MACROECONOMIC POLICY RESPONSES TO COVID-19

SECTORAL SUPPLY AND DEMAND SHOCKS DURING COVID-19: EVIDENCE FROM MEXICO

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Sectoral Supply and Demand Shocks during COVID-19: Evidence from Mexico *

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Abstract

The COVID-19 Pandemic has entailed both supply and demand shocks. Nevertheless, it is uncertain to what extent one or the other factor was more important in accounting for the evolution of prices and economic activity at different points since the onset of the COVID-19 Pandemic. Whether inflationary pressures are mainly due to demand or supply shocks can matter for the stance of monetary policy. Employing a sign-restricted SBVAR, we study supply and demand factors as potential sources of heterogeneity in sectoral performance in Mexican economic activity. We find that during the peak contraction in 2020-2Q, the demand shock was the dominant source of fluctuation across most sectors. Moreover, we assess the extent to which economic activity responds to foreign shocks and find that domestic demand shocks are the primary driver of GDP fluctuations in 2020-2Q, with external demand and supply conditions and exchange rate shocks also playing a significant role. In contrast, since the beginning of 2021, external supply has contributed negatively to the variation of several sectors, particularly in industrial production, while domestic and external demand factors have generally contributed positively.

JEL Codes:

Keywords: Mexico, COVID-19, Sectoral shocks, SBVAR models, Supply, Demand, Foreign shocks.

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1 Introduction

In 2020 the COVID-19 Pandemic impacted the global economy. Lockdown and social distancing measures were implemented worldwide to decrease the rate of contagion. Unemployment grew abruptly, and consumption patterns changed to face the lockdown and buffer the impact of health policies on household income. Two years since the initial outbreak, the COVID-19 Pandemic persists in most countries, including Mexico. The appearance of the rapidly spread Omicron variant at the end of 2021 has shown that risks persist around the Pandemic's evolution. However, a significant reduction in cases, hospitalizations, and deaths associated with this variant has recently been observed, contributing to sustaining the recovery of economic activity, both globally and in Mexico.

While most economists concur that the COVID-19 Pandemic has entailed both supply and demand shocks, it is uncertain to what extent one or the other factor has dominated at different points since the Pandemic began. Several papers have attempted to measure the Pandemic's economic impact in this complex environment to help policymakers take appropriate actions. Most studies have analyzed the effect in advanced economies, such as Andersen et al. (2020), Brinca et al. (2021), and del Rio-Chanona et al. (2020). Measuring this effect for a small open economy highly integrated into the global value chains, such as Mexico, is relevant for economic policy analysis since a better understanding of the extent to which demand versus supply-side forces are shaping economic activity is necessary to design policies that aim to support the economy during these times.

Like most other countries, since the beginning of 2020, health authorities in Mexico have implemented social distancing measures and the closure of non-essential activities to reduce the spread of the virus. On the one hand, confinement has led people to stay at home, reducing the consumption of specific goods and services, particularly those that require more physical contact. On the other hand, the closure of activities classified as non-essential has had effects on both the supply and demand sides of the economy. The results of these policies on economic activity have been generalized but heterogeneous across sectors, which brings forth the question of identifying the potential source for that heterogeneity.

In this sense, our main goal is to identify the contributions of demand and supply shocks to output growth at the aggregate and sectoral levels in Mexico. Furthermore, given the active role of Mexico in global markets, we aim to assess the impact of international shocks (i.e., shocks to foreign supply, foreign demand, and exchange rate) as sources of its economic fluctuation. By utilizing a sign-restricted Structural Bayesian Vector Autoregression (SBVAR), we seek to shed light on the heterogeneity across sectors regarding the magnitude and composition of the shocks that have affected them. Our work is mostly related to that of Brinca et al. (2021) and Baumeister & Hamilton (2015). To the best of our knowledge, this is the first paper to analyze the extent to

which demand and supply shocks shape sectoral economic activity during the COVID-19 Pandemic in Mexico utilizing a sign-restricted SBVAR.

Our results suggest that the weak performance of the Mexican economy before the Pandemic seems to be mainly associated with a balanced combination of demand and supply factors. As expected, during 2020-Q2, we observe the most harmful effect of COVID-19 on economic activity. In this initial economic contraction, the demand shock was the dominant source of fluctuation across most sectors, associated with the implementation of lockdown measures, mobility restrictions, and economic uncertainty. Once we consider the international dimension of the shocks, our results suggest a significant role of external demand and supply conditions and exchange rate shocks to explain the dynamic of economic activity during this period. Domestic and foreign demand have predominantly guided the fluctuations in the Mexican economy. More recently, since 2021-Q2, external supply has contributed negatively to the variation of several sectors, particularly in manufacturing, while domestic and external demand factors have, in general, contributed positively. These findings highlight the importance of including external conditions in similar analyses to better understand the source of economic fluctuations in Mexico.

The rest of our paper is organized as follows. Section 2 presents related literature. Section 3 details the chronology of the COVID-19 Pandemic in Mexico and provides a descriptive context of the repercussions on its economy. Section 4 describes our empirical strategy and the data. Section 5 presents the results for both the analysis that identifies demand and supply shocks and the analysis that also includes external economic conditions as determinants of economic activity and prices in Mexico. In Section 6, we discuss our results and their implications in the context of the literature.

2 Literature Review

Our work is mainly related to the work of Baumeister & Hamilton (2015). These authors explain the prior beliefs implicit in sign-restricted VARs and propose a general Bayesian framework to optimize prior information. In addition, they provide an application for measuring labor demand and supply shocks in the United States (US). Similar to our work, Brinca et al. (2021) measure labor demand and supply shocks at the sector level around the time of the COVID-19 outbreak by estimating a BVAR of hours worked and real wages.

In another related paper, del Rio-Chanona et al. (2020) provide quantitative predictions of supply and demand shocks for the US economy associated with the COVID-19 Pandemic at the level of individual occupations and industries. Similarly, Andersen et al. (2020) show that aggregate spending dropped by around 25 percent in Sweden and by four additional percentage points in Denmark due to the lockdown.

Baqaee & Farhi (2021) study supply and demand shocks in a disaggregated model with multiple sectors, multiple factors, and input-output linkages. Their model includes downward nominal wage rigidities, credit constraints, and a zero lower bound. They show that adverse sectoral supply shocks are stagflationary, whereas negative demand shocks are deflationary. They conclude that both can cause Keynesian unemployment. Guerrieri et al. (2020) present a theory of Keynesian supply shocks: supply shocks that trigger changes in aggregate demand more considerable than the shocks themselves. This result implies that demand may overreact to the supply shock and lead to a demand-deficient recession. Finally, Eichenbaum et al. (2020) extend the canonical epidemiology model to study the interaction between economic decisions and epidemics. Their model implies that people cut back on consumption and work to reduce the risk of infection. These decisions lessen the severity of the epidemic but exacerbate the size of the associated recession.

3 Motivation

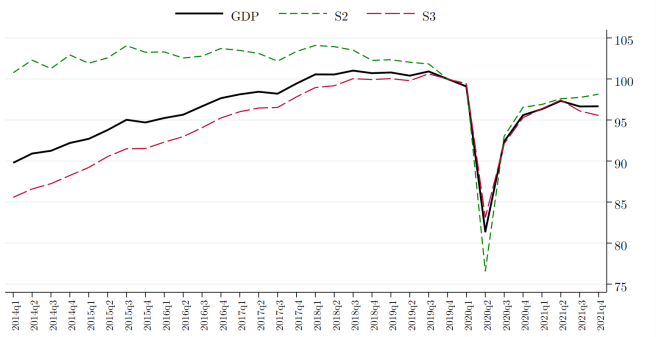
The health response to the 2020 COVID-19 outbreak has entailed several disruptions in the global economy. In Mexico, as in other countries, health authorities implemented social distancing measures that implied a heterogeneous shutdown of several production sectors. Additionally, households voluntarily reduced social interactions to avoid contagion. Moreover, economic downturn, unemployment, and uncertainty forced families to alter their consumption and saving patterns to cushion the impact of these various shocks. The closure of industrial activity could primarily affect the economy via the supply side. On the other hand, sectors related to services could experience less economic activity via the demand side due to confinement. We aim to disentangle which effect dominated during this period.

The COVID-19 outbreak had the most significant negative shock on the Mexican economy in 2020-Q2 (see Figure 1 panel (a)). The fall in the aggregate economy was driven by severe contractions in the secondary sector (industrial production) and the tertiary sector (services). The impact was heterogeneous among these broader sectors. Figure 1 panel (a) shows that the secondary sector experienced a relatively more severe economic contraction in 2020-Q2 and also a speedier recovery. Nevertheless, the tertiary sector, which has a higher relevance for economic activity (see Appendix Figure A21), guided the fluctuations of the economic activity in this period. In this sense, Figure 1 panel (a) shows synchronized fluctuations between the aggregate economy and the tertiary sector. The greater incidence of the tertiary sector in the decline of economic activity during 2020-Q2 can also be seen in Figure 2 panels (a) and (c). These panels also suggest that the tertiary sector (services) was the main driver of economic fluctuations during the recovery. Currently (2021-Q4), the aggregate economic output remains at a slightly lower

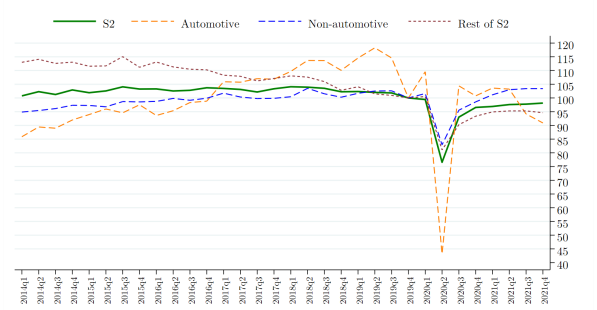
level than before the Pandemic, where industrial production is outperforming services. This evidence, along with panel (c) of Figure 2, suggests more persistence of obstacles for the recovery of services which could be associated with a demand-side shock.

Figure 1: Economic Activity During COVID-19 Pandemic

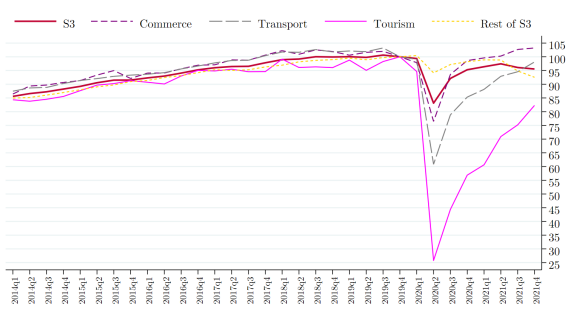
(a) GDP and Broad Sectors (2019q4=100)



(b) Industrial Production (2019q4=100)



(c) Services (2019q4=100)



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Data characteristics are the following: Sectoral GDP, quarterly frequency, seasonally adjusted, millions of pesos at 2013 prices. The series displayed are indexed at 2019-Q4.
The secondary sector (S2) includes NAICS sectors 21 to 33. The tertiary sector (S3) includes NAICS sectors 43-93. Automotive manufacturing refers to the NAICS sub-sector 336. Non-automotive manufacturing refers to all manufacturing but the NAICS sub-sector 336. Rest of Secondary Sector refers to all industrial production but NAICS sectors 31-33. Commerce refers to NAICS sectors 43 and 46. Transport refers to NAICS sectors 48-49. Tourism refers to NAICS sectors 71 and 72. Rest of Tertiary Sector refers to all tertiary sector but commerce, transport and tourism.

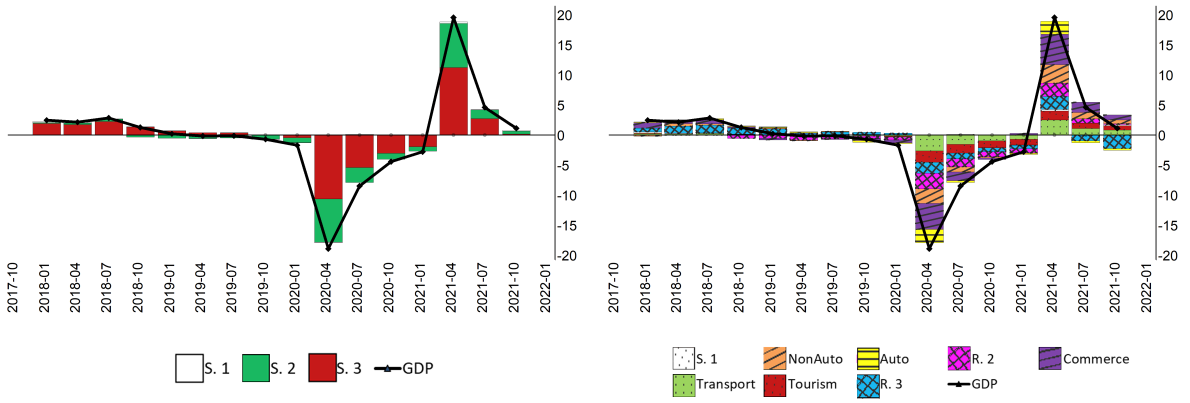
It is important to note that there is heterogeneity within the secondary and tertiary sectors, as disentangled in Figure 1 panels (b) and (c). Regarding the secondary sector, panel (b) of Figure 1 shows that the fall in activity for automotive manufacturing was significantly greater than that of the aggregated secondary sector. Its fall is also greater than for the rest of manufacturing and all other industrial activities. Nevertheless, the recovery of automotive manufacturing took place also much quicker. The latter is in line with the fact that the automotive manufacturing sub-sector was not initially an essential activity but was later classified as such by the government.[1] However, the recovery in

[1]On March 31st, 2020, the Mexican authorities established the essential activities that would avoid COVID-19 lockdown. These included, among others, medical, administrative, security, financial, logistic, and basic services (Diario Oficial de la Federación 2020). On June 1st, 2020, essential activities

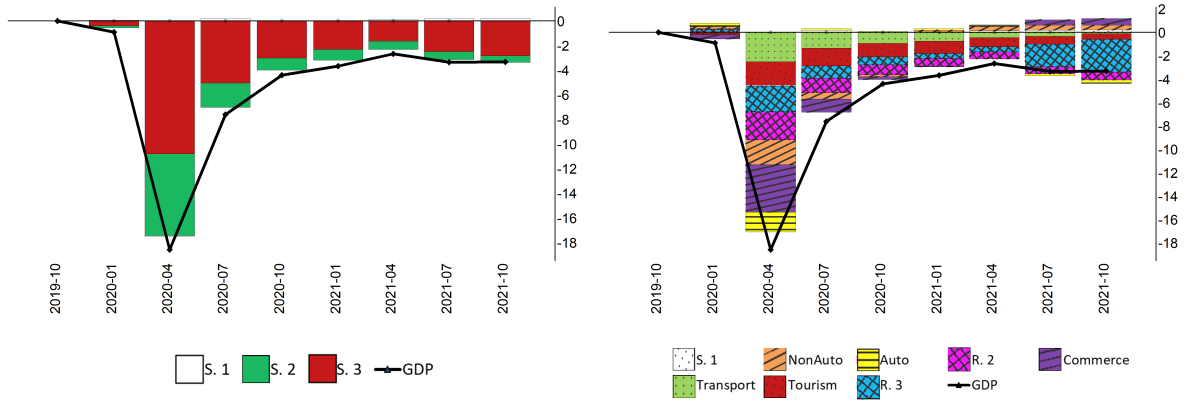
automotive manufacturing has been hindered in 2021, which is consistent with the global shortage of semiconductors. As of now, the automotive manufacturing output persists at a lower level than before the Pandemic. In contrast, non-automotive manufacturing had a slower recovery after the 2020-Q2 downfall, but it has shown an increment in its activity since then, and its output is currently above pre-pandemic levels.

Figure 2: GDP sector relevance

(a) Sectoral contribution to y-o-y GDP % var. (b) Sub-sectoral contr. to y-o-y GDP % var.



(c) Sectoral contribution to acc. GDP % var. (d) Sub-sectoral contr. to acc. GDP % var.



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Data characteristics are the following: Sectoral GDP, quarterly frequency, seasonally adjusted, millions of pesos at 2013 prices. Accumulation considered since 2020-Q1.
The secondary sector (S2) includes NAICS sectors 21 to 33. The tertiary sector (S3) includes NAICS sectors 43-93. Automotive manufacturing (Auto) refers to the NAICS sub-sector 336. Non-automotive manufacturing (NonAuto) refers to all manufacturing but the NAICS sub-sector 336. Rest of Secondary Sector (R. 2) refers to all industrial production but NAICS sectors 31-33. Commerce refers to NAICS sectors 43 and 46. Transport refers to NAICS sectors 48-49. Tourism refers to NAICS sectors 71 and 72. Rest of Tertiary Sector (R. 3) refers to all tertiary sector but commerce, transport and tourism. The Primary Sector (S1) is agricultural activity.
The gap between total GDP and the sum of the displayed components is due to the taxes component not being graphed to simplify the analysis.

Regarding the tertiary sector, Figure 1 panel (c) shows significant heterogeneity within services. Tourism-related activities had the most significant fall in 2020-Q2, even more

were broadened by the Mexican government to include automotive manufacturing and most industrial production activities (Instituto Mexicano del Seguro Social 2020).

than automotive manufacturing or any services sector, and are still far from recovering. The transport sector also experienced a severe decline in activity but is currently about to reach its pre-pandemic level. Commerce decline in 2020-Q2 was less than that for tourism or transport; nonetheless, it was still severe and almost as much as that of non-automotive manufacturing. However, commerce recovery was fast, and the sector currently performs above pre-pandemic levels, which could be associated with the rapid adoption of e-commerce during the lockdown. The rest of the tertiary sector experienced a slight economic activity decline during 2020-Q2, it recovered during 2020, but in 2021 it fell more than during 2020-Q2.

The contribution of sectors to the variation of economic activity is also heterogeneous, as shown in Figure 2 panels (b) and (d). In 2020-Q2, commerce, transport, tourism, and manufacturing mainly guided the decline in economic activity. Commerce had the most prominent initial negative contribution in 2020-Q2 but had the most significant positive contribution during the recovery in 2021. The latter could imply that demand-side shocks are the main drivers behind economic fluctuations in this period. Similarly, manufacturing had a strong negative influence on activity variation during 2020-Q2 but had almost a null contribution to the variation in subsequent periods until 2021-Q2. Since 2021-Q3, non-automotive manufacturing has positively affected the economic variation. In contrast, automotive manufacturing has had a marginal impact on variations after 2020-Q2. Transport and tourism have contributed negatively to the accumulated economic variation; obstacles to recovery in these sectors have persisted, especially for tourism, which is still negatively contributing to the accumulated variation (see panel (d) of Figure 2).

Furthermore, most of the sectors mentioned above are highly internationally integrated. Therefore, foreign shocks could also affect the Mexican economic fluctuations through them. To gain some sense of the relevance of international demand for Mexican economic activity, Figure A22 displays the historical ratio of exports to total output by sector. The industrial sector has the largest share, while services the least (panel (a)). This fact makes the secondary sector more exposed to the direct impact of external demand. Within the secondary sector, automotive manufacturing has the most significant share of exports (panel (b)). This fact, together with the strong recovery of external demand from the US and the declaration of this sector as an essential activity, is likely the reason behind the quick recovery shown by automotive manufacturing. As for services, Figure A22 panel (c) shows that commerce has a significant share of exports, even more so than the aggregate secondary sector. Thus, the strong recovery of external demand is also likely to have played a significant role in the recovery of this sector.

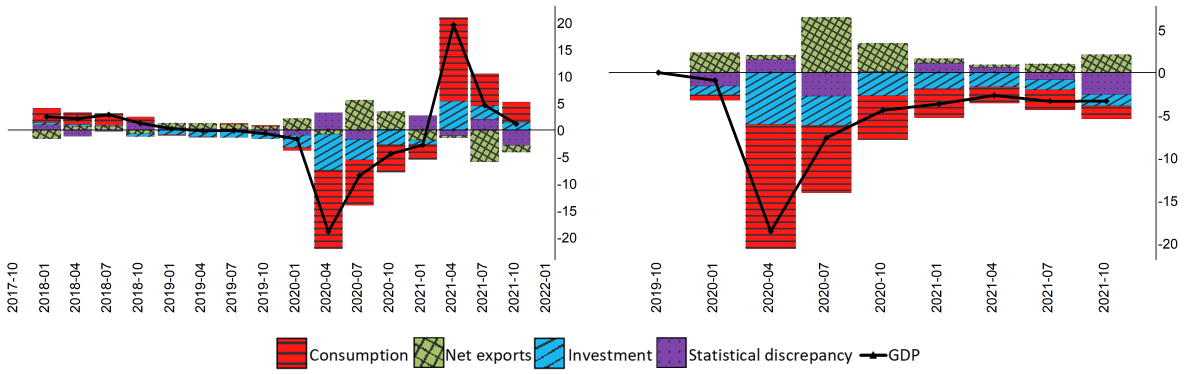
Similarly, Figure A23 shows the imported inputs as a share of total inputs, which indicates the degree of international integration of activities. The secondary sector is the most internationally integrated, with automotive manufacturing requiring the most

imports. The latter is more exposed to external supply shocks. Replicating this analysis for services, Figure A23 panel (c) shows that in this case, transport requires the most imports of inputs and commerce the least. Conversely, Figure A24 shows domestic inputs as a share of total inputs, which implies the analogous analysis from the one made for Figure A23. These analyses suggest that the economic activity in these sectors could be sensitive to the interruption in the supply conditions of other countries.

When analyzing economic activity from the perspective of the components of aggregate spending, Figure 3 panels (a) and (b) signal that consumption was the main driver behind the downturn in economic activity in 2020-Q2. This fact and the fact that commerce was also a significant driver of fluctuations could suggest that demand-side shocks could have an essential role in determining the variations in economic activity during the COVID-19 economic recession. Nevertheless, the reduction in consumption could also be a consequence of the closure of businesses due to lockdown. The latter is another reason we aim to disentangle the source of this variation in this study.

Figure 3: GDP sector relevance by expenditure concept

(a) Expenditure contr. to y-o-y GDP % var. (b) Expenditure contr. to acc. GDP % var.



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Data characteristics are the following: global supply and demand, quarterly frequency, seasonally adjusted, millions of pesos at 2013 prices. Accumulation considered since 2020-Q1.
Statistical discrepancy represents GDP minus consumption, investment, and net exports. Consumption includes private and public consumption. Net exports consider exports minus imports. The investment concept includes gross fixed capital formation and variation of existences.

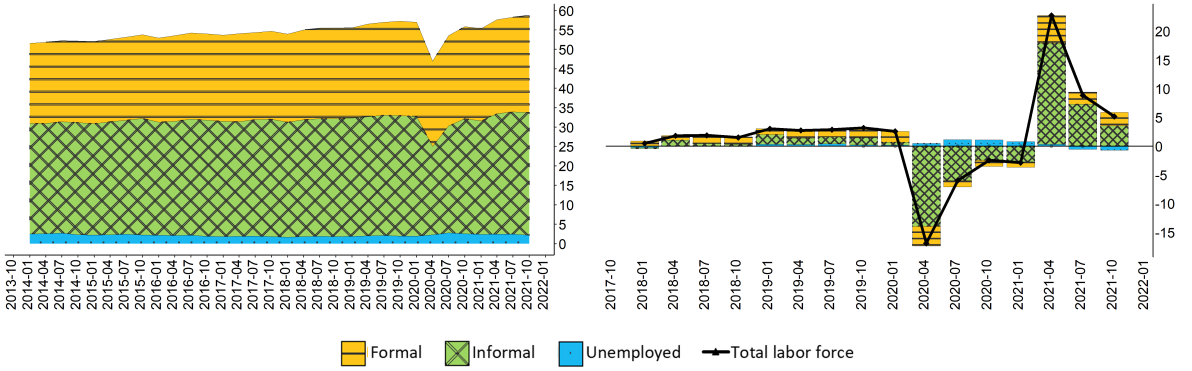
Finally, it is also essential to describe the behavior of the labor market. Figure 4 shows the variations of the labor force due to the COVID-19 crisis. Panel (c) shows that employment in the secondary sector had a more significant drop in 2020-Q2 but also had a quicker recovery. Similar to what happened in manufacturing, especially automotive manufacturing. On the other hand, employment in the tertiary sector varied with the aggregate economy. The latter is consistent with Figure 2 panels (a) and (c), where it is shown that the tertiary sector was the main driver behind the economic variations in this period. Panel (a) signals that more people left the labor force from the informal sector than from the formal sector in 2020-Q2. The fact that unemployment did not grow in the same proportion suggests that people were unwilling to work during 2020-Q2, probably

because of the sanitary conditions; or because people chose to accompany sick relatives or children attending online school instead of working. Panel (b) displays that almost all variations of the labor force occurred in the informal sector, which is a sector whose workers typically have fewer financial buffers such as bank savings, retirement savings, and access to financial markets. This fact could have a substantial incidence in the demand-side shocks, given that purchasing power is especially lost for the informal sector workers in an economic crisis such as this. In this regard, panel (d) of Figure 4 shows that the informal sector of the population is also more vulnerable to income poverty, which experienced an increase during 2020-Q2.

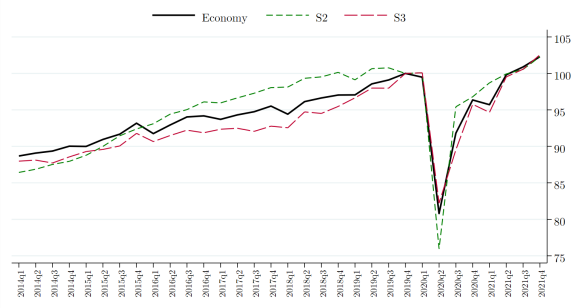
Figure 4: Employment

(a) Labor force (Millions)

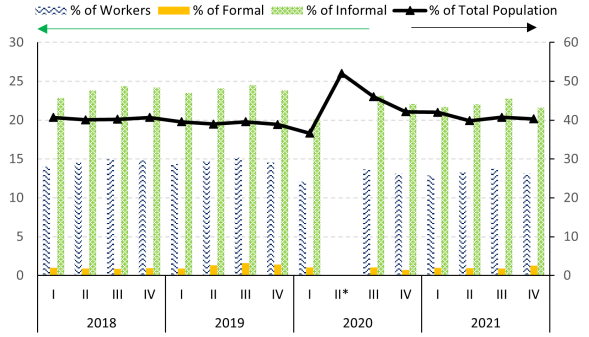
(b) Acc. contributions to labor force % var.



(c) Employment by broad sectors (2019q4=100)



(d) % of Workers in Labor Poverty



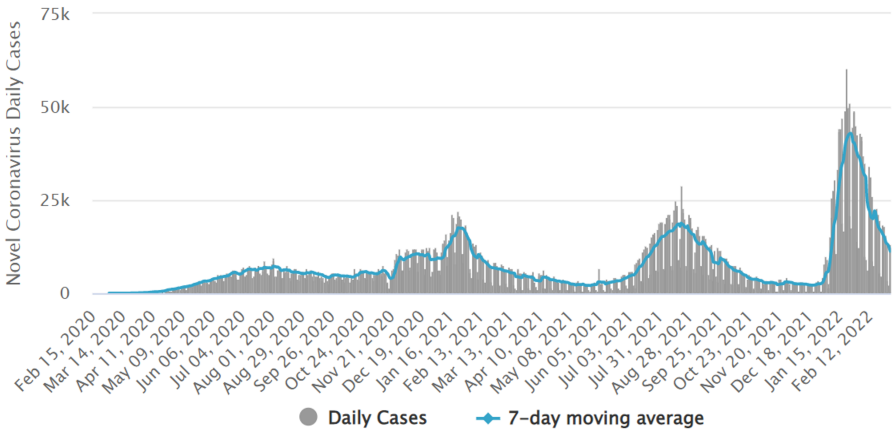
Notes: For panels (a), (b), and (c): Authors' calculations with data from ENOE, ETOE, and ENOEN, INEGI. Data characteristics: quarterly frequency. Accumulation considered since 2018-Q1.
Source for panel (d): Elaborated by CONEVAL with data from ENOE and ENOEN. *Due to the COVID-19 pandemic, INEGI suspended data collection from face-to-face interviews in 2020-Q2. Therefore, there is missing data to perform the necessary calculations regarding labor poverty for the working population. Share of the total population with labor poverty can be calculated with data from ETOE. Labor poverty refers to labor income below the food basket cost (the extreme poverty threshold). CONEVAL is the organization responsible for measuring poverty in Mexico.

As described above, there are several reasons why shocks from the demand or supply side could have guided the economic variations during the 2020-Q2 downturn and its subsequent recovery. With this study, we seek to identify the primary source of this variation.

3.1 Timeline of the COVID-19 Pandemic in Mexico

The four infection waves of COVID-19 are depicted in Figure 5. The peaks have occurred in 2020-Q3, 2021-Q1, 2021-Q3, and 2022-Q1. Official lockdown measures accompanied each wave, but voluntary confinement also played a significant role. Figure 6 shows a timeline of the lockdown measures implemented across countries. It evidences significant heterogeneity among countries when implementing mitigating measures, both in time and strictness. Mexico implemented measures relatively later than its trading partners, particularly the US, as shown in panels (b) and (c). From April 2020 to January 2021, Mexico implemented strict confinement measures. Since February 2021, Mexico has been somewhat less strict than in 2020. It has also been less strict than other economies in 2021, particularly the US.

Figure 5: COVID-19 Daily Cases in Mexico

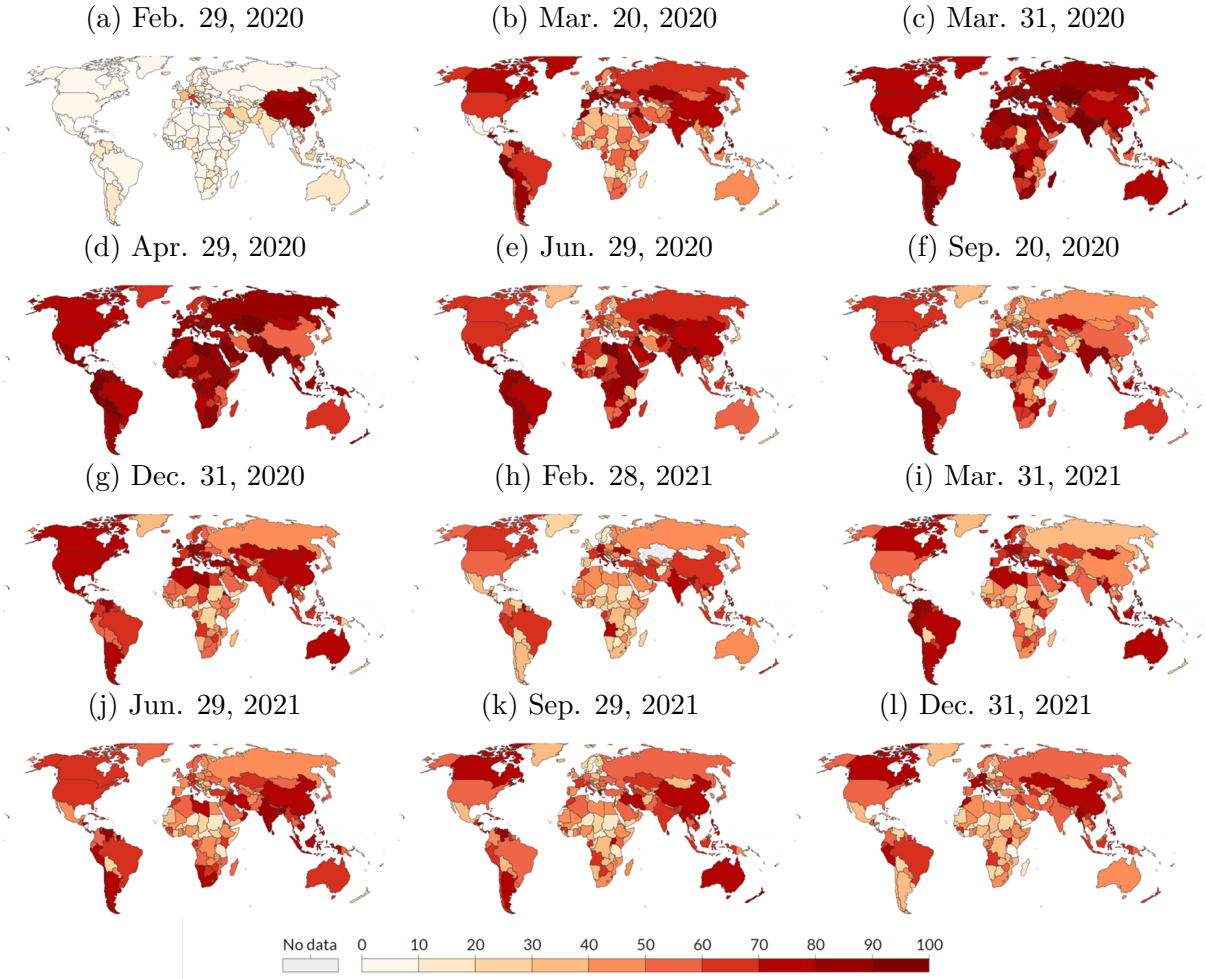


Notes: The graph displays the amount of new COVID-19 daily cases reported by the Mexican Ministry of Health. Source: Worldometers. https://www.worldometers.info/coronavirus/country/mexico/.

As we saw before, in April 2020 (2Q), the COVID-19 Pandemic had its most significant adverse effect on the Mexican economy. World stoppages in manufacturing production and various services led to a supply reduction. These events put at risk the functioning of global value chains and the provision of inputs for production. The global spread of the Pandemic led the Mexican economy to face lower external demand. Likewise, social distancing measures and lower income for businesses and households led to a contraction in domestic demand. Due to the Pandemic, there were also restrictions on business operations, which entailed adverse supply effects.

The economic recovery started in June 2020 in the industrial and some services sectors. The recovery was fostered by the demand recovery in the US and the fact that in June 2020, several industrial sectors were included as essential activities in Mexico to avoid lockdown (Instituto Mexicano del Seguro Social 2020). Furthermore, in July 2020, the United States-Mexico-Canada Trade Agreement (USMCA) started to operate, which helped avoid additional trading barriers. In the last quarter of 2020, the recovery was

Figure 6: COVID-19 Stringency Index



Notes: The stringency index is a composite measure based on nine response indicators, including school closures, workplace closures, and travel bans, rescaled to a value from 0 to 100 (100 = strictest). If policies vary at the subnational level, the index shows the response level of the strictest subregion. Source: Oxford COVID-19 Government Response Tracker, Blavatnik School of Government, University of Oxford. ourworldindata.org/coronavirus.

milder. In December 2020, new restrictions on mobility and the operation of businesses were implemented due to rising COVID-19 cases both in Mexico and globally. Between January and March 2021, economic activity showed a slowdown in its recovery. The latter is in line with new restrictions implemented between 2020-Q4 and 2021-Q1 due to the COVID-19 pandemic rebound. In addition, there were some disruptions in the supply of specific industrial inputs (the global shortage of semiconductors had significantly affected the automotive sector). There was also a temporary interruption in the supply of natural gas and power outages in mid-February in the northern region. Then, during 2021-Q4, the Omicron variant hindered economic activity as it entailed new global lockdown measures and voluntary confinement.

4 Empirical Strategy

4.1 Inputs of the Model

The Mexican statistics agency (INEGI) provides data for the output and prices of the Mexican economy at the aggregate and sector level. Regarding output, we use the quarterly GDP data.[2] For prices, we average for each quarter the monthly data of the National Consumer Price Index (INPC).[3] We use these data to make a structural identification of the demand and supply shocks from 2002-Q1 to 2021-Q4. This period includes the longest available data for all sectors with these data. GDP at constant prices and INPC are adequate measures of quantity and price levels in the economy and at the sectoral level.[4]

In order to have a deeper understanding of the shocks affecting the Mexican economy, in its context of a Small Open Economy, we attempt to disentangle the shocks by their domestic or foreign origin. The US is by far Mexico's most important trading partner, and, as such, foreign shocks affecting Mexico are typically associated with external factors linked to the US economy. Therefore, we use as a measure of foreign supply the US GDP (USGDP). As an indicator of the world price, we utilize the US Consumer Price Index for All Urban Consumers (USCPI). Finally, we employ the nominal bilateral exchange rate (ER) between Mexico and the US. Appreciation or depreciation of ER implies a change in the terms of trade that could affect the dynamics of exports/imports and, consequently, economic activity. In addition, ER can be interpreted as a proxy of uncertainty and several financial linkages between these economies.[5] The sources of this information are the Federal Reserve and Banco de México.

4.2 The Model

Formally, for each sector, we estimate a separate VAR:

$$y_t = C_B + \sum_{i=1}^{P} B_i y_{t-i} + u_t \tag{1}$$

[2]The use of quarterly data, instead of monthly and timely frequencies, allows us to focus on a more precise measure of economic activity such as GDP. Likewise, quarterly data allows us to smooth the estimation of structural shocks since higher frequency estimates could present wide variations from one period to another.

[3]Sub-sector level disaggregations for inflation are constructed by using the corresponding weights provided by INEGI. Output sub-sector disaggregations are more easily constructed since INEGI publishes data in real millions of pesos.

[4]As a robustness check, we also do our exercise using implicit GDP prices. Results for this methodology are consistent, as shown in Appendix 3.

[5]We also employ the real exchange rate for robustness with consistent results. This result could be attributed to the fact that Mexico has been characterized by presenting price stability that has led to movements in the real exchange rate being explained mainly by changes in the nominal exchange rate.

Where: y_t is a vector of the quarterly log variation of endogenous variables; C_B is a vector of constants; B_i for $i = 1, ..., P$ is a parameter matrix, where P is the number of lags; u_t is a vector of residuals with $u_t \sim N(0, \Sigma)$, where Σ is a variance-covariance matrix. The residuals of the model can be rewritten as a linear combination of structural shocks, $u_t = A\epsilon_t$ where $\epsilon_t \sim N(0, I_2)$ and A is a non-singular matrix of parameters for which $\Sigma = AA'$. Structural estimation aims to identify the matrix A from the estimated variance and covariance matrix $\hat{\Sigma}$ derived from the reduced form VAR. Our identification strategy relies on the sign-restricted Bayesian estimation of such VAR.

Our Bayesian VAR relies on Minnesota priors, where the hyperparameters of these priors are set by maximizing a likelihood function that allows us to choose the best model among the available ones by selecting values for the parameters in a feasible grid. Since we use quarterly growth rates that are stationary series for the estimates, we allow the model to select the autoregressive hyperparameter in a range between 0.1 and 1 to restrict the autocorrelation of the series artificially. For a detailed discussion of the relevance of unit roots in Bayesian estimation, see, for example, Dieppe et al. (2016), or Sims & Uhlig (1991) and the references therein. Minnesota priors are adequate for stationary series, as signaled by Dieppe et al. (2016). Identification of domestic and foreign demand and supply shocks is made by imposing sign restrictions.

It is important to note that data is included in our model as quarterly log variation of seasonally adjusted time series. The differentiation was selected following the Augmented Dickey-Fuller test and varied among sectors, as can be appreciated in Appendix Table A3. Another consideration is that the estimated VARs include different sectoral lags that were selected according to information criteria, as shown in Appendix Table A4.

5 Results

5.1 Supply and Demand Shocks

In this section, we consider the simplest version of our sectoral analysis in which we identify overall supply and demand shocks through a sign-restricted SBVAR, as described in the previous section. In this case, the vector y_t includes only prices and output; thus, we base our identification strategy on the conventional considerations for supply and demand shocks. The previous strategy means that the estimated exogenous demand and supply shocks are interpreted as shifts in the demand and supply curves. In particular, a positive demand shock will shift the demand curve to the right under this simple approach, increasing both prices and quantities. In contrast, a positive supply shock will shift the supply curve to the right, lowering prices and increasing quantities (See Table 1).

Our identification allows us to measure the size of the shocks hitting the economy

Table 1: Shocks Identification

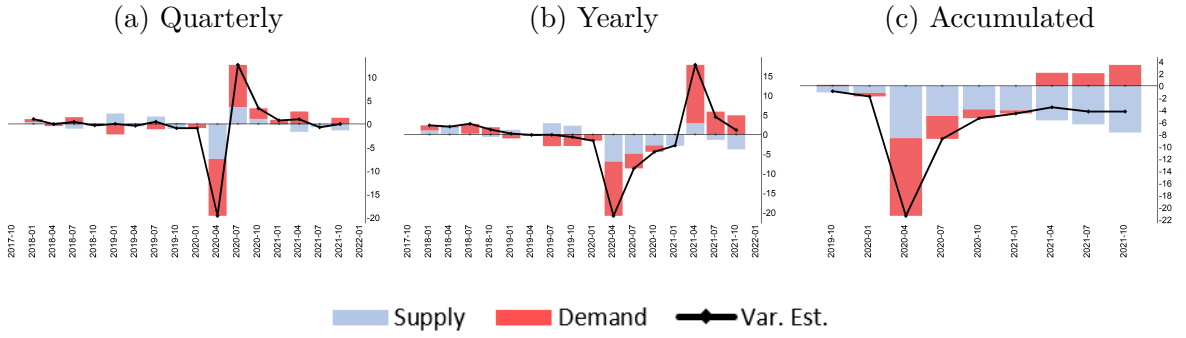
	Supply Q^{Mex}	Demand P^{Mex}
Q^{Mex}	+	+
P^{Mex}	-	+

during the COVID-19 Pandemic. However, it is necessary to consider that these effects are the net result of several aggregate or sectoral shocks that affect household consumption decisions and labor supply or firms' production plans and employment decisions.

Our approach is similar to those analyzed by Baumeister & Hamilton (2015) and Brinca et al. (2021). In particular, Brinca et al. (2021) measure labor demand and supply shocks at the sector level around the COVID-19 outbreak in the US by estimating an SBVAR for hours worked and real wages at monthly frequency. According to their results, most sectors were subject to large negative labor supply and demand shocks in March and April 2020, with substantial heterogeneity in the size of shocks across sectors.

We use quarterly output and prices data to analyze the aggregate secondary and tertiary sectors and some of the most representative sub-sectors within these activities. In particular, within secondary activities, we focus on automotive manufacturing, non-automotive manufacturing, and an aggregate for the rest of the secondary sector. On the other hand, within tertiary activities, we focus on commerce, transport, tourism, and an aggregate for the rest of the tertiary sector. We choose those sectors because they together have the largest share of Mexican GDP (see Appendix Figure A21). According to our data, the Mexican economy showed stagnation in economic activity since before the Pandemic. Our estimates in Figure 7 suggest that during 2018 and 2019-Q3, the stagnation was associated with similar contributions from both negative and positive demand and supply shocks. Those estimates also show that during 2020-Q1, no significant effects of the Pandemic were detected on the Mexican economy.

Figure 7: Economy (GDP)
Historical Decomposition % Var.

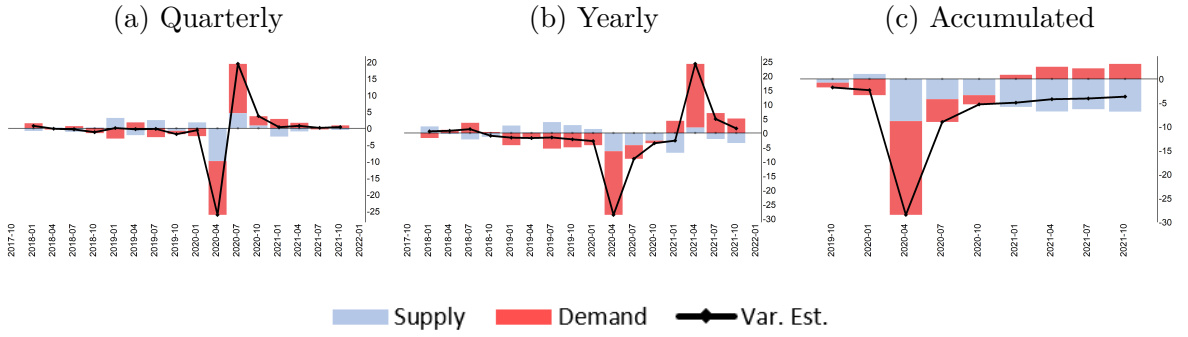


Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.

As we can observe in Figure 7, during 2020-Q2, the COVID-19 Pandemic had its most significant adverse effects on the Mexican economy. As pointed out before, measures to contain the spread of the virus in Mexico and worldwide caused simultaneous demand and supply shocks. The historical decomposition of the variation of GDP shows that most of the output variation during 2020-Q2 can be attributed to a demand shock. The economy began to recover gradually from 2020-Q3 onwards. During this phase, demand factors appear to be behind the recovery. The contribution of these factors was positive and increasingly modest towards the end of 2020. Since 2021-Q2, supply factors have contributed negatively to the quarterly recovery of economic activity. This fact is easily recognized when looking at the estimated cumulative variation of GDP since the beginning of 2020 (panel (c) in Figure 7). Indeed, for 2021, supply factors seem to explain almost entirely the slowdown of economic activity in Mexico, while the factors associated with demand started to contribute positively to the accumulated variation only since 2021-Q2.

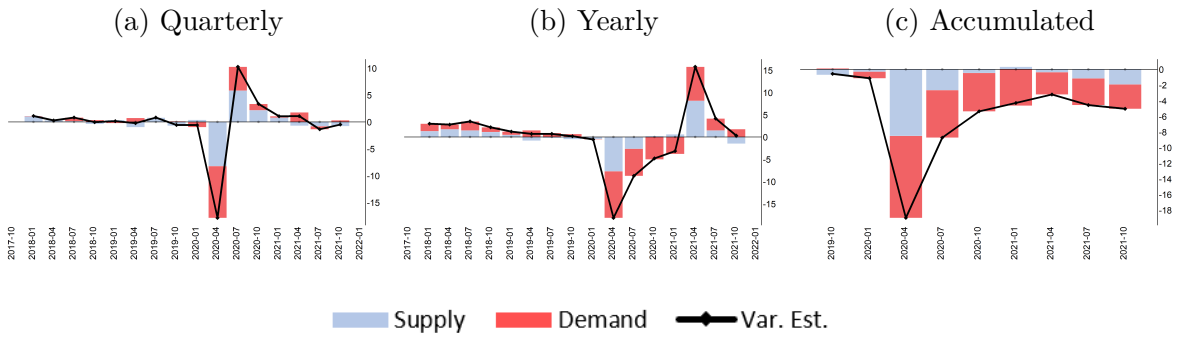
When analyzing the results for the secondary (Figure 8) and tertiary sectors (Figure 9), similar effects are observed in 2020-Q2. In particular, similarly to the performance of the aggregate economy, the dominant force driving GDP down in the secondary and tertiary sectors was the demand shock. During the recovery phase, demand factors seem to be relatively more important for the positive growth of industrial activity than for the tertiary sector. The latter could be related to the nature of each sector's shocks. While the secondary sector is more dependent on external demand, the tertiary sector depends to a greater extent on both domestic demand and supply factors related to the health policies implemented to contain the virus, i.e., services can be more contact intensive than some industrial activities, hence being more affected by social distancing policies. Thus, given the reactivation of global demand, the secondary sector could benefit more than the tertiary sector.

Figure 8: Secondary Sector (Industrial Production)
Historical Decomposition % Var.



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.
The secondary sector includes NAICS sectors 21 to 33. These encompass mining, energy generation, construction, and manufacturing.

Figure 9: Tertiary Sector (Services)
Historical Decomposition % Var.



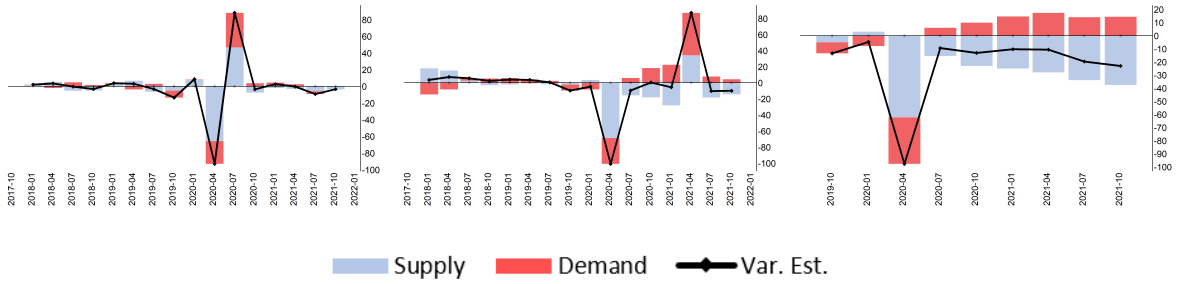
Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4. The tertiary sector includes NAICS sectors 43-93. These encompass the following services: i) wholesale and retail commerce, ii) transport, mail, and media, iii) financing, insurance, and real estate services, iv) professional, scientific, and technical services, v) education, health, and social services, vi) culture, sports, and other leisure services, vii) lodging, restaurants and other services related to tourism.

However, when comparing the behavior of the accumulated variations since the beginning of 2020, both in the secondary sector and in services, it is possible to observe the higher incidence of demand for services compared to industrial activity. In the case of the secondary sector (Figure 8), it is clear that since the beginning of 2021, demand has contributed positively to the variation of the sector, while supply factors have increased their contribution negatively during the same period. Both demand and supply have continued to contribute to the accumulated negative variation in the case of services (Figure 9).

Within the secondary sector, the importance of automotive manufacturing stands out due to its high integration in global value chains, especially with the US automotive industry, an industry that in 2021 was particularly hit by shortages of inputs, such as semiconductors. In this regard, Figure 10 shows relatively greater importance of the negative contribution of supply shocks to the variation of output in the automotive sector during 2020-Q2. Although supply shocks were also crucial for the rest of manufacturing production, the difference in its contribution to growth is evident, especially in the accumulated variation since the Pandemic's beginning (Figure 11). Another essential difference between automotive and non-automotive manufacturing dynamics occurs in the contribution of demand shocks, which affect to a greater extent non-automotive manufacturing. In the case of the rest of industrial production, there is a balanced contribution of demand and supply shocks, as shown in Figure 12.

Figure 10: Automotive
Historical Decomposition % Var.

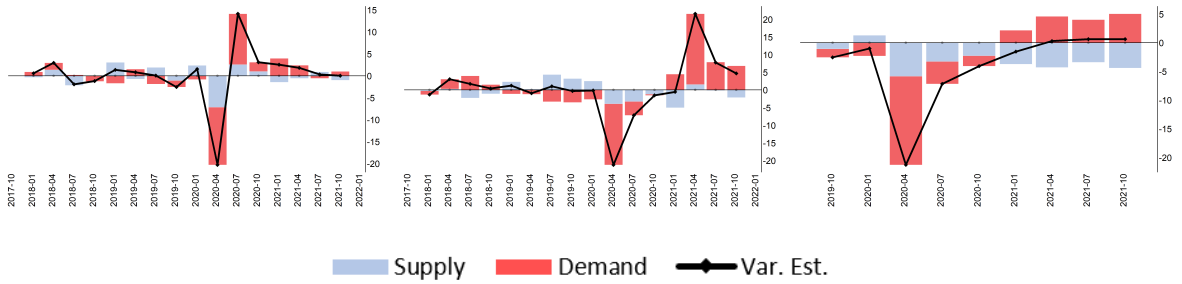
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4. It includes only automotive manufacturing, NAICS sub-sector 336.

Figure 11: Non-Automotive
Historical Decomposition % Var.

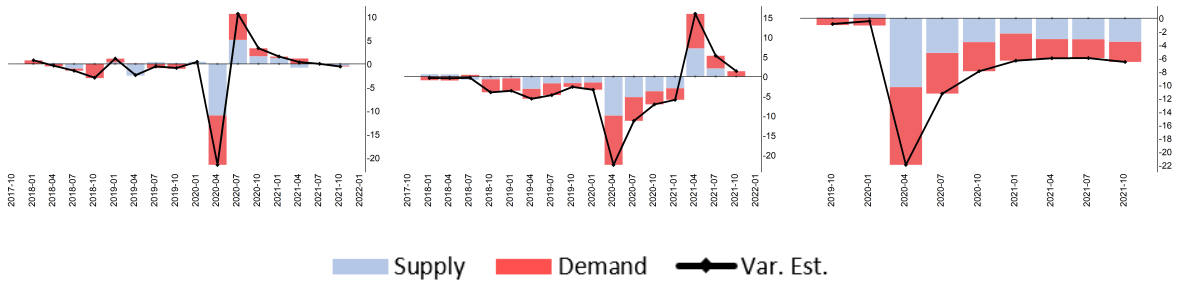
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4. It includes all manufacturing except automotive manufacturing, NAICS sector 31-33 except sub-sector 336.

Figure 12: Rest of Secondary Sector
Historical Decomposition % Var.

(a) Quarterly (b) Yearly (c) Accumulated

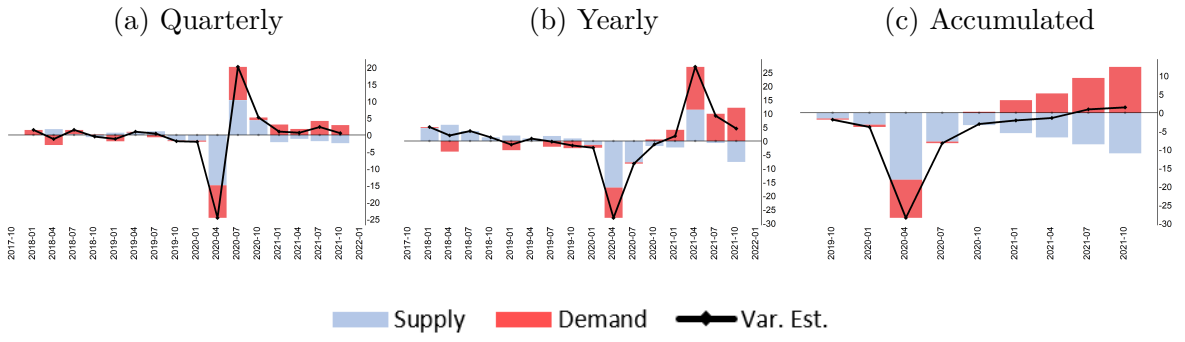


Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.
Includes all industrial production but NAICS sectors 31-33, manufacturing.

This difference in the contribution of the shocks on automotive and non-automotive manufacturing seems to respond to the shocks' nature. While both industries had stoppages following their categorization as non-essential activities by the health authorities, the automotive industry is much more dependent on the external sector both on the demand and supply side. Also, since the end of 2020, the slowdown in economic activity can be associated with various shocks experienced by the Mexican economy. In particular, new restrictions were implemented between 2020-Q4 and 2021-Q1, following a rebound of the COVID-19 Pandemic. Also, in mid-February 2021, there was a temporary interruption in the supply of natural gas and power outages in the country's northern region. In addition, there have been some disruptions in the supply of specific industrial inputs (the global shortage of semiconductors has primarily affected the automotive sector, among others).

Within tertiary activities, there is also heterogeneity in the contribution of supply and demand shocks to production dynamics in the sub-sectors. While commerce (Figure 13), strongly linked to the production and import of manufacturing, has been significantly affected by supply shocks since the Pandemic started, transport (Figure 14) has been negatively affected in its accumulated variation primarily by demand shocks. Similarly, tourism (Figure 15) explains most of its accumulated variation since the beginning of the Pandemic due to the negative effect of demand shocks associated with the closure of non-essential activities and the confinement of the population. The rest of the tertiary activities (Figure 16) associated with sub-sectors such as finance, education, health, and business support services have also been strongly affected by the demand side in the accumulated variation (panel (c)).

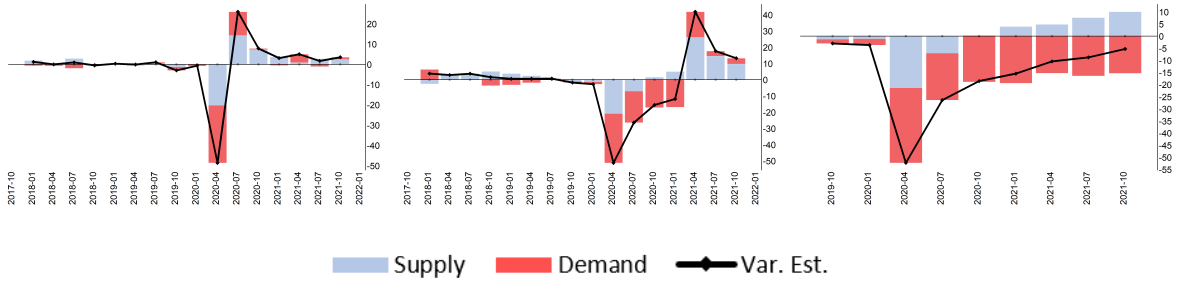
Figure 13: Commerce
Historical Decomposition % Var.



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.
Commerce refers to NAICS sectors 43 and 46.

Figure 14: Transport
Historical Decomposition % Var.

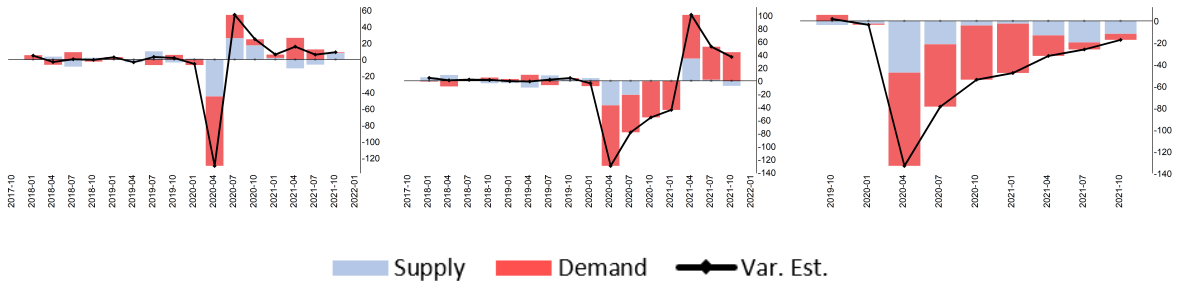
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.
Transport refers to NAICS sectors 48-49.

Figure 15: Tourism
Historical Decomposition % Var.

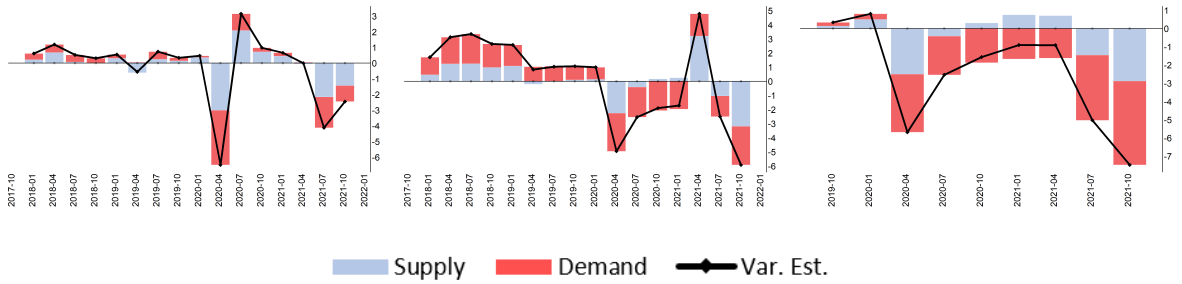
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.
Tourism refers to NAICS sectors 71 and 72.

Figure 16: Rest of Tertiary Sector
Historical Decomposition % Var.

(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.
It includes all tertiary sectors but commerce, transport, and tourism.

5.2 Supply and Demand Shocks: Domestic and International Origin

Given the historical relevance of global developments on the path of the Mexican economic activity, both at an aggregate and sectoral level, as a complement of our previous analysis and in order to have a deeper understanding of the sources of Mexico's economic fluctuation since the onset of COVID-19 Pandemic, we consider domestic, foreign and exchange rate factors aiming at identifying the exogenous forces driving the Mexican economy. We do this by including the real US GDP (USGDP), the US Consumer Price Index (USCPI), and the nominal bilateral Exchange Rate (ER) between the Mexican Peso and the US dollar into our analysis. Table 2 summarizes our key identification assumptions in this context.

Table 2: Extension of Shocks Identification

	Supply Q^{Mex}	Demand P^{Mex}	F. Sup Q^f	F. Dem P^f	ER e
Q^{Mex}	+	+	+		
P^{Mex}	-	+	-		+
Q^f	0	0	+	+	
P^f	0	0	-	+	
e	+	-			+

As in the previous section, a positive domestic supply shock (first column) increases domestic output and decreases home prices. Given that Mexico is a small open economy, it is influenced by external activity but has little effect on the global fluctuation. Consistent with this and related literature, we impose a zero effect of domestic supply and demand on the corresponding external variables. The reduction in domestic prices and the null effect on foreign prices of a domestic supply shock depreciate the exchange rate (positive sign in the last row of the first column).

A positive domestic demand shock (second column) is expansionary and inflationary. Given the increase in domestic prices and the zero effect on world variables, the inflationary shock appreciates the ER (negative sign in the last row of the second column).

A positive foreign supply shock (third column) is expansionary and deflationary at home and abroad. The latter translates into an increase in domestic demand. In particular, a positive shock to USGDP increases demand for Mexican exports, given that Mexican manufacturing provides a considerable share of inputs for US production. Since we do not have evidence on the dominant effect on the ratio of US/MX prices of such a shock, we decided not to impose any sign restriction on the ER and allow data to inform us about it.

We assume (fourth column) that a positive foreign demand shock is expansionary and inflationary globally, but we do not impose any sign restriction on its effect on the

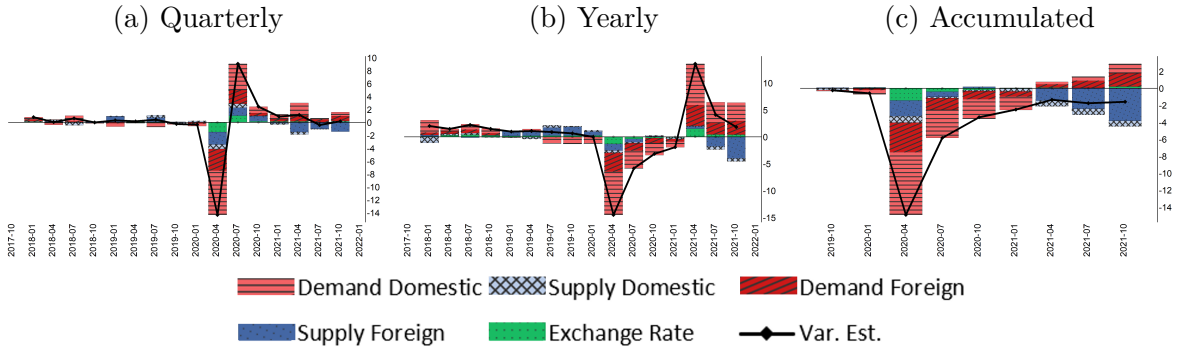
domestic output and prices. We also allow the exchange rate to vary freely after such a shock.

ER shocks (last column): given that there exists a debate regarding the sign of the effect of an exchange rate shock on domestic production, we allow data to clarify this issue for Mexico. Accordingly, we do not impose a sign restriction on this relationship. In contrast, empirical evidence for Mexico suggests a positive pass-through of exchange rate depreciation on inflation (Capistrán et al. 2011). Hence, we consider such evidence and impose it in our identification strategy. Finally, we allow data to inform us about the relationship between exchange rate depreciation in Mexico and foreign output and inflation.

The sign restrictions are established according to economic theory or results found in the literature. However, our estimation method allows us to leave different signs of the impacts of structural shocks without restriction because we do not have enough evidence to conjecture about the expected sign of the impact. In this case, the data is allowed to reveal such signs. It is worth mentioning that this identification strategy is different from establishing a restriction equal to zero in which we do explicitly propose the restriction of a null impact of structural shocks on the variables.

Figure 17 shows the results of the historical decomposition of the five fundamental forces driving Mexican GDP fluctuations. Congruent with the previous section, the main forces behind Mexico's GDP fluctuation are associated with demand. Domestic and foreign demand explain more than 50 percent of the fall during 2020-Q2. However, the domestic demand shock was the most critical exogenous shock driving down the growth of the Mexican economy in that quarter. Foreign demand's negative contribution to GDP was more extensive than domestic and foreign supply. However, the negative contribution of foreign supply to GDP growth was more significant than that of domestic supply. These effects reflect the uncertainty associated with the Pandemic.

Figure 17: Economy (GDP)
Historical Decomposition % Var.



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.

Depreciation of the exchange rate contributed negatively to the GDP growth during

the second quarter of 2020. As specified in our identification strategy, we did not impose any sign restriction on the effect of ER changes on GDP. Hence, data inform us about the sign of this reaction. Accordingly, this seems to suggest that GDP reacts negatively to a depreciation of the exchange rate, and together with the positive contribution to GDP growth of the exchange rate appreciation during 2020-Q3, it seems that data suggests a negative relationship between ER depreciation and quarterly GDP growth.

Results also suggest that the exchange rate component could encompass other shocks associated with supply-side fluctuations. The latter is possible since, as we mentioned above, our broad categorization of shocks could potentially incorporate several sub-shocks. In this sense, the ER component could encompass several financial indicators, such as the uncertainty associated with the Pandemic's closure and duration. This could explain why ER has a greater incidence than domestic supply shocks.

It is important to note that the negative contribution of the foreign demand to the GDP growth in Mexico is the result of the fall in foreign demand, which means that data inform us about a positive relationship between these two variables.

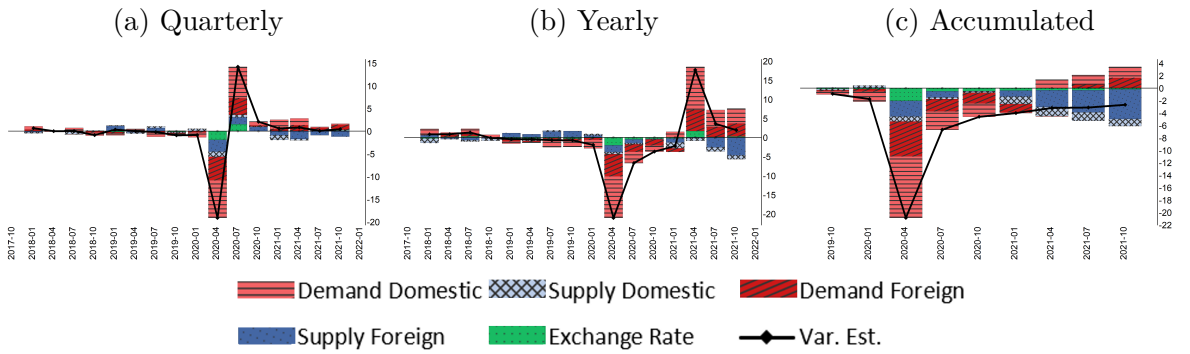
During 2020-Q3, all the factors contributed positively to the recovery. The two main forces were domestic demand and foreign demand. During the remainder of 2020, there was a combination of mild positive contributions of all the factors. However, in 2021-Q2, while domestic demand was the main contributor to the increase in GDP, the supply factors subtracted about two percentage growth points. The main negative contribution came from the foreign supply.

The negative contribution of supply factors since 2021-Q2 is clearer when looking at the panel (c) in Figure 17. The accumulated contribution of foreign supply has been negative since that quarter. As explained in the previous section, the global shortage of some production inputs contributed to appease the recovery of the Mexican economy.

The contribution of the exogenous shocks to the variation of GDP in Mexico was different across sectors. While domestic demand contributed positively since 2020-Q3, it has not compensated for the remaining sources' negative contribution or domestic demand's initial negative contribution in 2020-Q2. In particular, since 2021-Q2, the fall in aggregate economic activity and industrial production has been mainly due to problems associated with foreign supply. This fact is shown, for example, in Figure 18 panel(c).

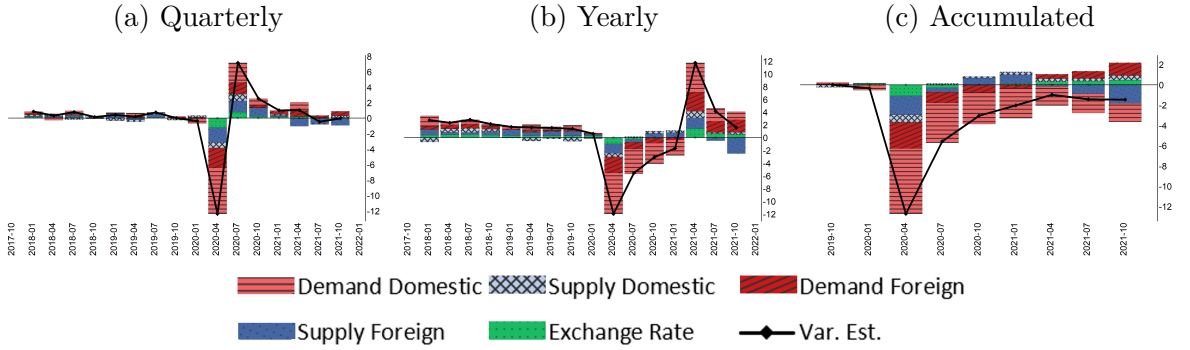
In contrast, the tertiary activities (Figure 19) have been mainly driven by the fluctuations in domestic demand. Furthermore, together with foreign demand, the demand factors were the primary source of growth in that sector, with higher relevance of foreign supply until 2021-Q4. Hence, the sectoral analysis of the historical decomposition of exogenous shocks in Mexico is congruent with its role in the global economy. The secondary sector, highly integrated into global value chains (GVC), makes this sector very sensitive to external forces. While the tertiary sector, with a high share of non-tradables, is more sensitive to domestic fluctuation, though also sensitive to foreign fluctuations.

Figure 18: Secondary Sector (Industrial Production)
Historical Decomposition % Var.



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
The secondary sector includes NAICS sectors 21 to 33. These encompass mining, energy generation, construction, and manufacturing.

Figure 19: Tertiary Sector (Services)
Historical Decomposition % Var.



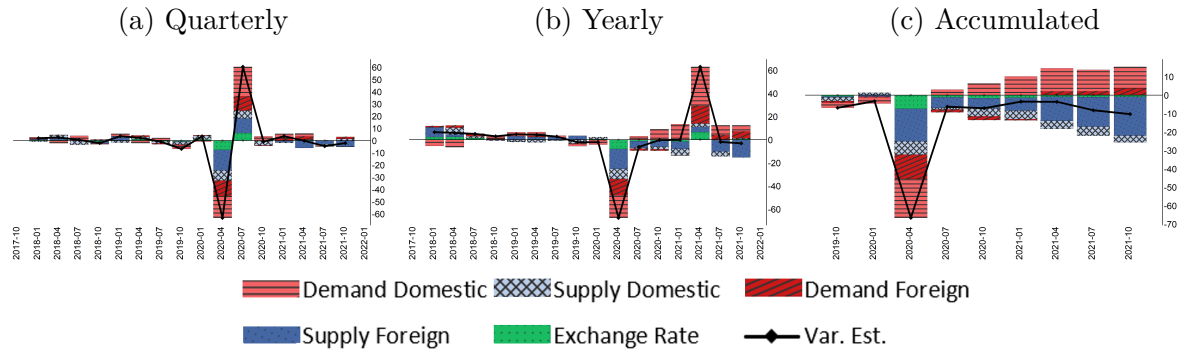
Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
The tertiary sector includes NAICS sectors 43-93. These encompass the following services: i) wholesale and retail commerce, ii) transport, mail, and media, iii) financing, insurance, and real estate services, iv) professional, scientific, and technical services, v) education, health, and social services, vi) culture, sports, and other leisure services, vii) lodging, restaurants and other services related to tourism.

The decomposition of exogenous contributions to the growth of the automotive sector is shown in Figure 20. In 2020-Q2, the fall in domestic demand and foreign supply were the primary sources of the fall in production in that sub-sector, followed by the foreign demand. Since then, the recovery has been explained mainly by the domestic demand factor. However, when looking at the accumulated contributions, it can be seen that supply factors, mainly from abroad, have contributed negatively to a greater extent than the demand factors during 2021. The contribution of foreign supply factors associated with the bottlenecks problems in the global economy has hindered the pace of recovery in this sub-sector.

Similarly, the performance of the non-automotive sector (Figure 21) has been dominated by domestic demand. Even if the foreign demand has contributed in the same

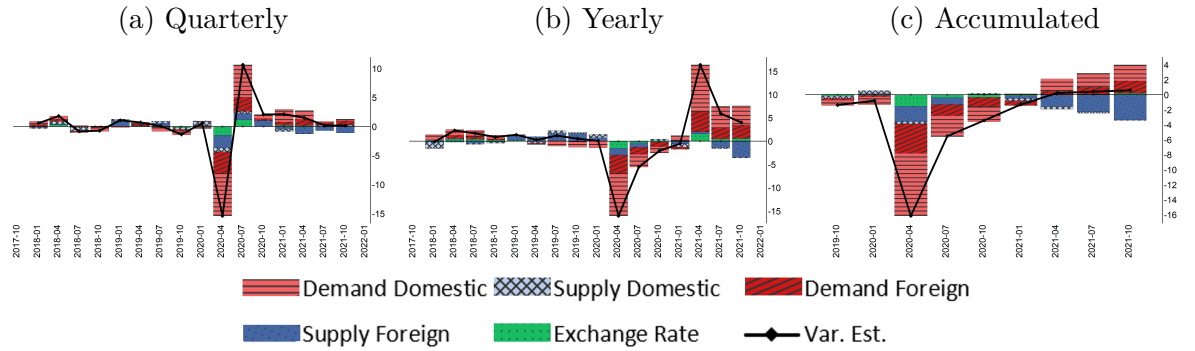
direction as the domestic demand, the foreign supply shock seems to have had a relatively small share of the explanation of growth in 2020. This pattern changed in 2021. While the domestic demand remained the main positive growth contributor, the accumulated growth shows that foreign supply contributed a large negative share to the growth in this sector.

Figure 20: Automotive
Historical Decomposition % Var.



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
It includes only automotive manufacturing, NAICS sub-sector 336.

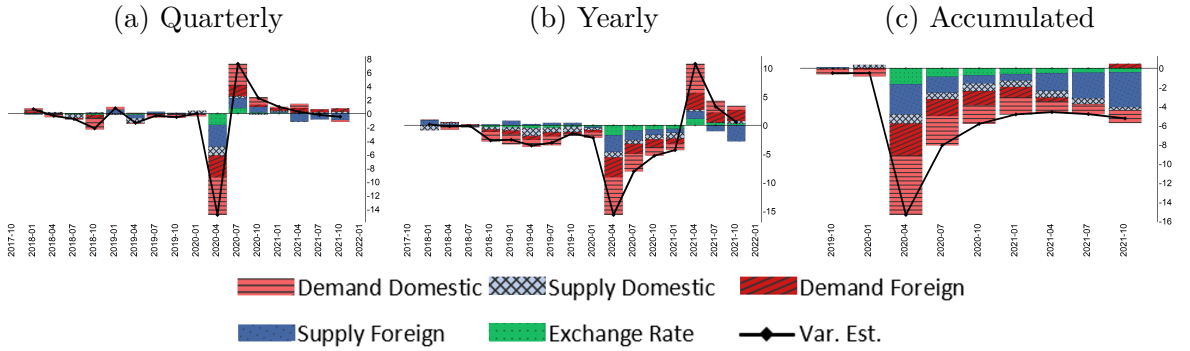
Figure 21: Non-Automotive
Historical Decomposition % Var.



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
It includes all manufacturing except automotive manufacturing, NAICS sector 31-33 except sub-sector 336.

Finally, the demand factors, mainly domestic, were the main contributors to the negative growth in 2020 for the rest of the secondary sectors (Figure 22). However, we can observe that since 2021-Q2, the foreign supply has been the main adverse driver for the accumulated variation. Similar to the case when we did not disaggregate shocks by their origin, within tertiary activities, there is also heterogeneity in the contribution of supply and demand shocks to production dynamics in the sectors. In this section, that heterogeneity is also shown by domestic or foreign contribution.

Figure 22: Rest of Secondary Sector
Historical Decomposition % Var.



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
Includes all industrial production but NAICS sectors 31-33, manufacturing.

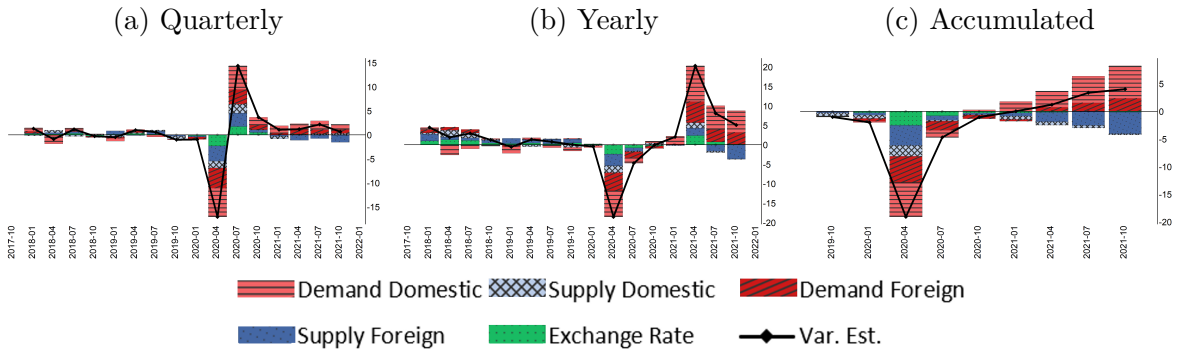
As mentioned, domestic demand is the primary driver of fluctuations in services (Figure 19). Nevertheless, foreign supply's considerable accumulated incidence towards the end of 2021 signals that businesses with a significant share of foreign inputs also guide economic fluctuations. Another factor to consider is that land borders between Mexico and the US were closed until November 2021.

Commerce (Figure 23), strongly linked to the production and import of manufacturing, has been significantly affected by foreign supply and demand shocks since the beginning of the Pandemic, but its main driver has been the domestic demand factors. Although, during 2021, the bottleneck problems in the global economy have reduced the dynamic of growth in that sector. Regarding the accumulated variation, domestic demand has offset since 2021-Q3 the adverse effect of foreign supply shocks. The adoption of e-commerce could be playing a significant role.

Transport, shown in Figure 24, has been negatively affected in its accumulated variation mainly by domestic demand, but foreign demand has also contributed to the negative accumulated growth in this sector during 2020. Similarly, Tourism (Figure 25) explains most of its accumulated variation since the beginning of the Pandemic due to the negative effect of domestic demand shocks associated with the closure of non-essential activities and the confinement of the population.

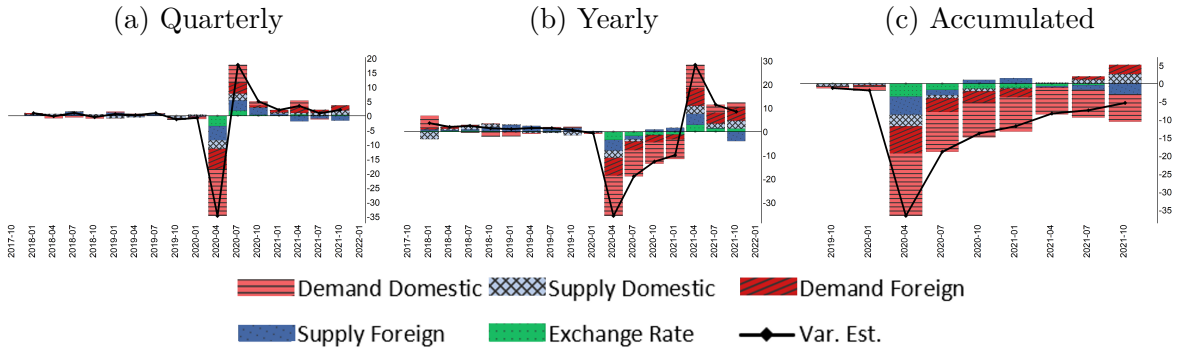
The rest of the tertiary activities (Figure 26) associated with sub-sectors such as finance, education, health, and business support services have also been strongly affected by the domestic demand. Like the abovementioned sectors, foreign supply has contributed negatively to this sector since 2021-Q3. However, unlike the other sectors of tertiary activities, a positive contribution associated with domestic supply shocks was observed until 2021-Q2, possibly explained by the increase in population mobility and the gradual return to normality of various activities. Foreign demand and exchange rate have also contributed positively to the recovery in these activities.

Figure 23: Commerce
Historical Decomposition % Var.



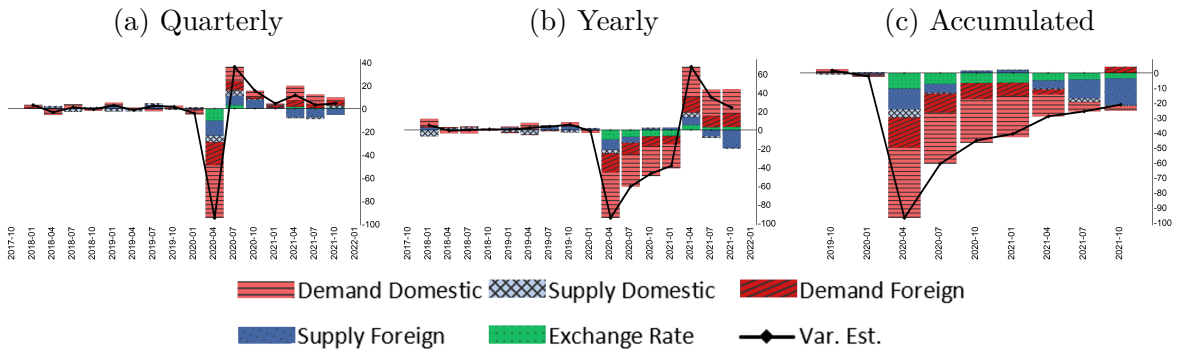
Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
Commerce refers to NAICS sectors 43 and 46.

Figure 24: Transport
Historical Decomposition % Var.



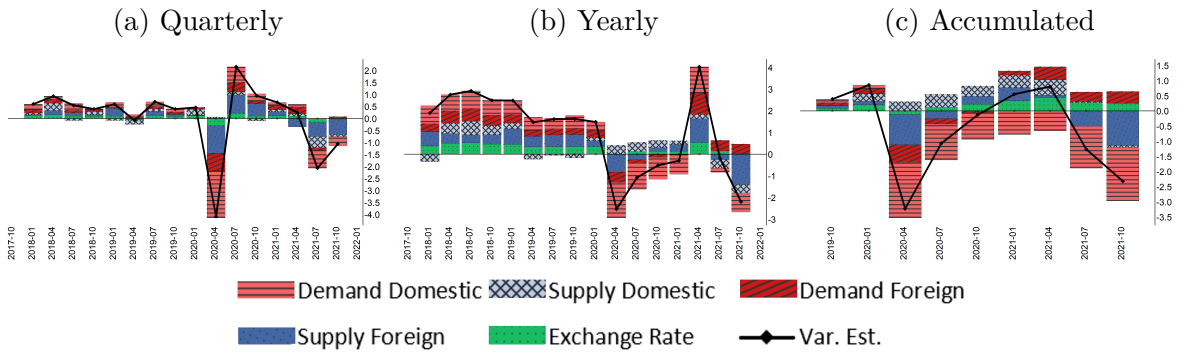
Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
Transport refers to NAICS sectors 48-49.

Figure 25: Tourism
Historical Decomposition % Var.



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
Tourism refers to NAICS sectors 71 and 72.

Figure 26: Rest of Tertiary Sector
Historical Decomposition % Var.



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
It includes all tertiary sectors but commerce, transport, and tourism.

6 Conclusion

Our estimates suggest relatively greater importance of the demand-side than the supply-side factor for driving overall economic fluctuations when COVID-19 impacted in 2020-Q2. This fact differs from studies analyzing other economies such as the US. However, supply-side factors have gained more relevance towards 2021 to explain the slowdown and intermittences in the recovery process of economic activity. Industrial production has been particularly affected by supply-side shocks during 2021. For example, Mexican automotive production was affected throughout the year due to the shortage of semiconductors. In comparison, services have experienced a more significant contribution of demand-side shocks overall.

We also find that shocks associated with external factors are important for explaining the evolution of output and prices in the Mexican economy during the health emergency due to COVID-19. Estimates show, in general, that external shocks account for a significant share of the fluctuations in economic activity during the Pandemic. This result is consistent with Mexico's role as a small and very open economy that is highly integrated into both regional and global value chains.

As for extensions and refinements, this work can be complemented by including long-run restrictions to disentangle persistent from transitory shocks, as in Blanchard & Quah (1989) and Furlanetto et al. (2021). Additional extensions can be done: i) high-frequency data: monthly estimations. ii) Hours worked or employment as proxies of production, as already proposed by Brinca et al. (2021). iii) Alternative priors (Baumeister & Hamilton 2015). However, we must recognize that Minnesota priors with hyperparameters chosen by an optimization process are adequate for Mexico, given that we do not have enough evidence of the type of prior distributions that can apply for each sector in Mexico for

which Minnesota priors are weak enough to be applied in this case. iv) Alternative measurements of prices: Producer Price Index (PPI). v) Alternative external controls: Exports and Imports; Global economic conditions index and international CPI.

Finally, results in this paper imply that a future line of research would be to develop a structural model of a small open economy that is in line with what is found in this study and allows for a deeper understanding of the mechanisms, as well as the implications of counterfactual scenarios and optimal policy design.

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Appendix 1 Sectors and Sub-sectors

Table A1: Sectors based on North American Industry Classification System (NAICS)

Broader sector	Code	Definition
Primary	11	Agricultural
Secondary	21	Mining
Secondary	22	Energy generation
Secondary	23	Construction
Secondary	31-33	Manufacturing
Tertiary	43	Wholesale commerce
Tertiary	46	Retail commerce
Tertiary	48-49	Transport
Tertiary	51	Media
Tertiary	52-53	Financing, insurance, and real estate services
Tertiary	54-55-56	Professional, scientific, and technical services
Tertiary	61-62	Education, health, and social services
Tertiary	71-72	Tourism
Tertiary	81	Other
Tertiary	93	Government

Table A2: Manufacturing Sub-sectors based on North American Industry Classification System (NAICS)

Code	Definition
311	Food industry
312	Beverage and tobacco industry
313	Textile inputs and textile finishing
314	Textile products, except clothing
315	Clothing
316	Tanning and finishing of leather and fur
321	Wood industry
322	Paper industry
323	Printing and related industries
324	Petroleum and coal products
325	Chemical industry
326	Plastics and rubber industry
332	Metal products
333	Machinery and equipment
334	Computer, communication, and other electronics
335	Electrical equipment
336	Automotive manufacturing
337	Furniture, mattresses, and blinds
339	Other manufacturing industries

Appendix 2 Sectoral Econometric Tests

Table A3: Serial differentiation (Augmented Dickey-Fuller Stability Test)

	Q dif.	P dif.
GDP	1	1
Secondary Sector	0	1
Tertiary Sector	1	1
Automotive	1	1
Non-automotive	1	1
Rest of Secondary S.	1	1
Commerce	1	1
Transport	1	1
Tourism	0	1
Rest of Tertiary S.	1	1
External (US)	1	1
Exchange rate (US-MXN)	1	

Table A4: VAR optimal lags (Akaike Information Criterion)

	2 shocks	5 shocks
GDP	4	2
Secondary Sector	4	1
Tertiary Sector	1	1
Automotive	1	1
Non-automotive	2	1
Rest of Secondary S.	1	1
Commerce	1	2
Transport	1	1
Tourism	4	1
Rest of Tertiary S.	1	1

Appendix 3 GDP implicit prices methodology

As argued above, in this paper, we seek to identify the contribution of supply and demand shocks to Mexico's economic activity dynamics. In particular, through our analysis, we seek to identify the demand shocks most closely related to household consumption. In this way, we use the National Consumer Price Index (INPC) as a proxy for the prices of the economy as a whole and each sector. According to the INEGI methodological document, the INPC is defined as an economic indicator that measures, over time, the average variation in the prices of a basket of goods and services representative of household consumption in the country (INEGI 2018). Therefore, although there are several price indices, the INPC is the one that best measures prices and inflation from the consumer's perspective.

Although the INPC is the most used indicator to measure inflation in Mexico, it is not the only price indicator. There are also implicit deflators derived from national accounts and other price measures such as the National Producer Price Index (INPP) or foreign trade indices. In the particular case of implicit deflators, the national accounts calculate production at constant prices for the entire economy and each sector and its subsectors. This information is complemented by the implicit price indices, which arise from relating current values to constant GDP values for each quarter (Heath 2012). In contrast to the INPC, the implicit GDP deflators measure the prices of all goods and services generated by the economy, including those not directly consumed by households.

According to the above, we present the results considering implicit prices instead of INPC for prices as an exercise of robustness. We keep using GDP at constant prices (2013) for quantities. As for the foreign sector, we now use the Personal Consumption Expenditures: Chain-type Price Index. For quantities and exchange rate, we keep using Real Gross Domestic Product and the US/MX exchange rate to settle obligations denominated in foreign currency. All quarterly series are seasonally adjusted.

This methodology could allow to broaden the analysis to the period between 1993-Q1 and 2021-Q4. Nevertheless, its important to note that in order to ensure the stability of the national currency's purchasing power, in 2001, Banco de México adopted an inflation target scheme as a framework for the conduct of monetary policy. For this reason we restrict our sample to start in 2002. We also restrict the sample for comparability with the other results in this paper. We find consistent results.

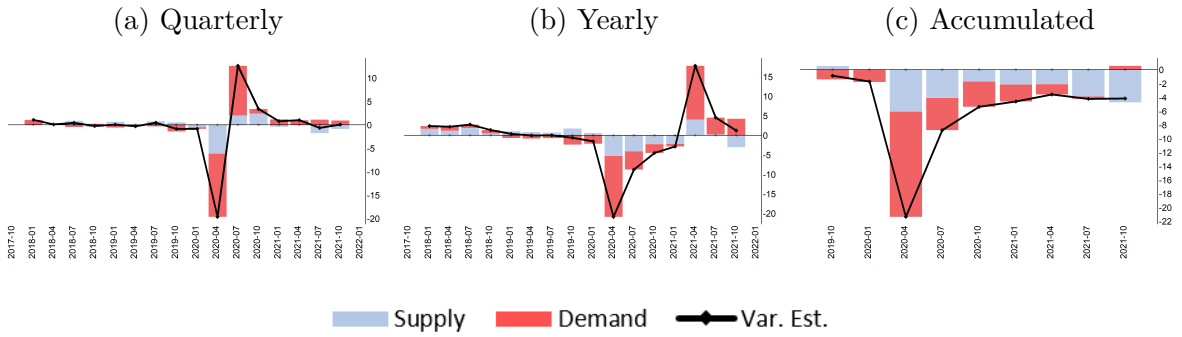
Table A5: Serial differentiation (Augmented Dickey-Fuller Stability Test) for GDP implicit prices methodology

	Q dif.	P dif.
GDP	1	1
Secondary Sector	0	1
Tertiary Sector	1	0
Automotive	1	1
Non-automotive	0	1
Rest of Secondary S.	1	1
Commerce	1	1
Transport	1	1
Tourism	0	1
Rest of Tertiary S.	1	0
External (US)	1	1
Exchange rate (US-MXN)	1	

Table A6: VAR optimal lags (Akaike Information Criterion) for GDP implicit prices methodology

	2 shocks	5 shocks
GDP	1	1
Secondary Sector	4	2
Tertiary Sector	2	2
Automotive	1	1
Non-automotive	4	4
Rest of Secondary S.	1	1
Commerce	4	2
Transport	1	1
Tourism	4	2
Rest of Tertiary S.	2	2

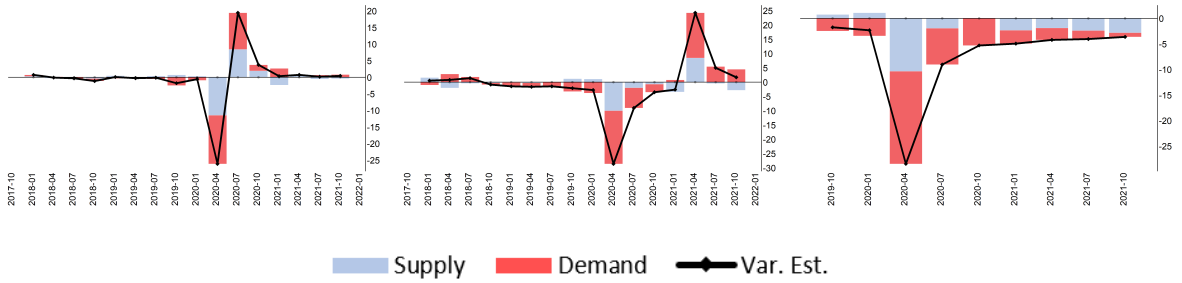
Figure A1: Economy (GDP)
Historical Decomposition % Var. (GDP implicit prices methodology)



Note: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.

Figure A2: Secondary Sector (Industrial Production)
Historical Decomposition % Var. (GDP implicit prices methodology)

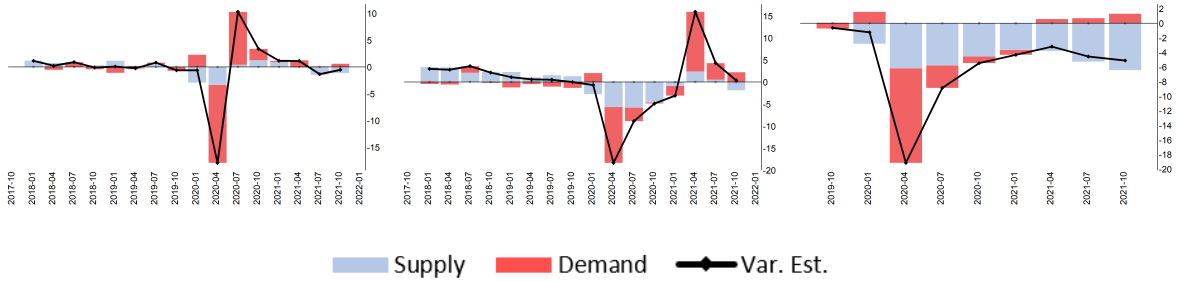
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.
The secondary sector includes NAICS sectors 21 to 33. These encompass mining, energy generation, construction, and manufacturing.

Figure A3: Tertiary Sector (Services)
Historical Decomposition % Var. (GDP implicit prices methodology)

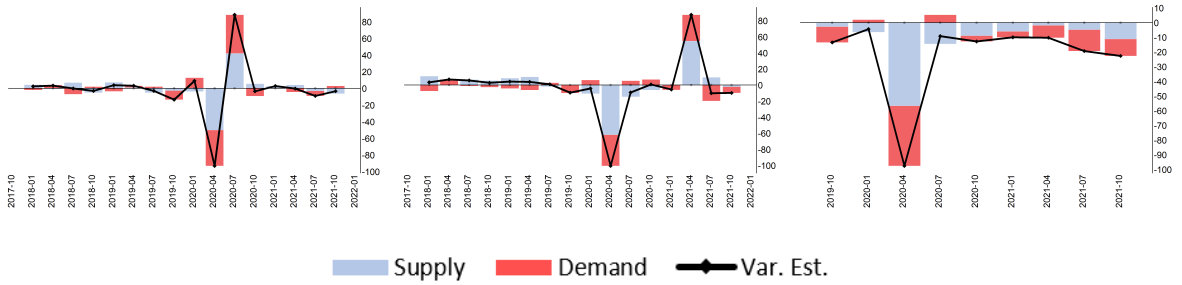
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4. The tertiary sector includes NAICS sectors 43-93. These encompass the following services: i) wholesale and retail commerce, ii) transport, mail, and media, iii) financing, insurance, and real estate services, iv) professional, scientific, and technical services, v) education, health, and social services, vi) culture, sports, and other leisure services, vii) lodging, restaurants and other services related to tourism.

Figure A4: Automotive
Historical Decomposition % Var. (GDP implicit prices methodology)

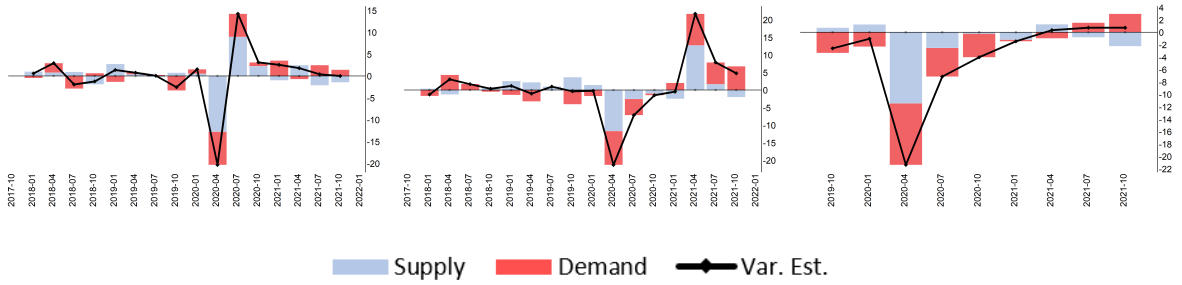
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4. It includes only automotive manufacturing, NAICS sub-sector 336.

Figure A5: Non-Automotive
Historical Decomposition % Var. (GDP implicit prices methodology)

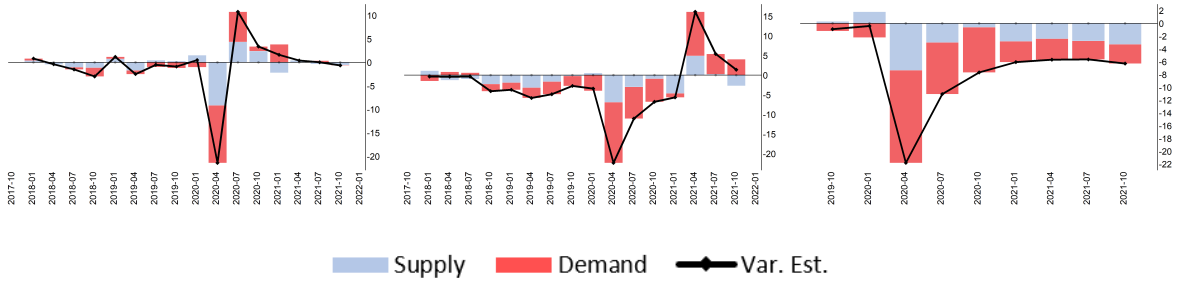
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4. It includes all manufacturing except automotive manufacturing, NAICS sector 31-33 except sub-sector 336.

Figure A6: Rest of Secondary Sector
Historical Decomposition % Var. (GDP implicit prices methodology)

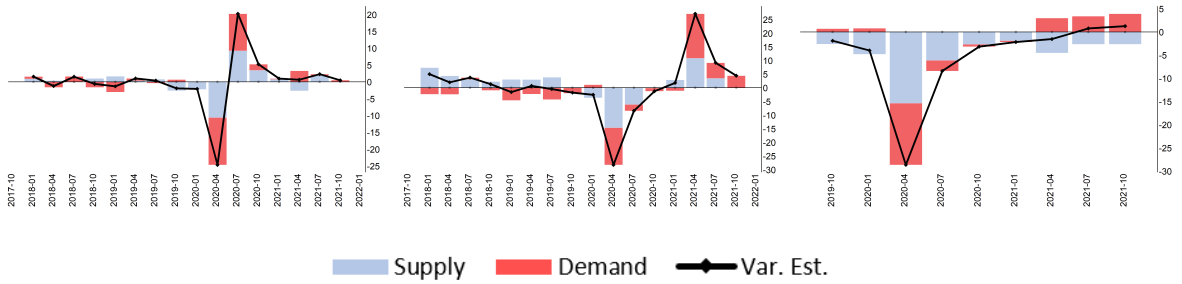
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.
Includes all industrial production but NAICS sectors 31-33, manufacturing.

Figure A7: Commerce
Historical Decomposition % Var. (GDP implicit prices methodology)

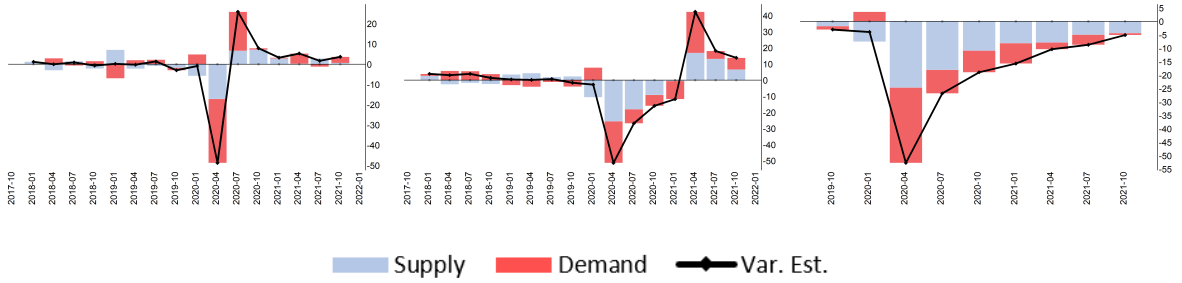
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.
Commerce refers to NAICS sectors 43 and 46.

Figure A8: Transport
Historical Decomposition % Var. (GDP implicit prices methodology)

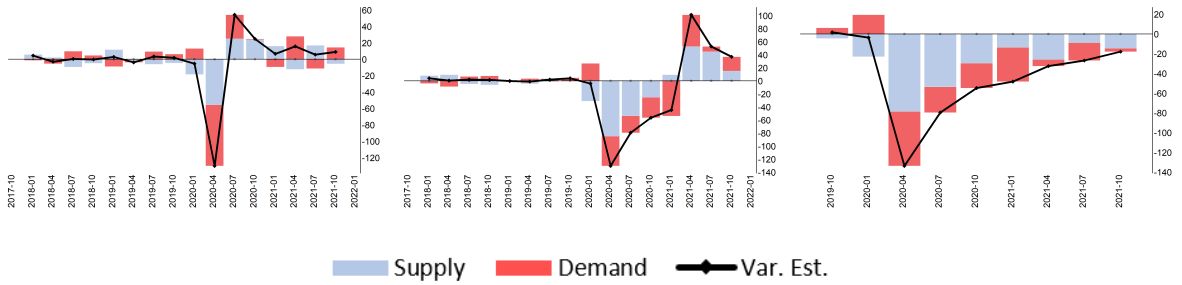
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.
Transport refers to NAICS sectors 48-49.

Figure A9: Tourism
Historical Decomposition % Var. (GDP implicit prices methodology)

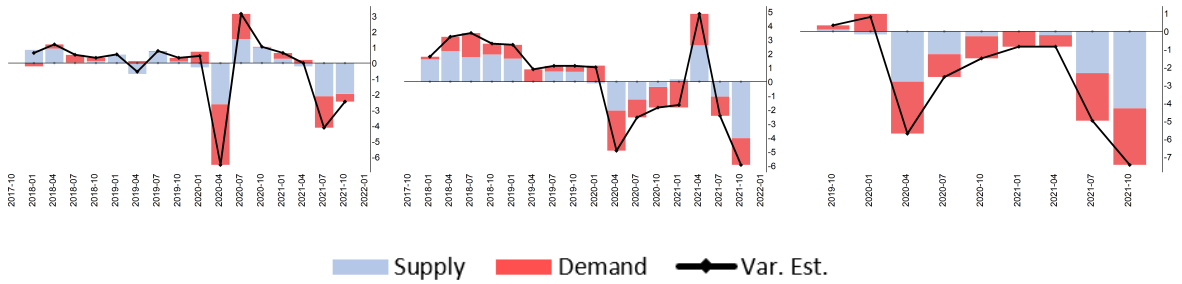
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.
Tourism refers to NAICS sectors 71 and 72.

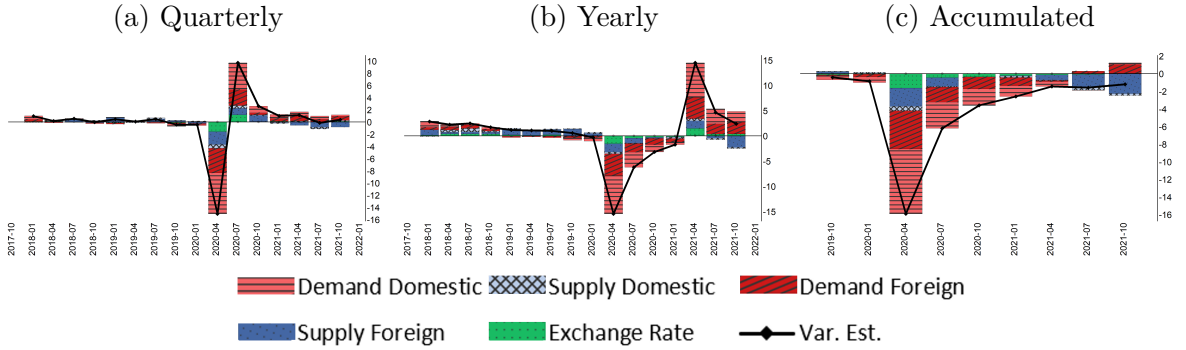
Figure A10: Rest of Tertiary Sector
Historical Decomposition % Var. (GDP implicit prices methodology)

(a) Quarterly (b) Yearly (c) Accumulated



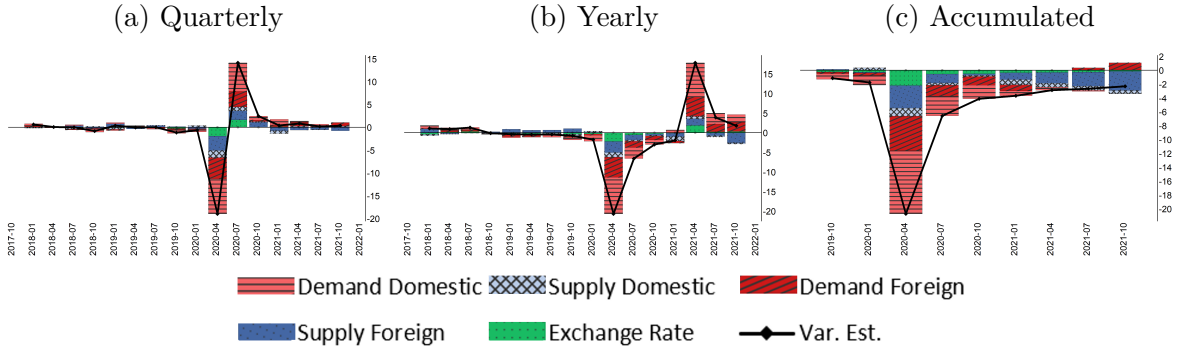
Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Accumulation considered since 2019-Q4.
It includes all tertiary sectors but commerce, transport, and tourism.

Figure A11: Economy (GDP)
Historical Decomposition % Var. (GDP implicit prices methodology)



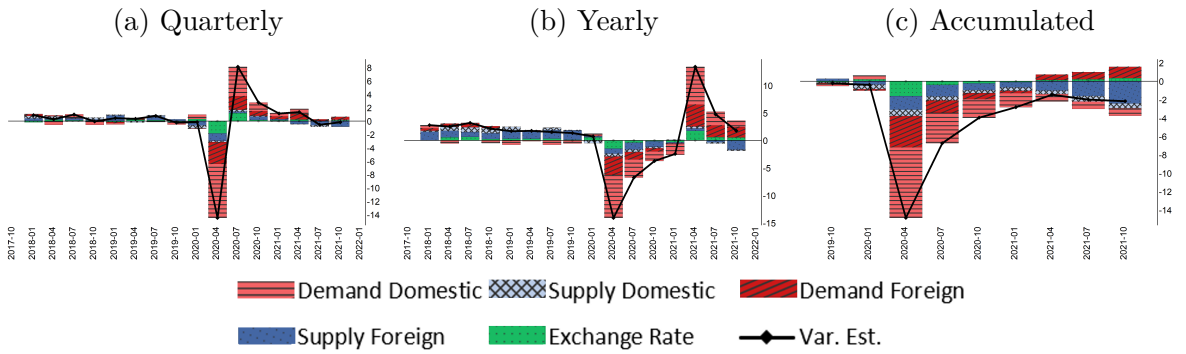
Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.

Figure A12: Secondary Sector (Industrial Production)
Historical Decomposition % Var. (GDP implicit prices methodology)



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
The secondary sector includes NAICS sectors 21 to 33. These encompass mining, energy generation, construction, and manufacturing.

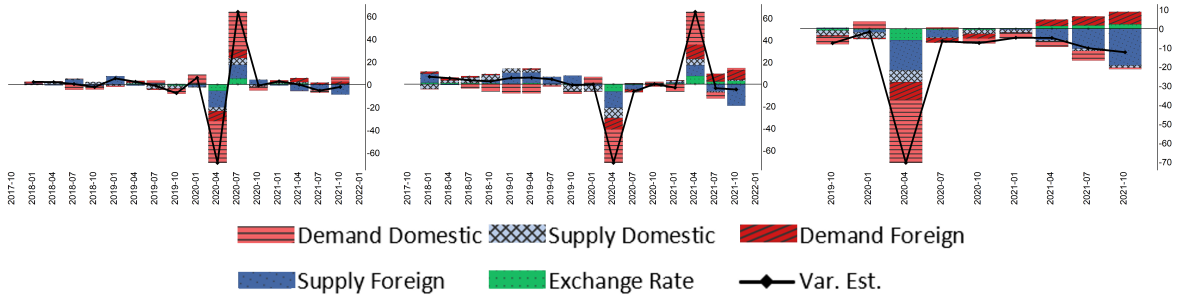
Figure A13: Tertiary Sector (Services)
Historical Decomposition % Var. (GDP implicit prices methodology)



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
The tertiary sector includes NAICS sectors 43-93. These encompass the following services: i) wholesale and retail commerce, ii) transport, mail, and media, iii) financing, insurance, and real estate services, iv) professional, scientific, and technical services, v) education, health, and social services, vi) culture, sports, and other leisure services, vii) lodging, restaurants and other services related to tourism.

Figure A14: Automotive
Historical Decomposition % Var. (GDP implicit prices methodology)

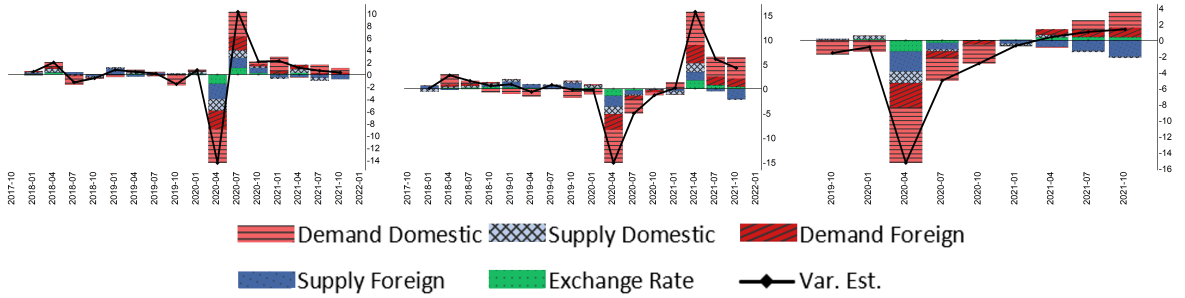
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
It includes only automotive manufacturing, NAICS sub-sector 336.

Figure A15: Non-Automotive
Historical Decomposition % Var. (GDP implicit prices methodology)

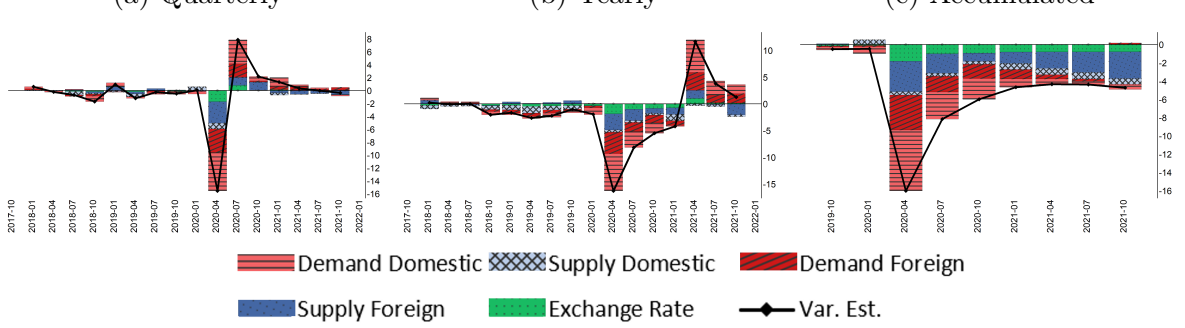
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
It includes all manufacturing except automotive manufacturing, NAICS sector 31-33 except sub-sector 336.

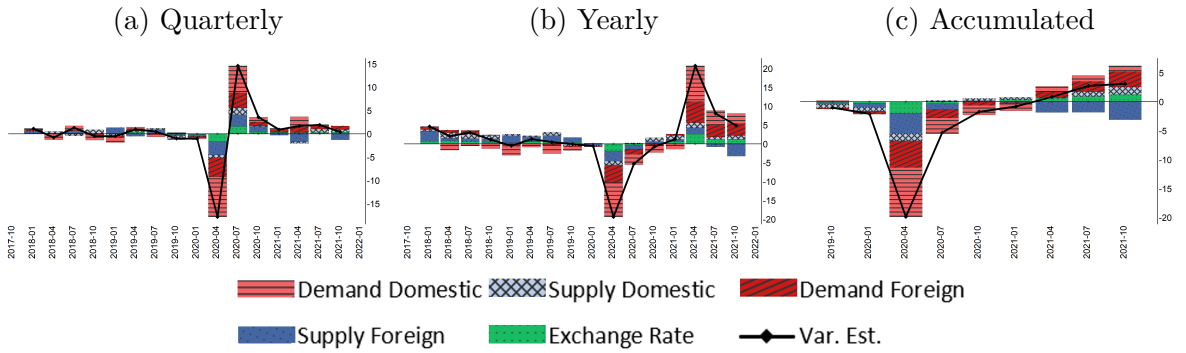
Figure A16: Rest of Secondary Sector
Historical Decomposition % Var. (GDP implicit prices methodology)

(a) Quarterly (b) Yearly (c) Accumulated



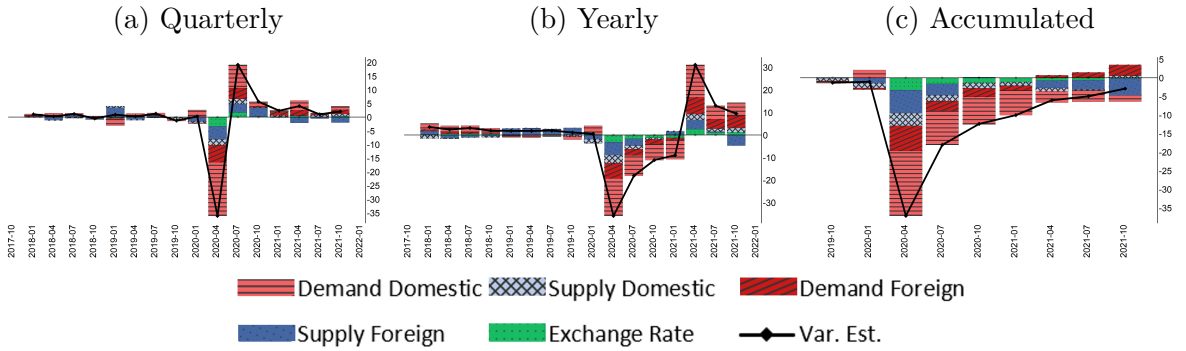
Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
Includes all industrial production but NAICS sectors 31-33, manufacturing.

Figure A17: Commerce
Historical Decomposition % Var. (GDP implicit prices methodology)



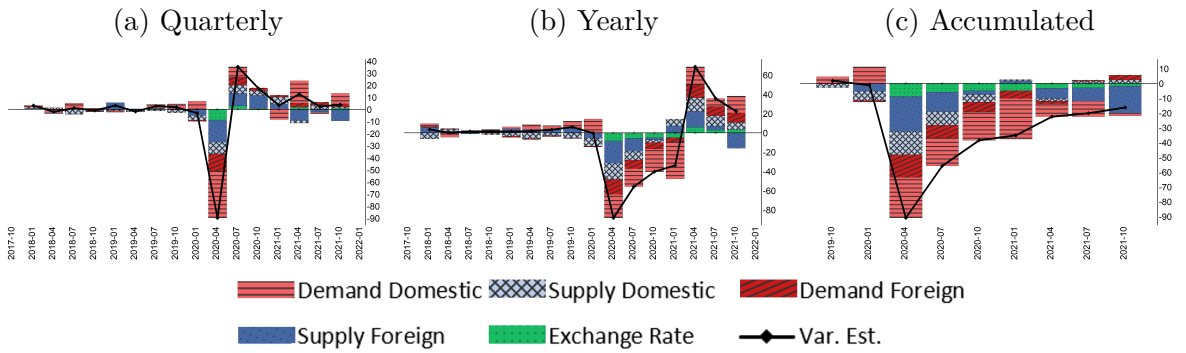
Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
Commerce refers to NAICS sectors 43 and 46.

Figure A18: Transport
Historical Decomposition % Var. (GDP implicit prices methodology)



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
Transport refers to NAICS sectors 48-49.

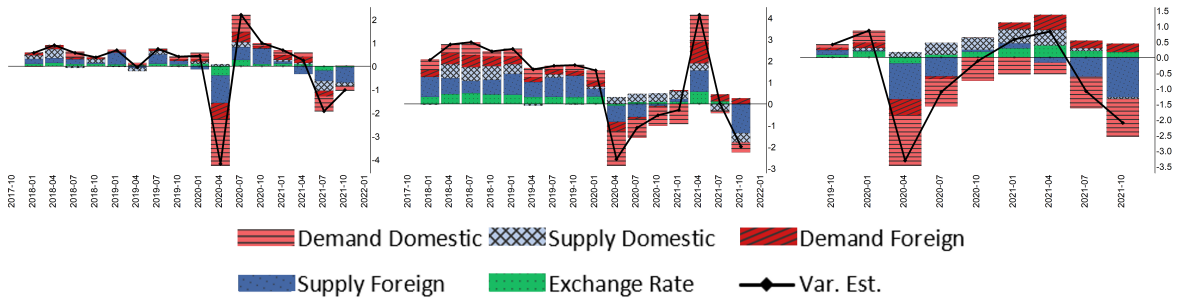
Figure A19: Tourism
Historical Decomposition % Var. (GDP implicit prices methodology)



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
Tourism refers to NAICS sectors 71 and 72.

Figure A20: Rest of Tertiary Sector
Historical Decomposition % Var. (GDP implicit prices methodology)

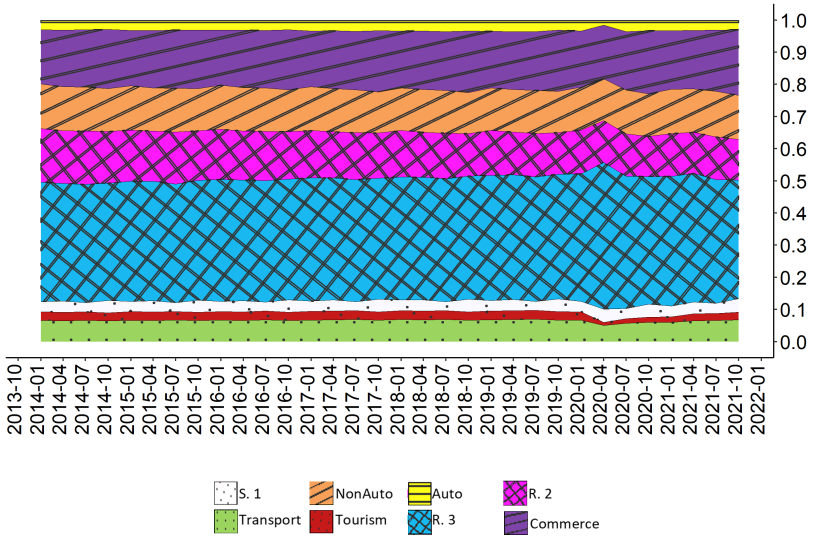
(a) Quarterly (b) Yearly (c) Accumulated



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI, and Federal Reserve Bank of St. Louis. Accumulation considered since 2019-Q4.
It includes all tertiary sectors but commerce, transport, and tourism.

Appendix 4 Additional Descriptive Statistics

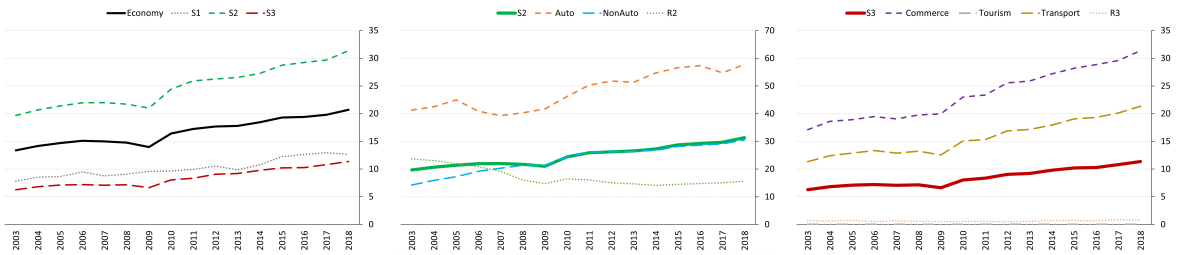
Figure A21: GDP sector relevance



Notes: Authors' calculations with data from the System of National Accounts of Mexico (SCNM), INEGI. Data characteristics are the following: Sectoral GDP, quarterly frequency, original series, millions of pesos at 2013 prices.
The primary sector (S1) is agricultural activity. The secondary sector (S2) includes NAICS sectors 21 to 33. The tertiary sector (S3) includes NAICS sectors 43-93. Automotive manufacturing (Auto) refers to the NAICS sub-sector 336. Non-automotive manufacturing (NonAuto) refers to all manufacturing but the NAICS sub-sector 336. Rest of Secondary Sector (R. 2) refers to all industrial production but NAICS sectors 31-33. Commerce refers to NAICS sectors 43 and 46. Transport refers to NAICS sectors 48-49. Tourism refers to NAICS sectors 71 and 72. Rest of Tertiary Sector (R. 3) refers to all tertiary sector but commerce, transport and tourism.

Figure A22: Exports as a % of total output

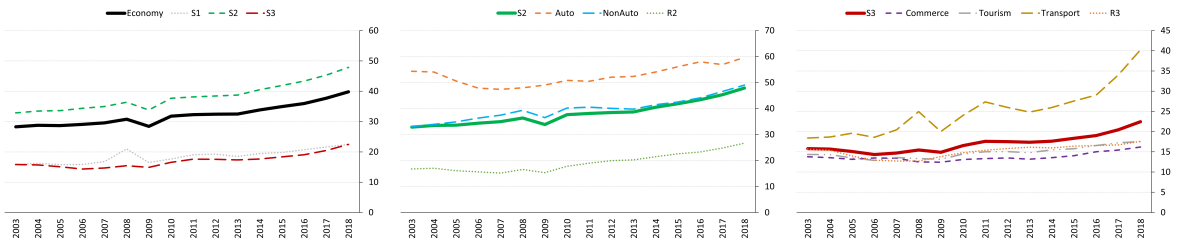
(a) GDP and Broad Sectors (b) Industrial Production (c) Services



Notes: Authors' calculations with data from INEGI. Data characteristics are the following: Projected Input-Output Matrices, millions of pesos at constant 2013 prices, industry by industry.
The primary sector (S1) is agricultural activity. The secondary sector (S2) includes NAICS sectors 21 to 33. The tertiary sector (S3) includes NAICS sectors 43-93. Automotive manufacturing (Auto) refers to the NAICS sub-sector 336. Non-automotive manufacturing (NonAuto) refers to all manufacturing but the NAICS sub-sector 336. Rest of Secondary Sector (R. 2) refers to all industrial production but NAICS sectors 31-33. Commerce refers to NAICS sectors 43 and 46. Transport refers to NAICS sectors 48-49. Tourism refers to NAICS sectors 71 and 72. Rest of Tertiary Sector (R. 3) refers to all tertiary sector but commerce, transport and tourism.

Figure A23: Imported inputs as a % of total inputs

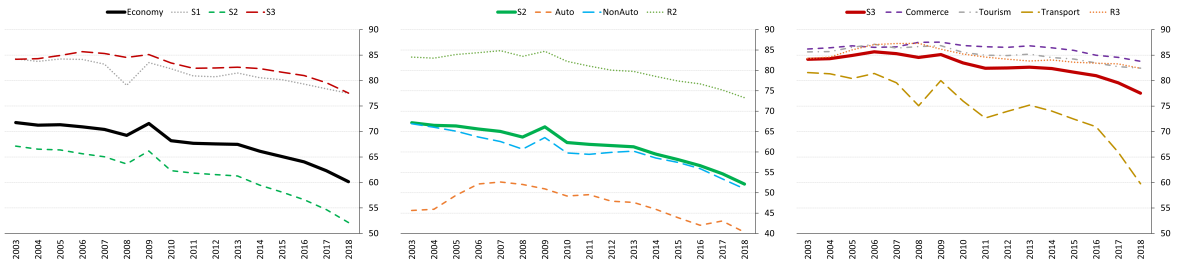
(a) GDP and Broad Sectors (b) Industrial Production (c) Services



Notes: Authors' calculations with data from INEGI. Data characteristics: Projected Input-Output Matrices, millions of pesos at constant 2013 prices, industry by industry.
The primary sector (S1) is agricultural activity. The secondary sector (S2) includes NAICS sectors 21 to 33. The tertiary sector (S3) includes NAICS sectors 43-93. Automotive manufacturing (Auto) refers to the NAICS sub-sector 336. Non-automotive manufacturing (NonAuto) refers to all manufacturing but the NAICS sub-sector 336. Rest of Secondary Sector (R. 2) refers to all industrial production but NAICS sectors 31-33. Commerce refers to NAICS sectors 43 and 46. Transport refers to NAICS sectors 48-49. Tourism refers to NAICS sectors 71 and 72. Rest of Tertiary Sector (R. 3) refers to all tertiary sector but commerce, transport and tourism.

Figure A24: Domestic inputs as a % of total inputs

(a) GDP and Broad Sectors (b) Industrial Production (c) Services



Notes: Authors' calculations with data from INEGI. Data characteristics: Projected Input-Output Matrices, millions of pesos at constant 2013 prices, industry by industry.
The primary sector (S1) is agricultural activity. The secondary sector (S2) includes NAICS sectors 21 to 33. The tertiary sector (S3) includes NAICS sectors 43-93. Automotive manufacturing (Auto) refers to the NAICS sub-sector 336. Non-automotive manufacturing (NonAuto) refers to all manufacturing but the NAICS sub-sector 336. Rest of Secondary Sector (R. 2) refers to all industrial production but NAICS sectors 31-33. Commerce refers to NAICS sectors 43 and 46. Transport refers to NAICS sectors 48-49. Tourism refers to NAICS sectors 71 and 72. Rest of Tertiary Sector (R. 3) refers to all tertiary sector but commerce, transport and tourism.