Disruptions in Global Supply Chains and their Effects in Mexico's Regional Gross Output in the Context of the COVID-19 Pandemic*

June 2021

BANCO DE MÉXICO

I. Introduction

- **The first case of COVID-19 in Mexico was registered in February 27 of 2020, more than two months after it was first identified in China (November 17, 2019), and about a month later of the first case detected in the United States (January 21, 2020).**

- **As the virus spread around the world, there was an increasing number of countries implementing, at different times, temporary closures of economic activity, which in turn led to *disruptions in global supply chains* [Yu et al, 2021; Guan et al, 2020; Kejzar y Velic, 2020; Ferreira et al, 2020].**

- ***These disruptions could have affected, in turn, Mexican intermediate goods imports even before restrictions went into effect in April 1st of 2020. But how large they could have been? How sensitive are sectors and regions in Mexico to these shocks?***

I. Introduction: Motivation

- **Imports of Intermediate goods (MIG) from:**

    ✓ *China Feb-Mar 2020 vs Feb-Mar 2019: - 12%*

    ✓ *United States April 2020 vs April 2019: -43%*

    ✓ *European Union April 2020 vs April 2019: -19%*

Annual Variation of Mexico's Imports of Intermediate Goods

Total Intermediate Goods Imports
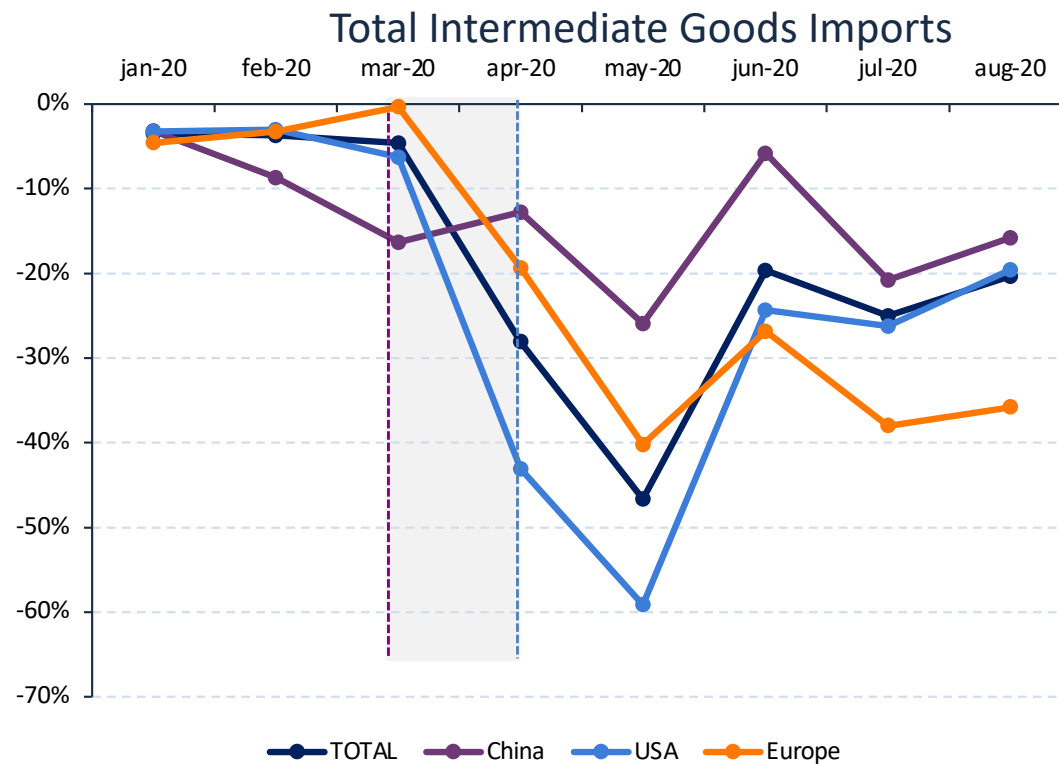
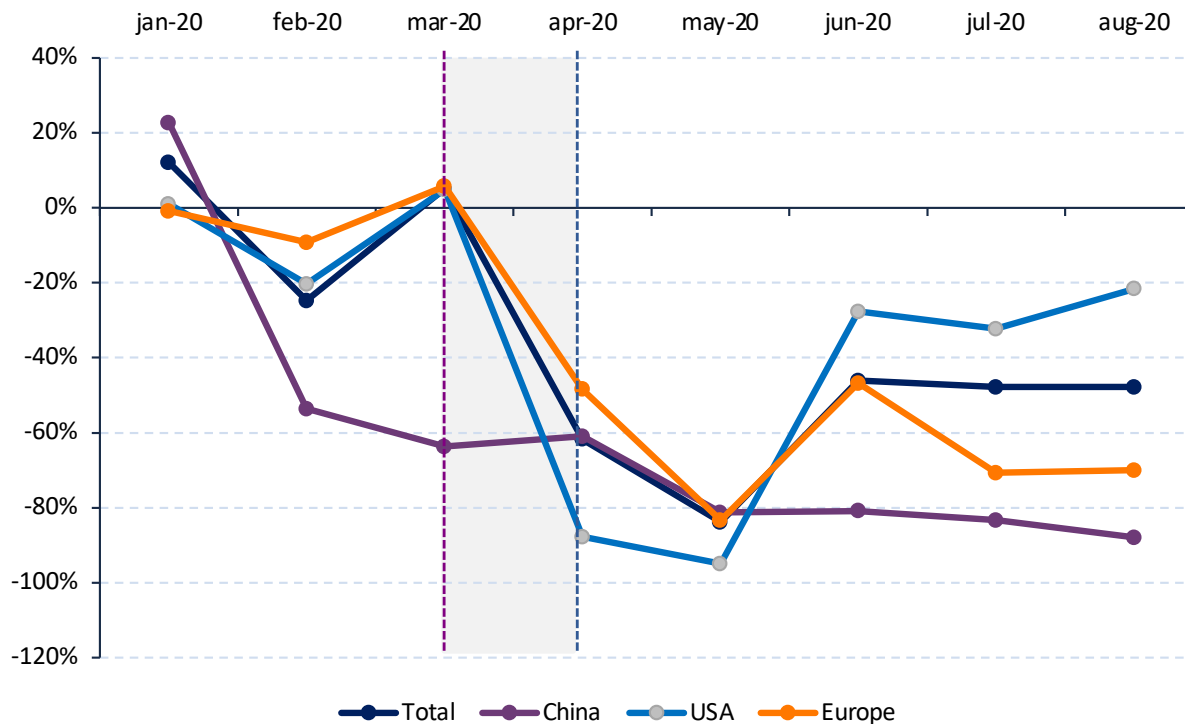Source: Banco de México

I. Introduction: Motivation

- **Imports of Motor vehicle parts from:**

  ✓ *China Feb-Mar 2020 vs Feb-Mar 2019: - 58%*
  ✓ *United States April 2020 vs April 2019: -88%*
  ✓ *European Union April 2020 vs April 2019: -48%*

Annual Variation of Mexico's Imports of Intermediate Goods

Motor Vehicle Parts Imports

Source: Banco de México

I. Introduction: Motivation

- We focus on how the *initial disruption* in the supply of MIG resulting from the pandemic, affected regional gross output in Mexico.

Regions

At least one Car Assembler

Source: Banco de México and Automotive News

Regional Manufacturing Production, 2019

|	Share of regional Manufacturing GDP in Total GDP of the region	Share of regional Manufacturing GDP in National Manufacturing GDP	Share of Regional Automotive Industry GDP in the National Automotive Industry GDP [1]
Northern	26.2	37.6	39.2
Central North	16.9	19.3	18.9
Central	14.4	34.4	41.8
Southern	8.5	8.8	0.08 [*]
National	16.7	100.00	100.00

Source: INEGI

[1] The estimated data for the automotive industry is based on INEGI's 2018 Economic Census. The other estimates use the 2019 National Accounts data.

[*] The Southern region has some Motor Vehicle Parts Manufacturing.

I. Introduction: Motivation

- We assume that disruptions in regional MIG in Mexico emerged from reductions in MIG from China, the United States and the European Union; and these disruptions interfered, in turn, with the regional output of other goods and services.

- The shock in Chinese MIG capture more closely a supply-side disruption. Those from the EU and the US may be capturing also demand side disruptions. However, we will treat the contractions in the latter also as supply side shocks.

Supply Shocks →

February (China)	March (China)	April (USA and EU)

Demand Shocks →

?
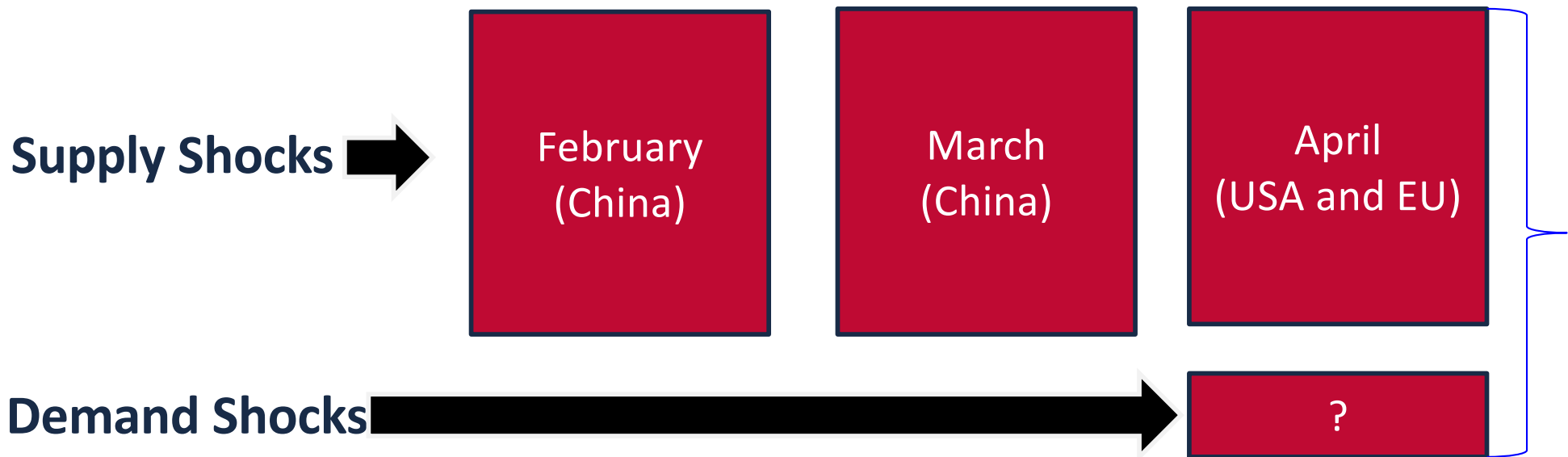
I. Introduction: Motivation

- A key aspect of our work has to do with estimating MIG at the regional level, as they are not available for the case of Mexico. We indicate ahead how we tackled this issue.

- We use Regional Input-Output Matrices to *derive the effects on Gross Output at the sectoral, regional and national levels in Mexico, which could have resulted from the supply shock in MIG due to the pandemic*.

I. **Introduction**

II. **Methodology**

III. **Identification of Supply Shocks in Imports of Intermediate Goods**

IV. **Results**

V. **Concluding Comments**

II. Methodology

- We use **the Ghosh Supply Model,** which proposes that **sector Gross Output in region R equals the sum of regional consumption of intermediate goods produced in such region,** plus value added, taxes, purchases of intermediate goods from other regions, and imports of intermediate goods:

- **For a regional economy with "n" goods, the above can be expressed in matrix notation as:**

> Intersectoral trade of goods and services within region R: B^R is the "allocation matrix", containing the proportions of sales of sector i to sector j

$$x^R = x^R B^R + v^R \qquad (1)$$

> Row vector of sectoral Gross Output in region R

> Row vector of value added, taxes, purchases of inputs to other regions, and imports of intermediate goods by sector in region R.

II. Methodology

- Solving (1) for x^R:

Row vector of sectoral imports of intermediate goods, in region R

$$x^R = v^R (I - B^R)^{-1}$$

(2)

Row vector of sectoral Gross Output in region R

Inverse Ghosh Matrix, with elements δ_{ij}^R which indicate the change in Gross Output of sector j in region R **given a unit change in** v_i^R.

δ_{ij}^R are known as the **input multipliers**.

III. Identification and Allocation of Supply Shocks in Imports of Intermediate Goods

■ Since **there is no data of MIG (v^R) by country at the state level**, two assumptions were made: (1) **The structure of MIG by country at the regional level equals the structure** of country imports at the **national level**:

1

$$MIG_i^{R,C} = \alpha_i^{N,C} * MIG_i^R \qquad (3)$$

MIG of sector *i* in region *R* from country *C*

Share of MIG from country *C* in national MIG

MIG of sector *i* in region *R*. Data obtained from Regional Input-Output Matrices
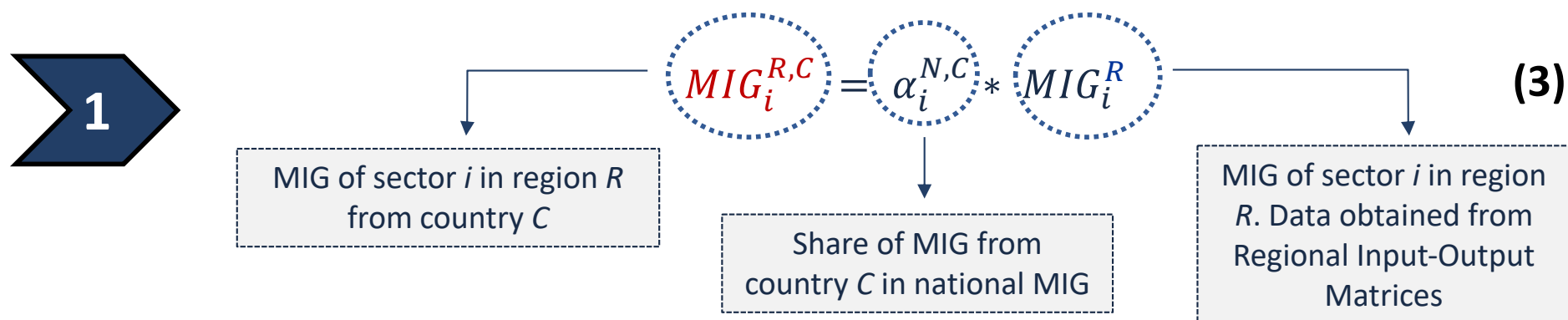
(2) Percentage changes in regional MIG of sector *i* from country "C" are equal to the percentage changes in MIG of sector *i* at the national level for each sector :
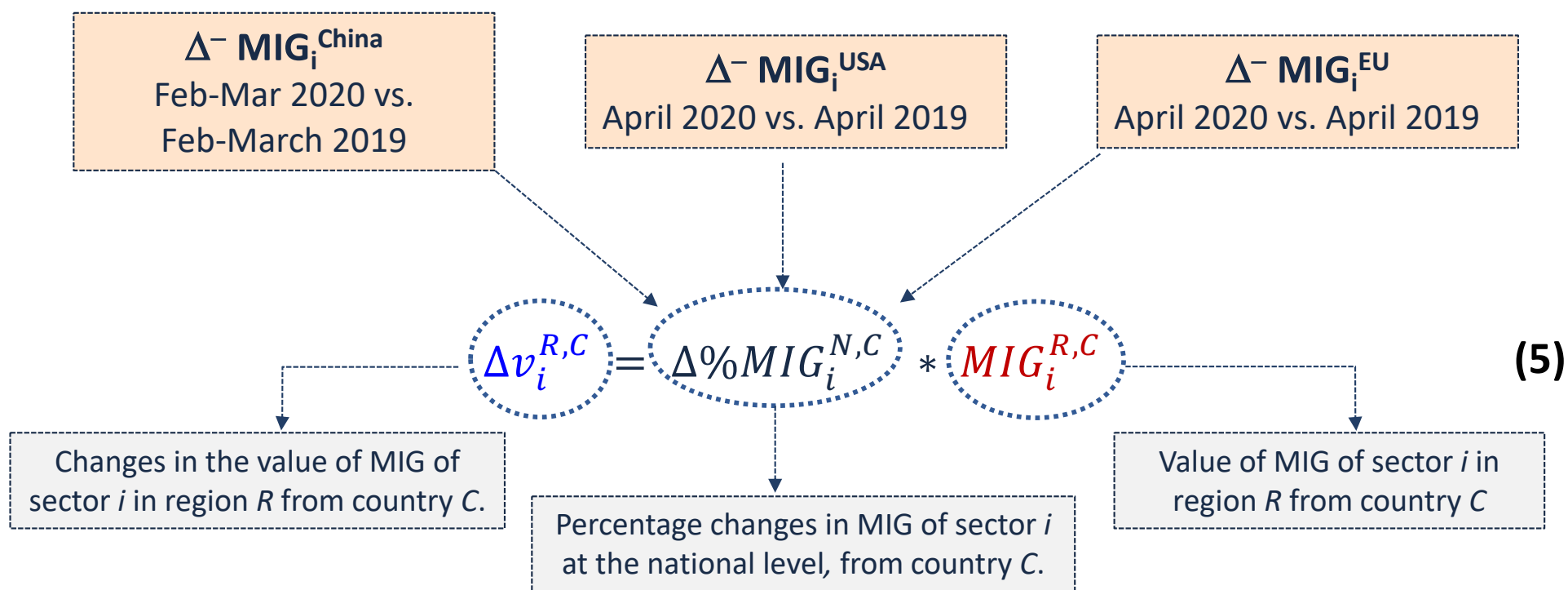
2

$$\Delta\% MIG_i^R = \Delta\% MIG_i^N \qquad (4)$$

III. Identification and Allocation of Supply Shocks in Imports of Intermediate Goods

- The previous assumptions and the use of the Regional Input-Output Matrices imply that **the effects in Gross Output stemming from the shock in MIG by sector and region depend on the structure of Gross Output according to how intensive is each region in the use of MIG by sector.**

III. Identification and Allocation of Supply Shocks in Imports of Intermediate Goods

■ The **initial "supply" shock** is defined as the contraction in MIG at the start of the pandemic, and **is given by** the three shocks :

Δ^- **MIG**$_i^{China}$
Feb-Mar 2020 vs. Feb-March 2019

Δ^- **MIG**$_i^{USA}$
April 2020 vs. April 2019

Δ^- **MIG**$_i^{EU}$
April 2020 vs. April 2019

$$\Delta v_i^{R,C} = \Delta\% MIG_i^{N,C} * MIG_i^{R,C}$$

(5)

Changes in the value of MIG of sector *i* in region *R* from country *C*.

Percentage changes in MIG of sector *i* at the national level, from country *C*.

Value of MIG of sector *i* in region *R* from country *C*

III. Identification and Allocation of Supply Shocks in Imports of Intermediate Goods

- Once the shock in monetary terms in the value of MIG is identified, we apply the Ghosh Matrix.

- The effects in Gross Output in sector j given a change in the value of MIG of sector i from country C ($\Delta x_{ij}^{R,C}$) are calculated as:

$$\Delta x_{ij}^{R,C} = \Delta v_i^{R,C} * \delta_{ij}^R \qquad \text{(6)}$$

III. Identification and Allocation of Supply Shocks in Imports of Intermediate Goods

■ The total effect in gross output of sector *j* as a result of the initial disruptions in the intermediate goods imports of all sectors from United States, China and the European Union in a given region is calculated as:

(7)
$$O_j^R = \sum_{C=1}^{3} \sum_{i=1}^{n} \Delta x_{ij}^{R,C}$$

Sum of the effects in sector *j*'s Gross Output due to the interruption in sector *i*'s supply of inputs from country *C*.

Total effect in sector *j*'s Gross Output in region *R* as a result of the initial interruption in the supply chains of all sectors that supply production inputs to sector *j*.

I. **Introduction**

II. **Methodology**

III. **Identification of Supply Shocks in Imports of Intermediate Goods**
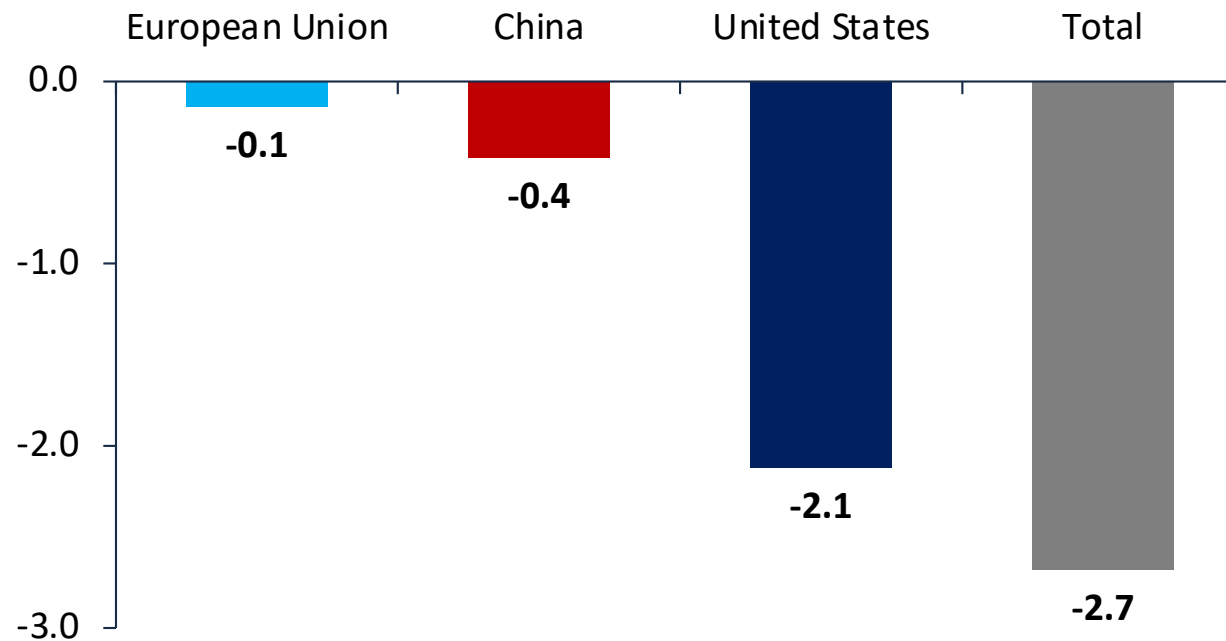
IV. **Results**

V. **Concluding Comments**

IV. Results

Graph 1

Contributions of Disruptions in the Supply Chains of China, the European Union and United States to México's Gross Output Contraction
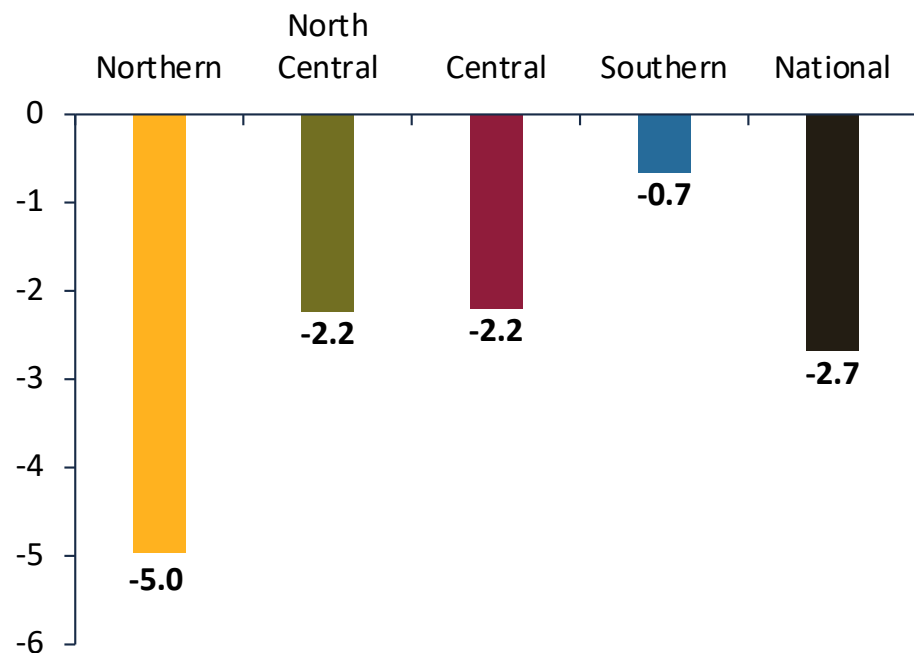
Percentage points

Source: Own estimates.

IV. Results

Graph 2

Estimated Fall in Regional's Gross Output due to the Contraction in Intermediate Goods Imports at the Beginning of the Pandemic

Percentage points

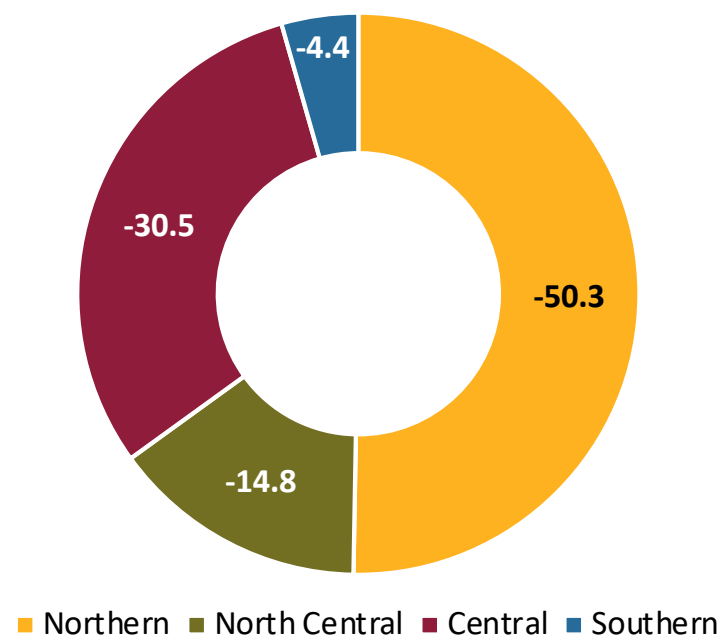
Source: Own estimates.

Graph 3

Regional Contribution to the Estimated Decrease in Domestic Gross Output Due to the Contraction in Intermediate Goods Imports at the Beginning of the Pandemic
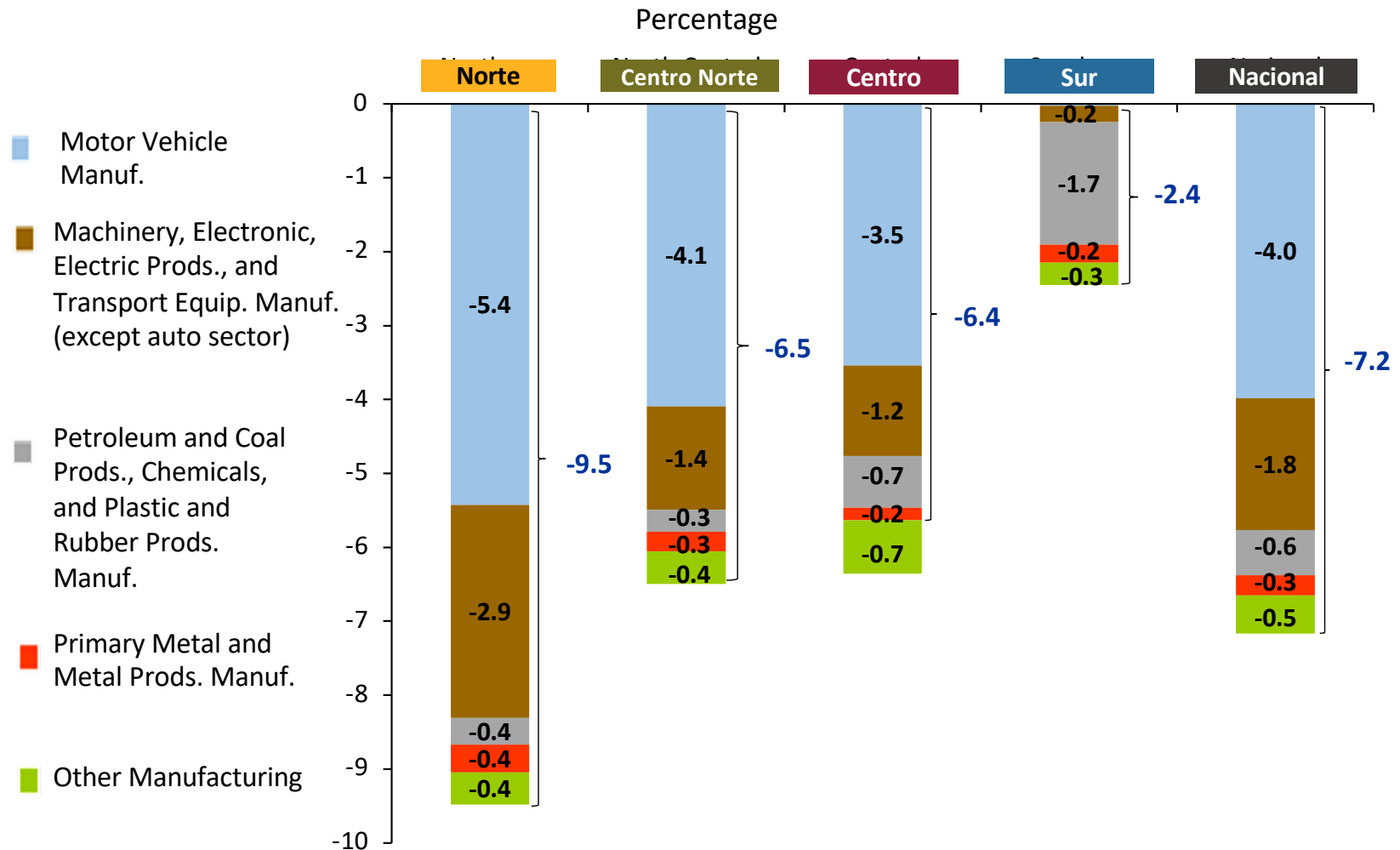
Percentage

Source: Own estimates.

IV. Results

Graph 4

Sector Contribution to the Estimated Contraction in Manufacturing Gross Output due to the Contraction in Intermediate Goods Imports at the Beginning of the Pandemic

Percentage

Legend:
- Motor Vehicle Manuf.
- Machinery, Electronic, Electric Prods., and Transport Equip. Manuf. (except auto sector)
- Petroleum and Coal Prods., Chemicals, and Plastic and Rubber Prods. Manuf.
- Primary Metal and Metal Prods. Manuf.
- Other Manufacturing

Categories: Norte | Centro Norte | Centro | Sur | Nacional

Norte (-9.5): -5.4, -2.9, -0.4, -0.4, -0.4
Centro Norte (-6.5): -4.1, -1.4, -0.3, -0.3, -0.4
Centro (-6.4): -3.5, -1.2, -0.7, -0.2, -0.7
Sur (-2.4): -0.2, -1.7, -0.2, -0.3
Nacional (-7.2): -4.0, -1.8, -0.6, -0.3, -0.5

Source: Own estimates.

V. Final Comments

- We identified **heterogeneous regional effects of MIG shocks due to the initial transmission channel of the sanitary crisis.**

- **The Northern region was the most affected**, and the Southern the least.

- **The manufacturing sector showed, in turn, the largest contraction, particularly, Motor vehicle manufacturing.**

- **In the South, the largest relative effect was estimated in the Oil and carbon derivatives, chemistry, and plastic and rubber.**

- **These results imply that current global supply chains disruptions such as international logistic problems and microchips shortages, in the context of the COVID-19 pandemic, may be inducing heterogeneous responses in regional economic activity.**

V. Final Comments

- **It must be kept in mind that for our shocks to capture disruptions in supply chains, we assume that they are not being influenced by demand side effects, something that may not be the case,** particularly in the case of the US and the European Union.

- **Hence, these results should be viewed as an estimate of a shock on economic activity that could have emerged as a consequence of the strong contraction in imports of intermediate goods, beyond that of other effects that may have had a preponderant role on output.**

- **Additionally, these results emerge from a model which implies that:**
    - ✓ *The Leontief coefficients may vary arbitrarily*
    - ✓ *Value added is assumed fixed*
    - ✓ *Changes in final demand lead to changes in gross output, which in turn modify the allocation matrix.*
    - ✓ *The economy retains the 2013 regional economic structure, as captured in the Regional Input-Output Matrices estimated by Banco de Mexico.*

VI. Additional comments

■ In the previous presentation, we received some interesting feedback on the estimates presented here:

1. Find amplified effects since the disruptions in global chains are a common worldwide shock.

   ➢ *To consider shocks on other economies, we require a world input-output matrix, since this captures all trading relations between countries by sector. However, since we are interested in the effects in the Mexican regions, we consider shocks that may have affected the Mexican economy.*

2. Fluctuations in the real exchange rate may have triggered some demand effects.

   ➢ *Although the shocks on supply could be contaminated by shocks on demand, mainly in the case of the US and the EU given real exchange rate fluctuations, we think these effects are being softened since the value of imports of intermediate goods, measured in US dollars, were transformed to constant Mexican pesos using the averages of the FIX exchange rate and the GDP price deflator.*

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Table 1
Intermediate Goods Imports by Sector and Country of Origin
Annual percentage change

Sector	April 2020 vs. April 2019		Feb-Mar 2020 vs. Feb-Mar 2019
	United States	European Union	China
Mining (except Oil and Gas)	-	-	-27.9
Electric Power Generation, Transmission and Distrib.	-53.2	-	-
Textile Mills and Textile Product Mills	-46.2	-26.3	-30.7
Apparel and Leather and Allied Product Manufacturing	-73.8	-41.7	-
Wood Produc Manufacturing	-33.6	-26.6	-28.0
Paper Manufact / Printing and Related Support Activities	-18.7	-2.0	-5.0
Petroleum and Coal Products, Chemicals, and Plastic and Rubber Prods.	-39.8	-7.9	-19.0
Nonmetallic Mineral Product Manufacturing	-43.9	-16.5	-18.4
Primary Metal and Metal Product Manufacturing	-39.7	-22.2	-14.9
Mach., Electron., Electric Prods, and Transp. Equip. (except Motor Vehicle Parts)	-56.6	-26.8	-8.9
Motor Vehicle Parts Manufacturing	-87.8	-48.4	-58.4
Furniture and Related Product Manufacturing	-55.5	-28.8	-26.0
Miscellaneous Manufacturing	-27.5	-15.8	-42.1

Note: Empty spaces indicate the sector did not have any effet or had an increase in imports of intermediate goods in the period analyzed. To classify by SCIAN sectors, the TIGIE-SCIAN 2019 Correlation Table from INEGI was used.

Source: Prepared by Banco de México with data from SAT, SE, Banco de México, INEGI. Commercial Balance of Goods of Mexico. SNIEG. Information of National Interest.