

An Analysis of Sectoral Supply and Demand Shocks in Mexico During COVID-19

2021 CEMLA Joint Research Program: Macroeconomic Policy Responses to COVID-19

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- We identify the contribution of supply and demand shocks on the monthly variation of economic activity, both at an aggregate and sectoral level, with a particular focus on the period of the COVID-19 pandemic.
- Since the beginning of 2020, health authorities in Mexico have implemented social distancing measures and the closure of non-essential activities in order to reduce the spread of the virus.
- On the one hand, confinement has led people to stay at home, reducing the consumption of certain 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 side and the demand side of the economy.

- While most economists concur that the pandemic has entailed both supply and demand shocks, it is uncertain to what extent demand and supply factors have dominated at different points during the COVID-19 recession.
- The effects of the pandemic on economic activity have been generalized, but heterogeneous across sectors.
- We study supply and demand factors at the sectoral level as potential sources for that heterogeneity.
- Moreover, since Mexico is an open and well integrated economy in global value chains, we assess the extent to which economic activity responds to external demand and supply, as well as exchange rate shocks.
- Our results are relevant for the analysis of economic policy, since a better understanding of the origin of shocks is necessary to design economic policies that aim to support the economy during a period of contraction.

Key findings

- Typically before the pandemic, the weak performance of Mexican economy seems to be mostly associated with a balance combination of demand and supply factors.
- **First Wave.** During April-May 2020 we observe the most negative effect of COVID-19 on economic activity.
 - During the peak contraction in economic activity, the demand shock was the dominant source of fluctuation across most sectors.
 - When controlling for external conditions, our results suggest an important role of external demand and supply conditions and exchange rate shocks to explain the dynamic of economic activity.
- **Second Wave.** The second lockdown in December is associated to domestic health policies. Since the beginning of 2021, external supply has contributed negatively to the variation of several sectors, particularly in manufacturing, while both domestic and external demand factors have, in general, contributed positively.

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Our approach

- In the complex environment of the COVID-19 pandemic, several papers have attempted to measure its economic impact, based on different approaches, in order to help policymakers to take appropriate actions.
 - Our work is mostly related to what has been done by Brinca et al. (2020) and Baumeister and Hamilton (2015). We include a detailed discussion of their results and related literature in the Appendix.
- **Our goal: to identify supply and demand shocks at the sectoral level taking into account the international dimension of the shocks originating the fluctuation. We seek to shed light on the heterogeneity across sectors regarding the magnitude and composition of the shocks that have affected them, particularly during the period of the COVID-19 pandemic.**
- We also try to identify the impact of external shocks (supply, demand and exchange rate) among economic sectors.
- To the best of our knowledge, this is the first paper to analyze the effect of COVID-19 on sectoral activity in Mexico by means of a sign restricted SBVAR.

Inputs of the model

- Monthly data of production and prices of the Mexican economy at sector level from 2002m2 to 2021m4.
 - Economic Activity Index (IGAE), Industrial Activity Index (IMAI), Manufacturing Industry Survey (EMIM) from INEGI.
 - Consumer Price Index (INPC) from INEGI.
 - Industrial Production in the US (USIP), Consumer Price Index in the US (USCPI) and real bilateral exchange rate (RER) between Mexico and the US.
- Monthly log variation of seasonal adjusted time series.
- 1 lag (Similar results for 2, 4 and 6 lags suggested by information criteria for several sectors).
- Bayesian VAR with Minnesota priors with optimized hyper-parameters by maximum likelihood.
- Identification of demand and supply shocks by sign restriction.
- Identification of the origin of the disturbances.

- Formally, we estimate a VAR for each sector:

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

- Where: y_t is a vector of the monthly log variation of endogenous variables; C_B is a vector of constants; B_i and D_i for $i = 1, \dots, P$ are parameter matrices, 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 $\Sigma = AA'$.
- The aim of structural estimation is to identify the matrix A from the estimated variance and covariance matrix $\hat{\Sigma}$ derived from the reduced form VAR.

Shocks Identification 1

- We identify two sets of shocks. In the first set, we only identify supply and demand shocks by sectors. In the second set, we use 3 additional variables (RER, USIP, USCPI) in order to disentangle domestic and foreign demand and supply shocks. We base our identification strategy on Alexius (2008) and on the next considerations:
- **Overall Supply and Demand Shocks**
 - A positive supply shock moves in opposite directions the quantity produced and its price (Baumeister and Hamilton, 2015).
 - In contrast, a demand shock moves both variables in the same direction (Brinca et al., 2020).
 - Identification of this set allows to get a sense of the size of the shocks hitting the economy during the months of the pandemic.
 - However, in order to have a deeper understanding of the sources of fluctuation during that period, we disentangle the overall shock in its domestic, foreign and exchange rate components.

● **Disentangling Domestic and Foreign Shocks**

- Given that Mexico is a small open economy, it is influenced by external activity, but has little effect on global fluctuation with the exception of exchange rate. Consistent with this fact and with related literature, we impose a zero effect of domestic supply and demand on the corresponding external variables.
- A positive supply shock decreases domestic prices, its effect on exchange rate is a real depreciation. In contrast, the increase in the domestic prices after a demand shock appreciates the RER.
- We now turn to the effects of foreign variables on domestic factors.
 - A positive shock to US Industrial Production (USIP) increases demand for Mexican exports given that a considerable share of inputs for US production are provided by Mexican manufacturers. This translates into an increase in domestic demand.
 - As in the domestic case, a positive supply shock moves in opposite directions prices and quantities abroad. Demand shocks move them in the same direction.

• Disentangling Domestic and Foreign Shocks

- We allow data to tell us the direction in which the real exchange rate (RER) moves when there are supply and demand shocks, as well as the direction of domestic prices and quantities in case of a foreign demand shock.
- Given that in literature there exists a debate about the sign of the effect of a shock to the exchange rate on domestic production, we allow data to clarify this issue for Mexico. Accordingly, we do not impose a sign restriction on this variable.
- However, empirical evidence for Mexico suggests there is a positive pass-through of exchange rate depreciations on inflation. Hence, we impose a positive effect of real depreciation on inflation. Finally, we allow that data inform us about the relationship between real depreciation in Mexico and production and inflation abroad.

Shocks Identification: Summary

- This table summarizes our sign restrictions to disentangle RER, domestic and foreign supply and demand shocks.

	Supply Q^d	Demand P^d	F. Sup Q^f	F. Dem P^f	RER e
Q^d	+	+	+		
P^d	-	+	-		+
Q^f	0	0	+	+	
P^f	0	0	-	+	
e	+	-			+

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Timeline of COVID-19 Pandemic 1

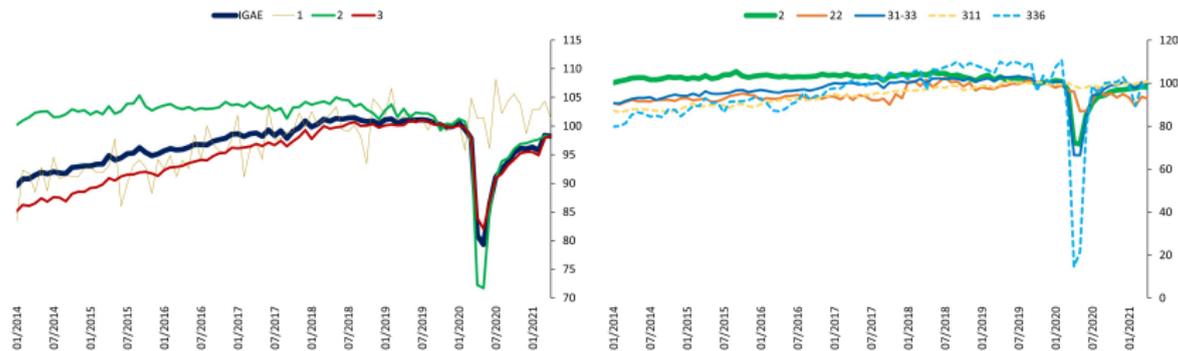
- As we saw before, in April 2020 the COVID-19 pandemic had its greatest negative shock on the Mexican economy.
 - Stoppages in manufacturing production and in various services led to a supply reduction. These events put at risk the functioning of global value chains and the provision of inputs for production.
 - 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.
- The economic recovery started in June 2020 in the industrial and services broader sectors. Our estimates suggest that it was importantly driven by external conditions.
- In July 2020 the United States-Mexico-Canada Trade Agreement (USMCA) was implemented.
- In the last quarter of 2020 the recovery was milder.

Timeline of COVID-19 Pandemic 2

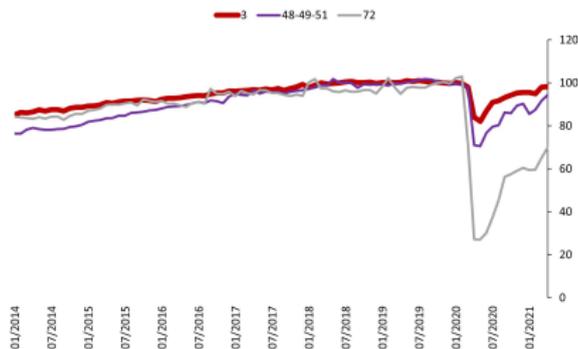
- In December 2020 new lockdown mobility restrictions were implemented due to rising COVID-19 cases both in Mexico and globally.
- Between January and March 2021, economic activity shows a slowdown in its recovery. This can be associated with several shocks at the beginning of the year. In particular:
 - Between the end of 2020 and the beginning of 2021 new restrictions were implemented in the face of a rebound of the COVID-19 pandemic.
 - In addition, there were some disruptions in the supply of certain industrial inputs (global shortage of semiconductors had especially affected the automotive sector).
 - There also was a temporary interruption in the supply of natural gas and power outages in mid-February in the northern region of the country.

Economic Activity During COVID-19 Pandemic

(a) IGAE and Broad Sectors (2019q4=100) (b) Industrial Production (2019q4=100)



(c) Services (2019q4=100)



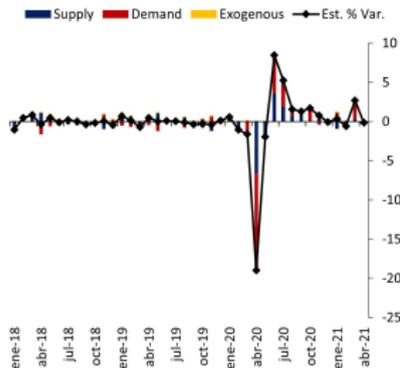
A Simple Demand and Supply Approach

- As a first step we analyze a simple framework with only two shocks: Demand and Supply (Brinca et al., 2020).
- In April 2020 the COVID-19 pandemic had its greatest negative shock on the Mexican economy. Measures to contain the spread of the virus all over the world caused a demand and supply shock. The dominant effect was the demand factor.
- In annual terms, the supply shocks seemed to have dissolved by the end of 2020. However, in early 2021 an important negative contribution of supply factors was observed.
- The latter is more evident in accumulated contributions, where both supply and demand factors continue to contribute negatively to the accumulated variation in economic activity.
- Across sectors of the economy, the effect of the pandemic in April 2020 was generalized but heterogeneous.
- The deepest effects were in manufactures and in services such as transportation, tourism and leisure.
- As observed in the case of the economy as a whole, demand factors had a greater incidence, although for some sectors supply factors were relatively more important.

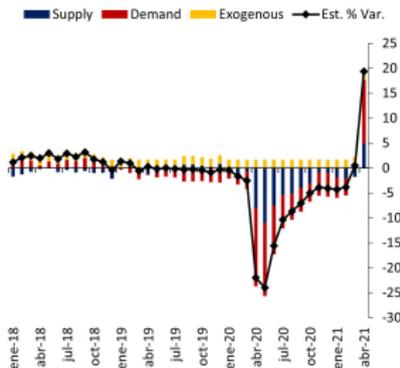
Supply and Demand Approach: IGAE

Economy (IGAE). Historical Decomposition % Var.

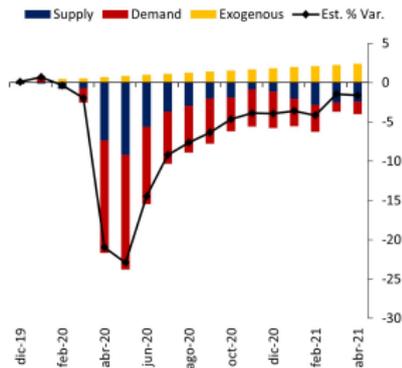
(a) Monthly



(b) Yearly



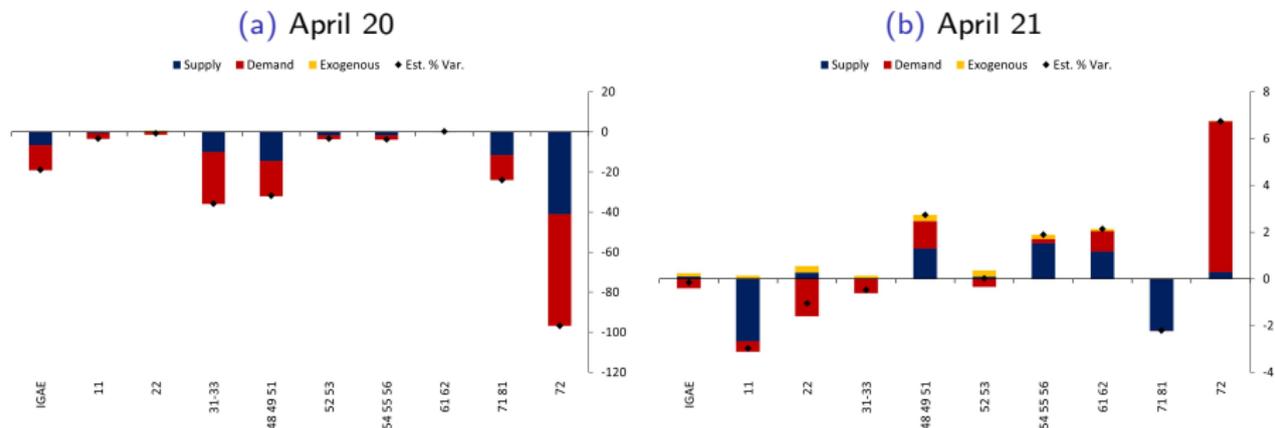
(c) Accumulated



Source: Elaboration by Banco de México.

Supply and Demand Approach: Sectoral Analysis

Historical Decomposition of Production, Monthly % Var. of IGAE by Sector



Source: Elaboration by Banco de México. X-axis includes global activity (IGAE) and sectors (coded).

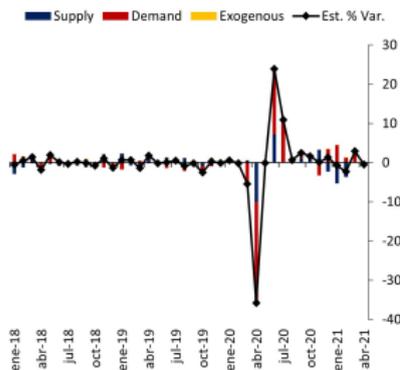
Supply and Demand Approach: Manufacturing

- In the case of manufacturing, the supply and demand shocks affected this sector in a similar fashion to that of the overall economy in April 2020.
- Since the beginning of 2021, supply factors have contributed negatively to the variation in manufacturing, while demand factors have contributed positively.
- For several manufacturing sectors supply factors seem to be relatively more important than demand factors during April 2020.
- Supply factors were relatively more important for export oriented industries like transport equipment.
- Even though the electronics manufacturing (334) and electrical equipment (335) sectors did not suffer such a sharp drop in April 2020, the role of supply shocks in these sectors is very important.

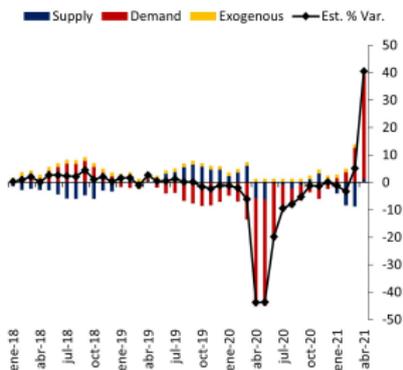
Supply and Demand Approach: Manufacturing

31-33: Manufactures. Historical Decomposition % Var.

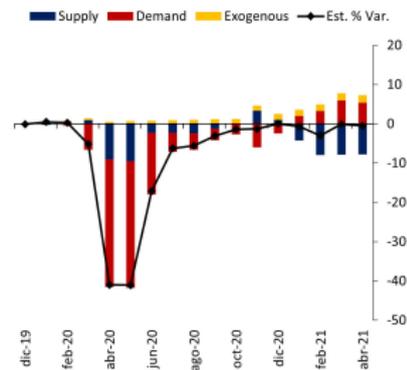
(a) Monthly



(b) Yearly



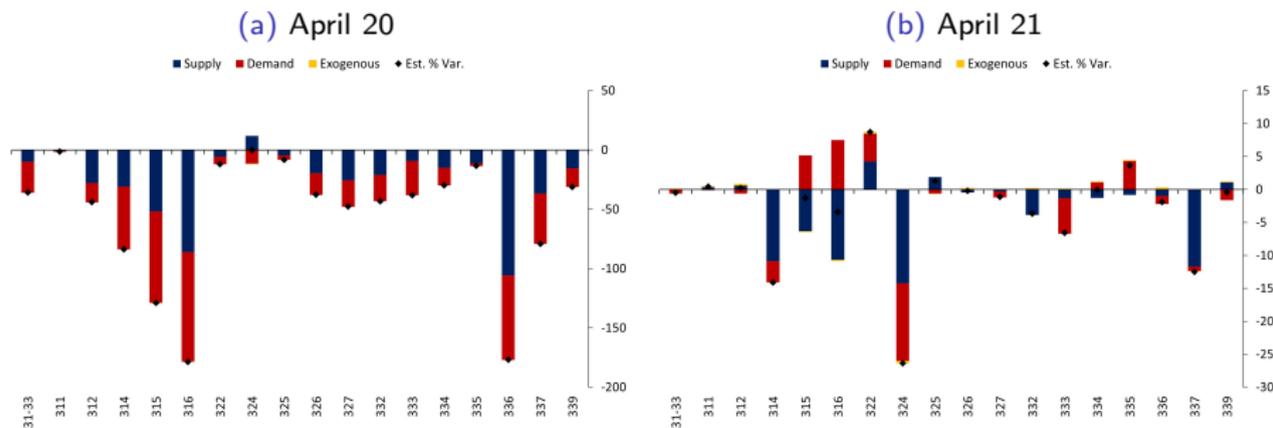
(c) Accumulated



Source: Elaboration by Banco de México.

Supply and Demand Approach: Manufacturing by Sub-sector

Hist. Decomp. of Production, Monthly % Var. of Manufactures by Sub-sector



Source: Elaboration by Banco de México. X-axis includes manufacturing sector (31-33) and its sub-sectors (coded).

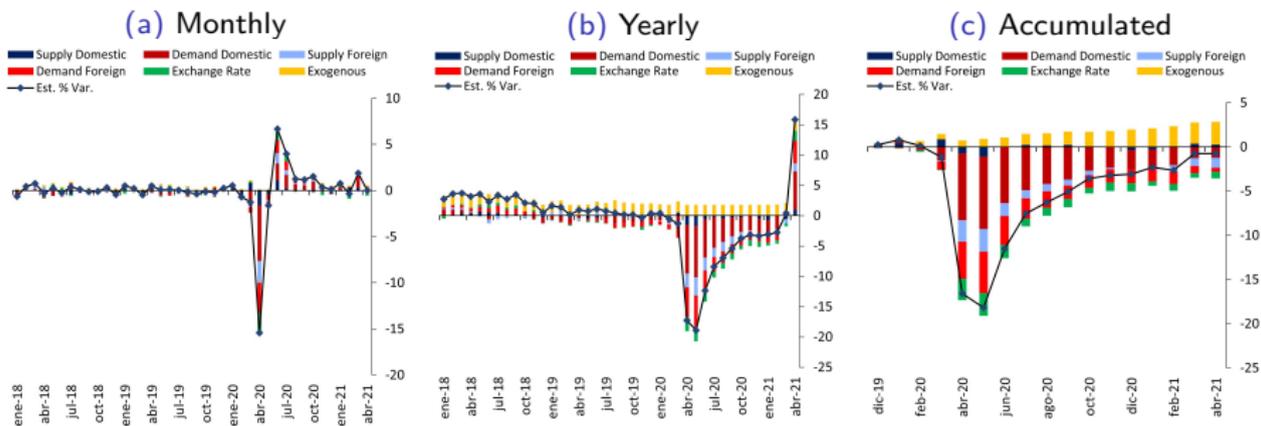
- As we argued before, Mexico is a small open economy that is heavily exposed to external factors that affect the domestic economy, but has little influence on global economic conditions.
- Consistent with this fact, we attempt to disentangle the disturbances by domestic and international origin, as well as a RER component.
- In the Baseline model, we identify 5 types of shocks:
 - A domestic supply shock.
 - A domestic demand shock.
 - A foreign supply shock.
 - A foreign demand shock.
 - An exchange rate shock.

Baseline Model: Results

- Once controlling for external economic conditions and real exchange rate, we found that around one half of the great decrease in economic activity in Mexico in April 2020 was due to external factors.
 - External demand seems to be the main driver of the drop followed by domestic demand, external supply, exchange rate and domestic supply shocks.
- During the recovery period, domestic supply factors had a negligible impact on production.
- Since the beginning of 2021, external supply factors have negatively contributed to production variation along almost all sectors of the economy.
- Both domestic and external demand factors have slowly reduced their contribution.
- Our estimates highlight the role of contributions of external factors on the growth of several sectors.
- However, domestic demand factors seem to be very important not only for services more related with tourism, but also for the manufacturing industry.

Baseline model: Mexican Economy as a Whole

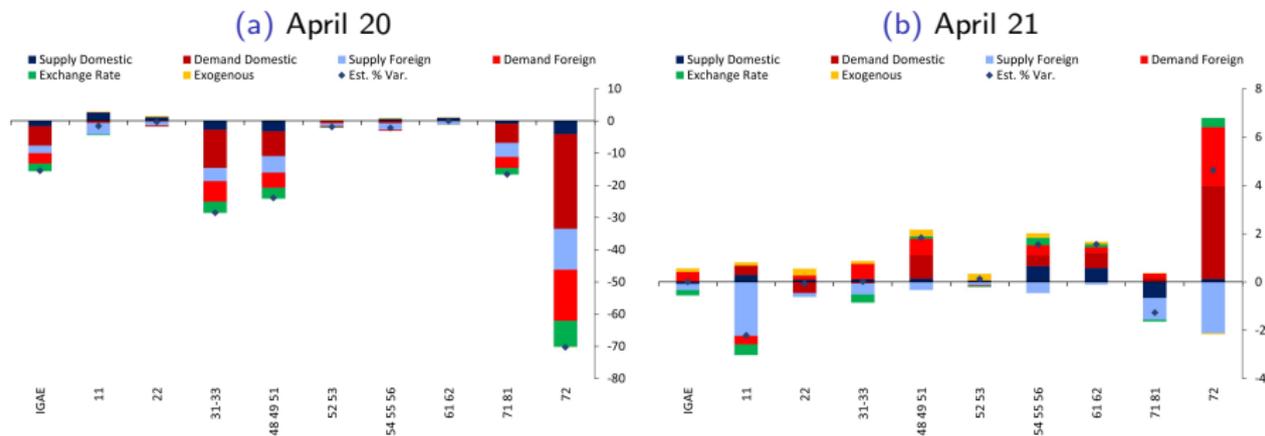
Economy (IGAE). Historical Decomposition % Variation



Source: Elaboration by Banco de México.

Baseline model: Mexican Economy by Sectors

Historical Decomposition of Production, Monthly % Var. of IGAE by Sector



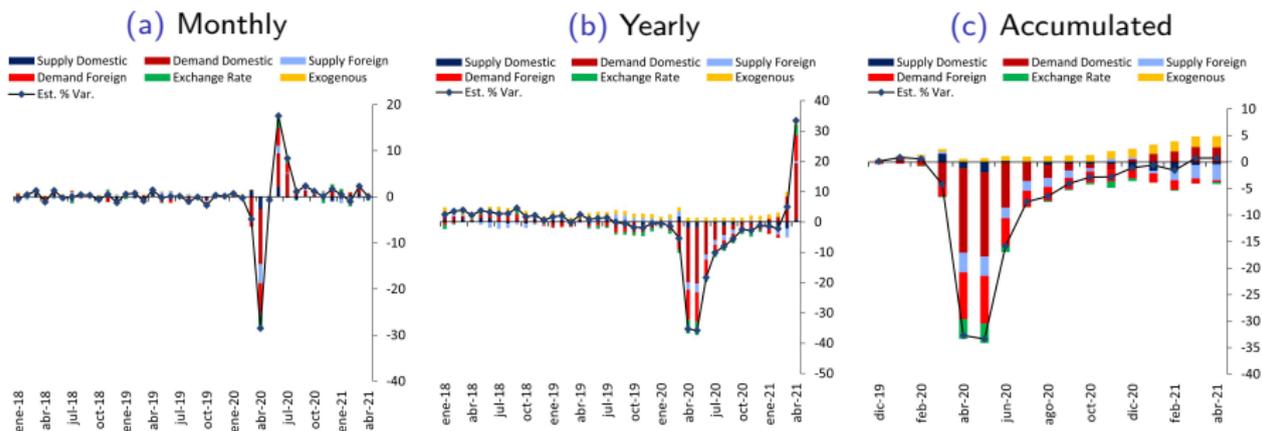
Source: Elaboration by Banco de México. X-axis includes global activity (IGAE) and sectors (coded).

Baseline Model: Manufacturing Results

- As in the case of the whole economy, in the case of the manufacturing sector external demand and supply factors together with exchange rate shocks play an important role in the dynamic of the sector.
- However, unlike the whole economy since the end of 2020 both domestic and external supply factors have contributed negatively to the variation of production.
- Moreover, since the beginning of 2021 domestic demand is one of the main drivers of the recovery of the sector.
- External factors seem to be very important among manufacturing sub-sectors, especially those more export intensive such as transportation equipment (336), computers and electronics (334) and electrical equipment (335).
- During April 2021 foreign supply factors are still a determinant of the slow recovery of most of the manufacturing sub-sectors.

Baseline Model: Manufacturing

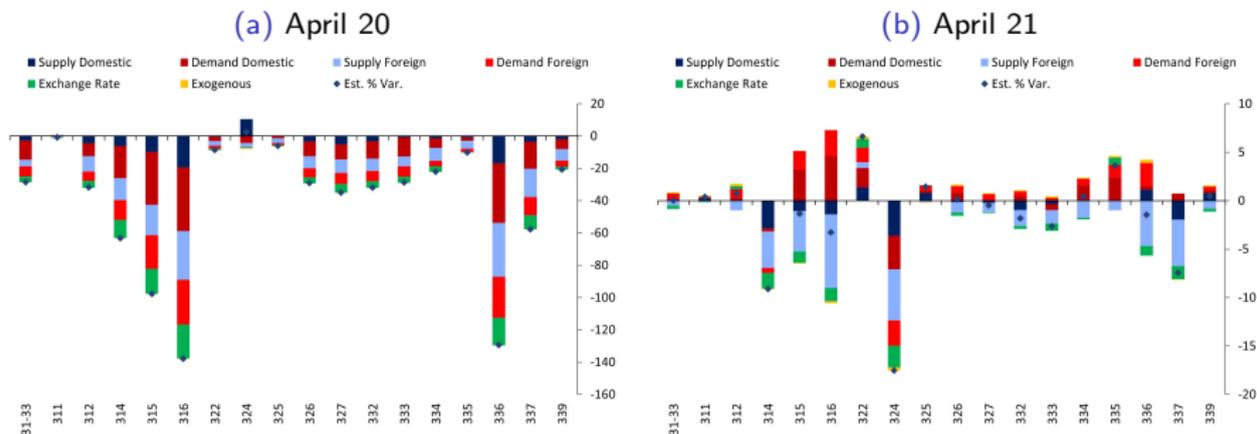
31-33: Manufactures. Historical Decomposition % Var.



Source: Elaboration by Banco de México.

Baseline Model: Manufacturing by Sub-sector

Hist. Decomp. of Production, Monthly % Var. of Manufactures by Sub-sector



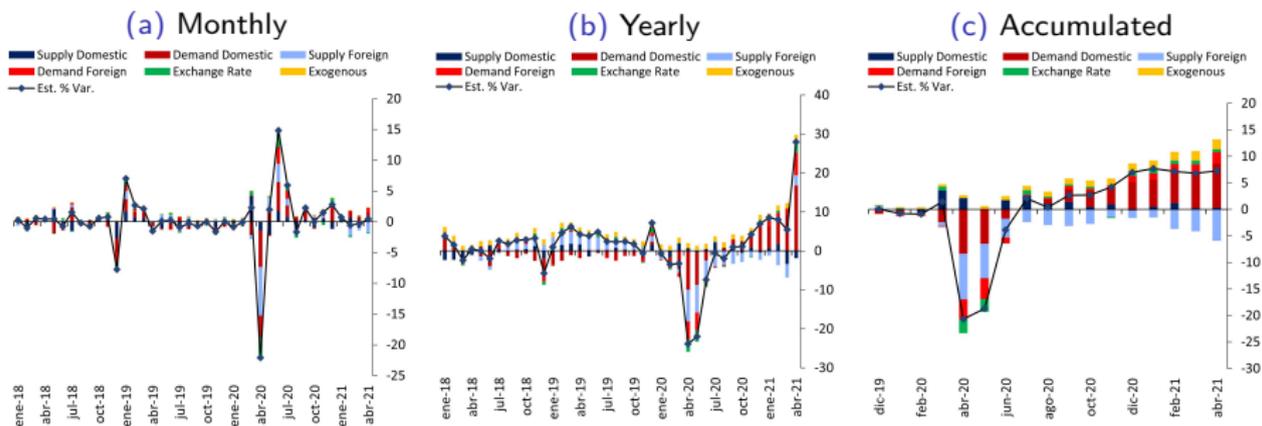
Source: Elaboration by Banco de México. X-axis includes manufacturing sector (31-33) and its sub-sectors (coded).

Baseline Model: Particular manufacturing and services

- Our estimates suggest that external supply factors have affected the transport equipment sector (336) more than the computers and electronics sector (334).
- It is also interesting to note that domestic demand, domestic supply and exchange rate shocks have positively contributed to the accumulated variation of the computers and electronics sector (334). In contrast, only domestic demand shocks seems to positively contribute to the accumulated variation of the transport equipment sector (336).
- In the case of services like Transport, mailing and media (48 49 51) and Lodging, restaurants and tourism (72) the dynamics of sectors seem to be driven by domestic demand.
- However, external demand and supply as well as exchange rate shocks seem to make a relevant contribution.

Historical Decomposition % Variation

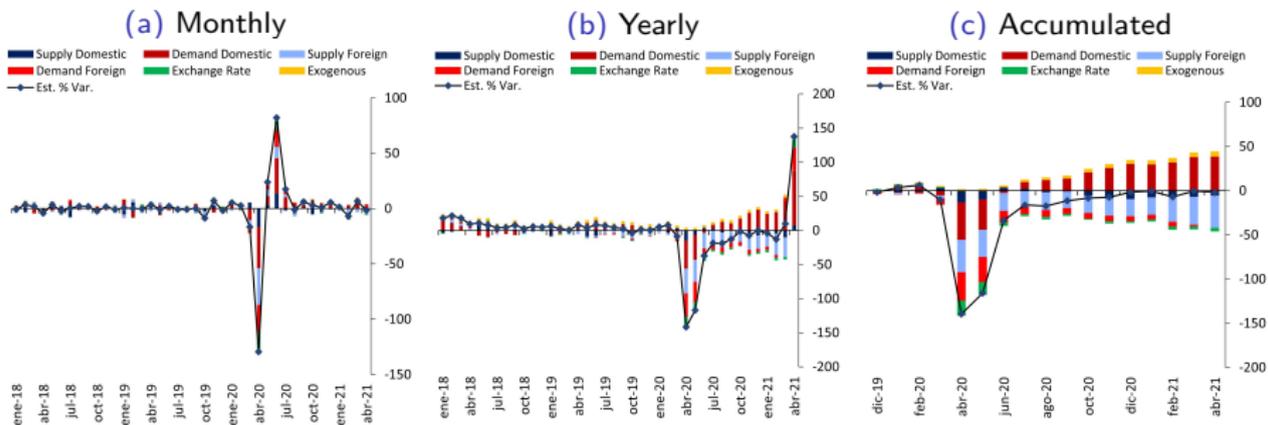
334: Computers, communication and other electronics



Source: Elaboration by Banco de México.

Historical Decomposition % Variation

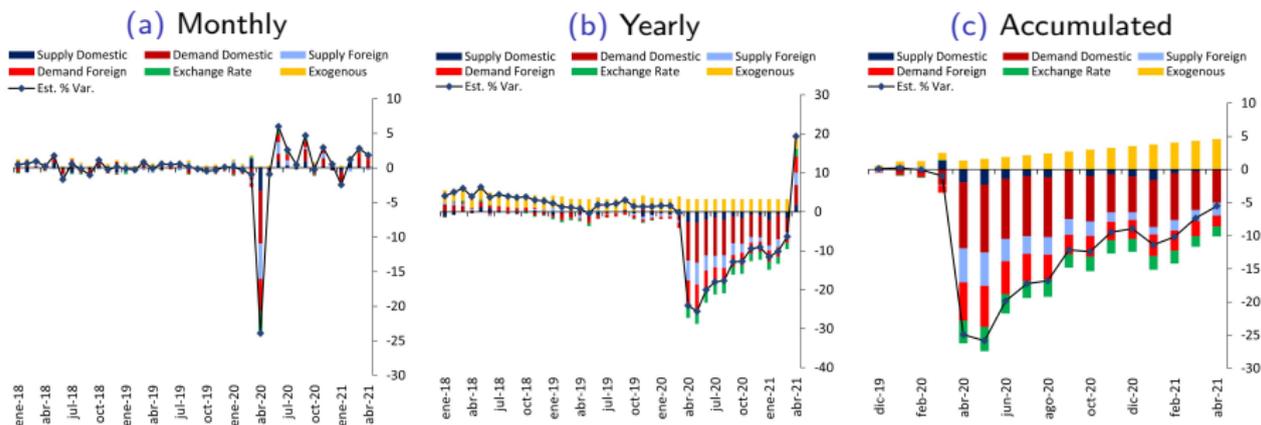
336: Transport equipment



Source: Elaboration by Banco de México.

Historical Decomposition % Variation

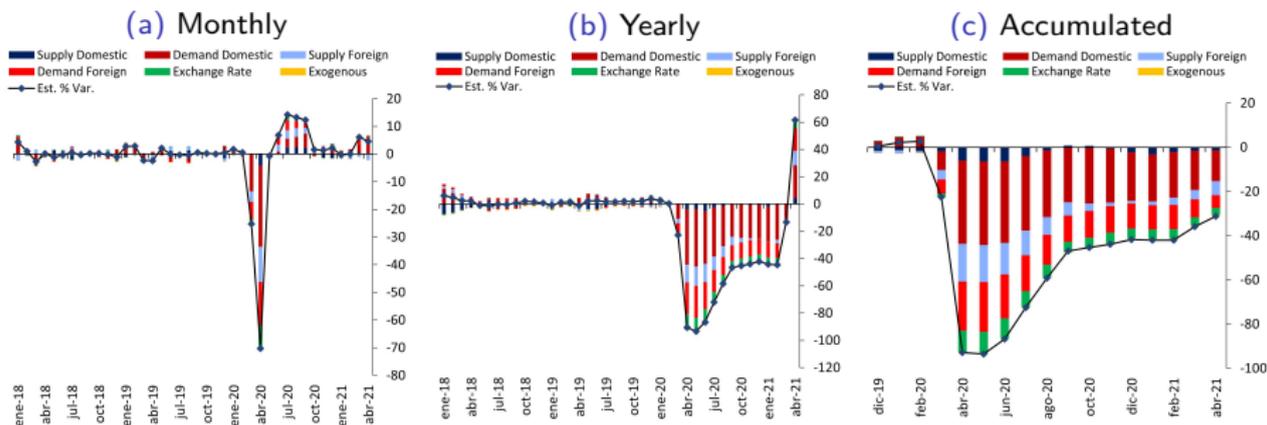
48 49 51: Transport, mailing and media



Source: Elaboration by Banco de México.

Historical Decomposition % Variation

72: Lodging, restaurants and tourism



Source: Elaboration by Banco de México.

Final considerations

- Our estimates suggest a great importance of external factors for identifying the shocks hitting the Mexican economy during the health emergency of COVID-19.
 - Estimates show, in general, that external shocks account for a significant share of the fluctuations in economic activity during the period of the pandemic.
 - This result is consistent with Mexico's role as a small and very open economy highly integrated into the global value chains.
- In the first wave, the drag and recovery of economic activity are explained by domestic and foreign factors.
 - Our results show that the demand shock was the main source for the initial contraction.
 - Estimates suggest that both external supply and demand conditions had greater relative incidence for the initial contraction than the domestic ones for several sectors.
- In the second wave, we find that external supply factors have contributed negatively to the variation of several sectors, particularly in manufacturing, while both domestic and external demand factors have, in general, contributed positively.

- Long-run restrictions (Blanchard and Quah, 1989).
- Robustness checks:
 - Low frequency data: Quarterly estimations.
 - Hours worked or employment as proxies of production.
 - Alternative priors (Baumeister and Hamilton, 2015). But we must recognize that Minnesota with optimization is adequate for Mexico, given that we do not have evidence of the type of prior distributions that can apply for each sector in Mexico.
 - Alternative measurements of prices: Producer Price Index (PPI); GDP deflator.
 - Alternative external controls: Exports and Imports; Global economic conditions index and international CPI.

References I

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Related literature

- Baumeister and Hamilton (2015):
 - They explain the prior beliefs that are implicit in sign-restricted VARs and proposed a general Bayesian framework that can be used to make optimal use of prior information.
 - In addition, they provide an application for measuring labor demand and supply shocks in the US.
- Brinca et al. (2020):
 - Similar to us, they measure labor demand and supply shocks at the sector level around the COVID-19 outbreak by estimating a BVAR of hours worked and real wages.
 - In contrast to them, we initially focus on the effects on quantities and prices, but then we extend it to consider the effects on labor.
- del Rio-Chanona et al. (2020):
 - They provide quantitative predictions of first-order supply and demand shocks for the US economy associated with the COVID-19 pandemic at the level of individual occupations and industries.
- Andersen et al. (2020):
 - They show that, as a result of the shutdown, aggregate spending dropped by around 25 percent in Sweden and by 4 additional percentage points in Denmark.

- Baqaee and Farhi (2021):
 - They study supply and demand shocks in a disaggregated model with multiple sectors, multiple factors, input-output linkages, downward nominal wage rigidities, credit-constraints, and a zero lower bound.
 - They show that negative sectoral supply shocks are stagflationary, whereas negative demand shocks are deflationary, even though both can cause Keynesian unemployment.
- Guerrieri et al. (2020):
 - They present a theory of Keynesian supply shocks: supply shocks that trigger changes in aggregate demand larger than the shocks themselves.
 - This implies that demand may indeed overreact to the supply shock and lead to a demand-deficient recession
- Eichenbaum et al. (2020):
 - They 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 chances of being infected. These decisions reduce the severity of the epidemic but exacerbate the size of the associated recession.

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Broader sector	Code	Definition
Primary	11	Agricultural
Secondary	21	Mining
Secondary	22	Energy generation
Secondary	23	Construction
Secondary	31-33	Manufacturing
Tertiary	43	Wholesale trade
Tertiary	46	Retail trade
Tertiary	48-49-51	Transport, mailing and 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	71-81	Cultural, sports and other leisure services
Tertiary	72	Lodging, restaurants and tourism

Manufacturing Sub-sectors

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	Transport equipment
337	Furniture, mattresses and blinds
339	Other manufacturing industries