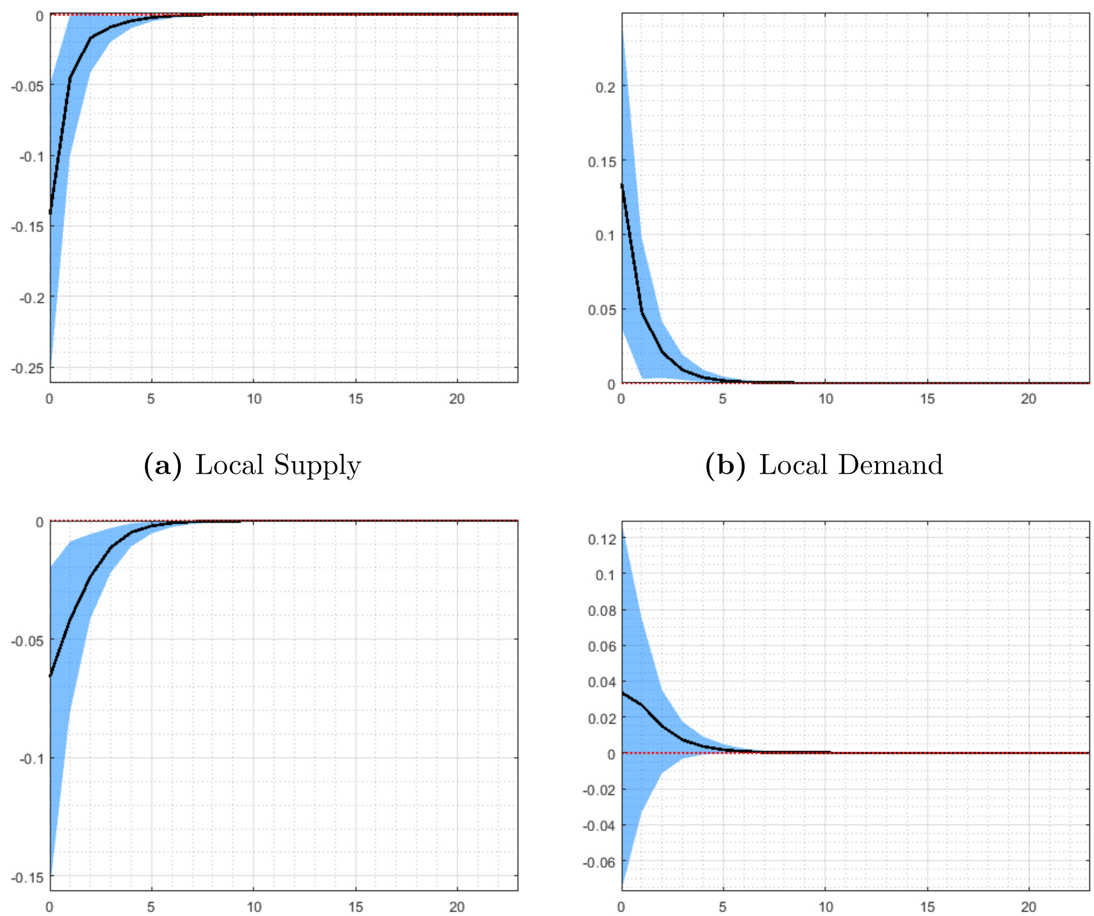


(c) External Supply



(d) External Demand

Figure B11: (North-Central Region). Impulse Response Functions of the Monthly Growth Rate of the Production Level of Transportation Equipment to the Indicated Structural Shock.
Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



(a) Local Supply

(b) Local Demand

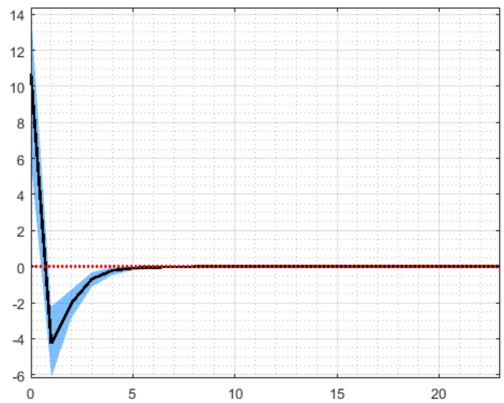
(c) External Supply

(d) External Demand

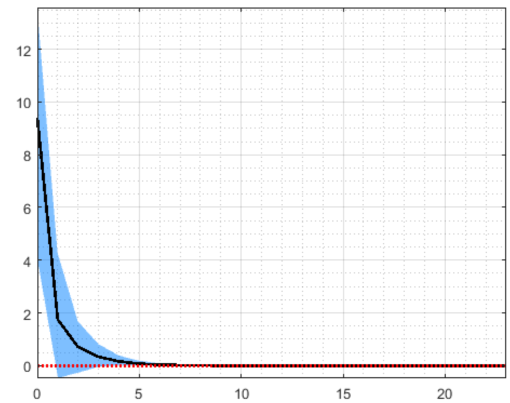
Figure B12: (North-Central Region). Impulse Response Functions of the Monthly Growth Rate of the Price Index of Cars and Motor Vehicle Parts to the Indicated Structural Shock.

Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.

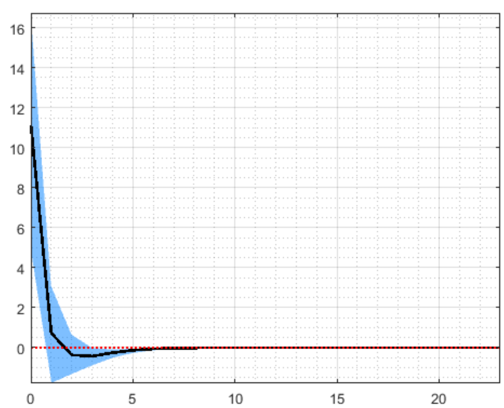
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



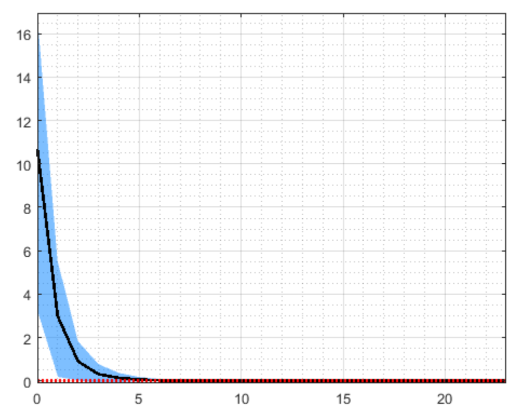
(a) Local Supply



(b) Local Demand



(c) External Supply

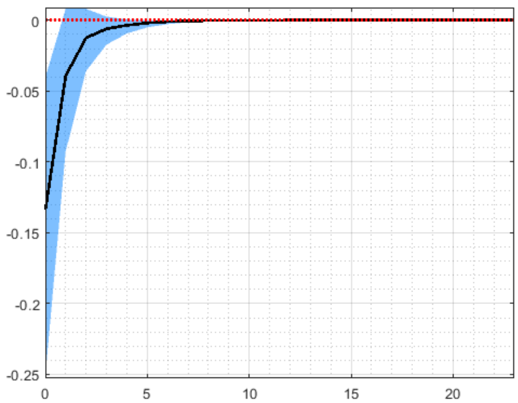


(d) External Demand

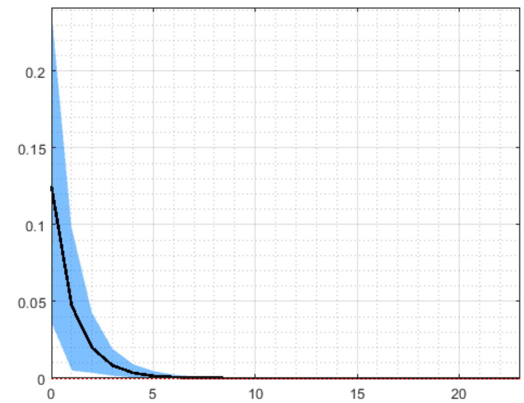
Figure B13: (Central Region). Impulse Response Functions of the Monthly Growth Rate of the Production Level of Transportation Equipment to the Indicated Structural Shock.

Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.

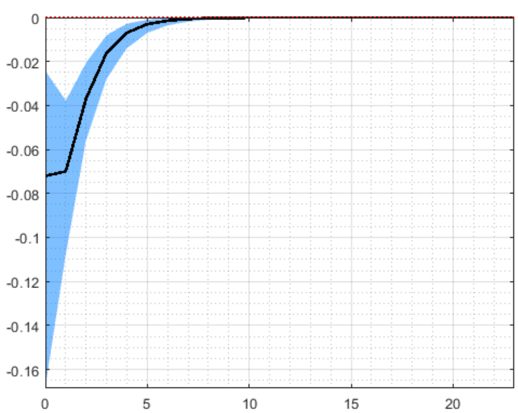
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



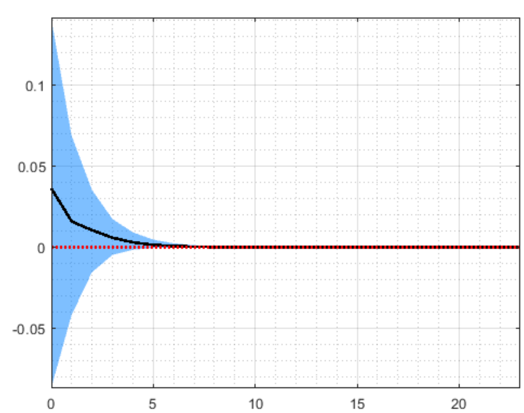
(a) Local Supply



(b) Local Demand



(c) External Supply

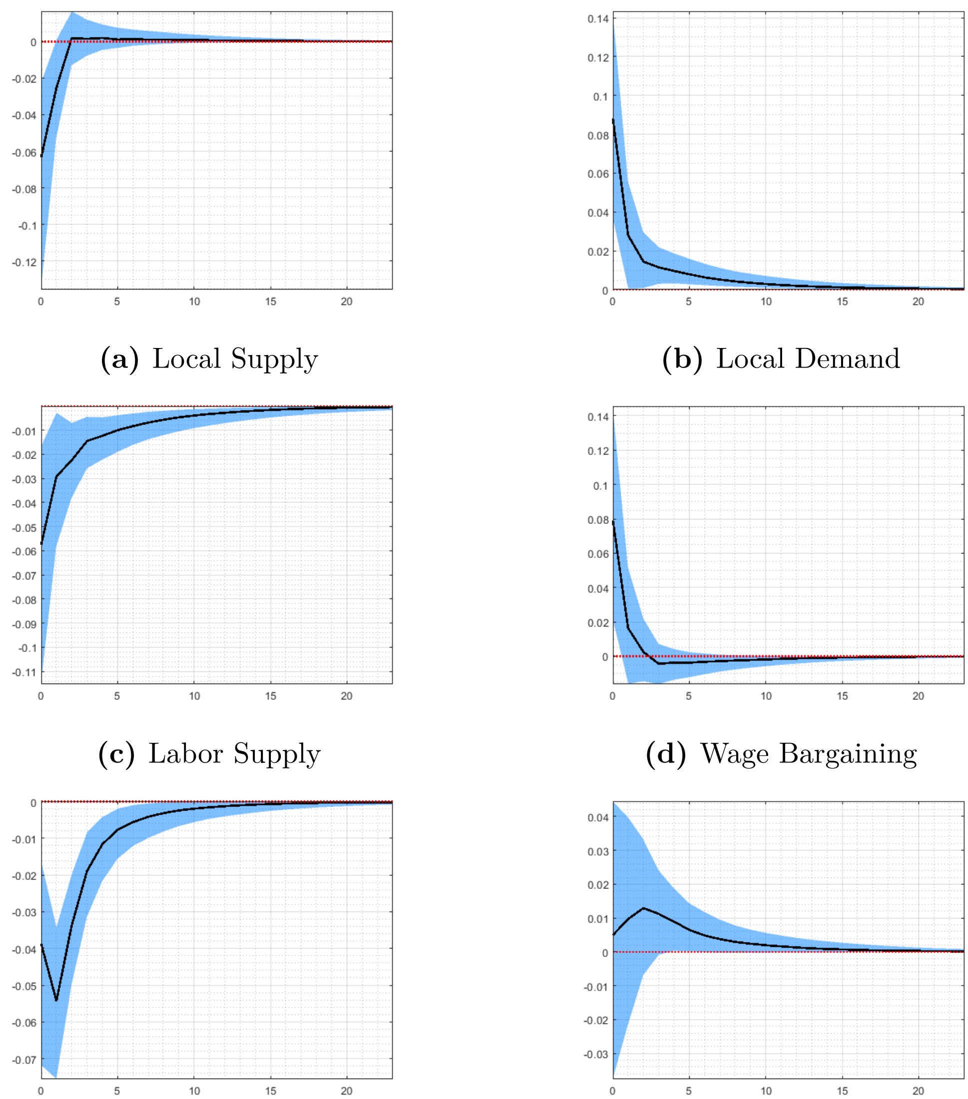


(d) External Demand

Figure B14: (Central Region). Impulse Response Functions of the Monthly Growth Rate of the Price Index of Cars and Motor Vehicle Parts to the Indicated Structural Shock.

Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.

Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



(a) Local Supply **(b)** Local Demand

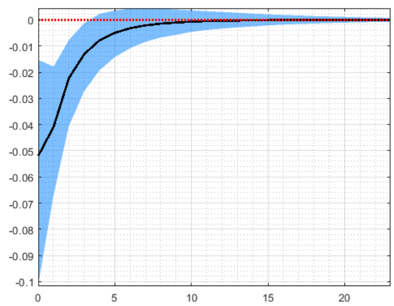
(c) Labor Supply **(d)** Wage Bargaining

(e) External Supply **(f)** External Demand

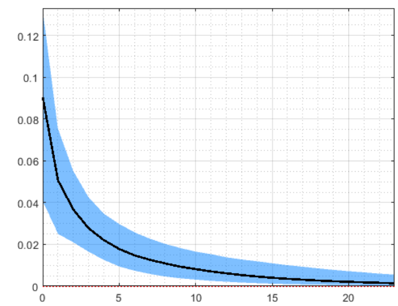
Figure B15: (Northern Region). Impulse Response Functions of the Monthly Growth Rate of the Price Index of Manufactured Goods to the Indicated Structural Shock.

Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.

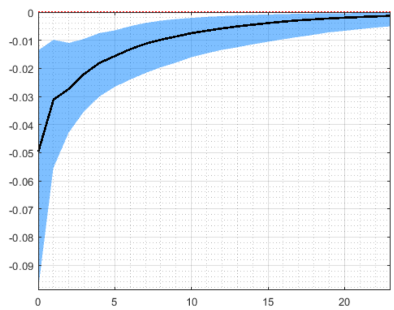
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



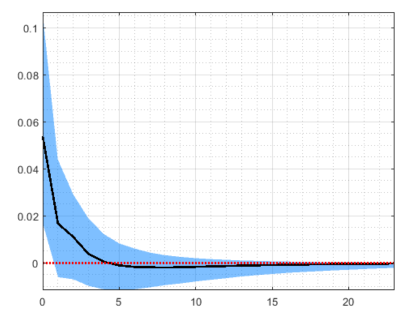
(a) Local Supply



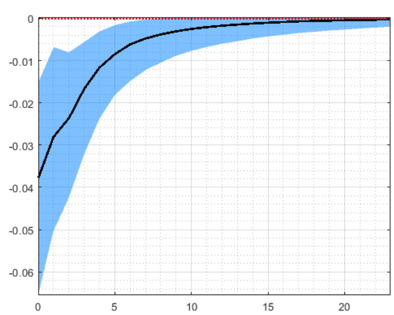
(b) Local Demand



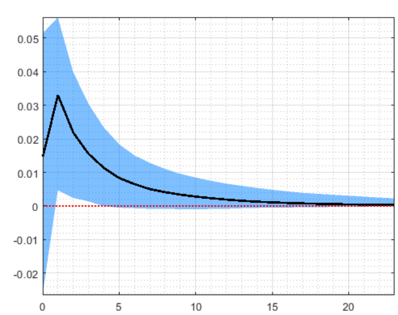
(c) Labor Supply



(d) Wage Bargaining



(e) External Supply

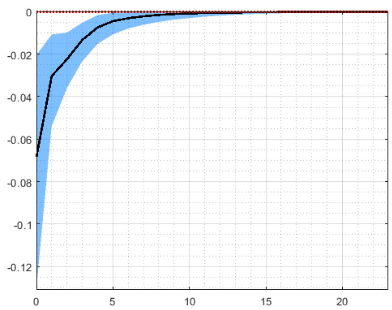


(f) External Demand

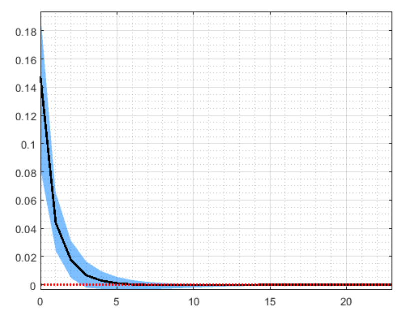
Figure B16: (North-Central Region). Impulse Response Functions of the Monthly Growth Rate of the Price Index of Manufactured Goods to the Indicated Structural Shock.

Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.

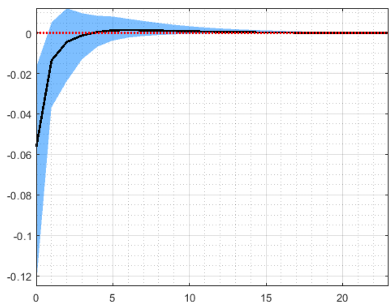
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



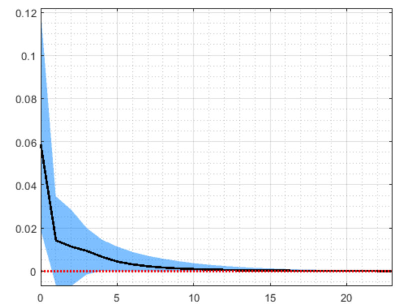
(a) Local Supply



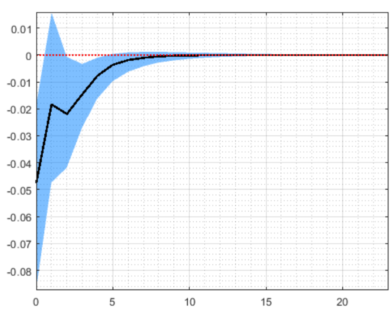
(b) Local Demand



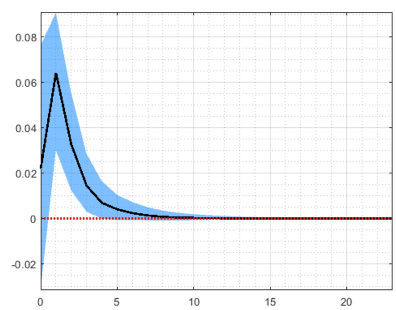
(c) Labor Supply



(d) Wage Bargaining



(e) External Supply

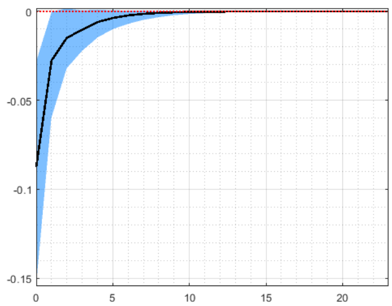


(f) External Demand

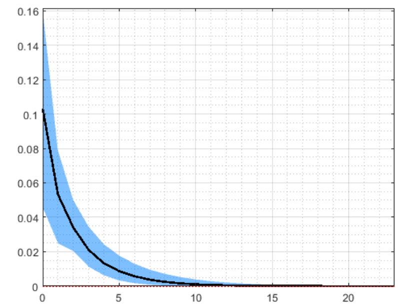
Figure B17: (Central Region). Impulse Response Functions of the Monthly Growth Rate of the Price Index of Manufactured Goods to the Indicated Structural Shock.

Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.

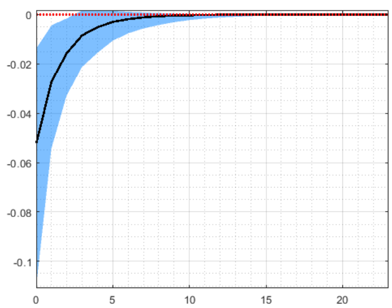
Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.



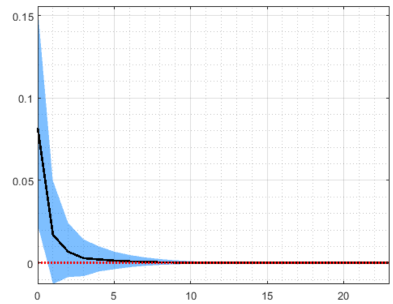
(a) Local Supply



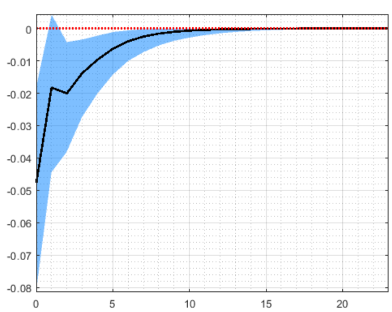
(b) Local Demand



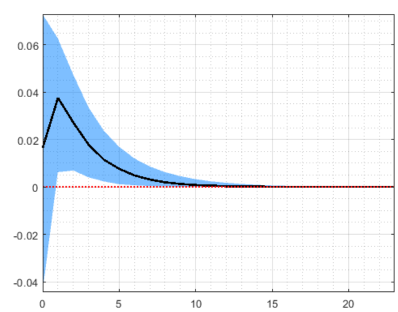
(c) Labor Supply



(d) Wage Bargaining



(e) External Supply



(f) External Demand

Figure B18: (Southern Region). Impulse Response Functions of the Monthly Growth Rate of the Price Index of Manufactured Goods to the Indicated Structural Shock.

Notes: Time in months (horizontal axis) and units in percent (vertical axis). Shaded area represents 67 percent credibility intervals.

Source: Own estimates using data from INEGI, Banco de México, and the Federal Reserve of St. Louis.