Allocative Efficiency during a Sudden Stop*

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Abstract

Production and total factor productivity (TFP) fall dramatically during sudden stop episodes. This paper shows that reallocation of resources can explain a significant share of observed decline in TFP. The key mechanism explored in this paper is the reallocation of resources from domestic-oriented activities to export-oriented activities. Due to a combination of differences in market power and tax treatment, export-oriented activities have smaller distortions. Therefore, a sudden stop causes a decline in TFP by shifting resources from high-distortion to low-distortion activities. Leveraging detailed microdata from Mexico, I provide new empirical evidence demonstrating the difference in distortions and reallocations of resources at the plant–product–destination level during the 1994 Mexican sudden stop. To evaluate how these empirical observations impact allocative efficiency and TFP, I develop a stylized model of a sudden stop and provide a sufficient statistics formula for the change in allocative efficiency up to the second order. By utilizing the sufficient statistics formula, I demonstrate the quantitative importance of both first-order and second-order terms. Last, I construct a multisector small open economy model and show that about 50% of the decline in value added in the manufacturing sector can be explained by reallocation effects.

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1. Introduction

A sudden stop is characterized by three empirical patterns: (i) reversals of international capital flows, reflected in sudden increases in net exports and the current account, (ii) declines in production, and (iii) corrections in asset prices. The growth accounting exercise shows that the reduction in TFP, as measured by the Solow residual, accounts for a large portion of the overall reduction in output. For example, during the 1994 Mexican sudden stop, aggregate TFP declined by 5.7%, and aggregate real GDP declined by 6.1%. In the manufacturing sector, TFP declined by 4.5%, and real value-added decreased by 5.2%.

This paper shows that reallocation of resources can explain a significant share of observed TFP decline. The central hypothesis of this paper is as follows: During a sudden stop, there is a reallocation of resources from domestic-oriented activities toward export-oriented activities. Due to market power and tax reasons, export-oriented activities have smaller distortions (gaps between price and marginal cost) than domestic-oriented activities. Therefore, sudden stop causes a decline in TFP by shifting resources from high-distortion activities to low-distortion activities. Given the same production technology, activities with higher distortion generate higher value added because larger tax payments and higher profits which are the sources of the higher distortion contribute to the increase in value added. Reallocations of resources away from high-distortion activities toward low-distortion activities lower aggregate value added because of the composition effect and aggregate TFP declines given the supply of factors constant. Specifically, I focus on the following two reallocations of resources: (i) reallocation of resources toward product lines for foreign markets at the plant–product level, and (ii) reallocation of resources toward *maquiladoras* that are specialized export plants enjoying various tax benefits.

To test this hypothesis, I exploit a novel detailed microdata to establish the following empirical facts on the Mexican sudden stop. First, prior to the sudden stop, unit values in foreign markets were on average 11% lower than those in the domestic market, while there was no clear difference in unit values during the sudden stop. In most cases, observing unit values across different markets is difficult because the unit measurement for products varies between the markets. However, in the construction of my dataset, plants were asked to adjust their product units for equivalence across the two markets. This ensures that the unit values can be compared across markets. Assuming uniform marginal costs across domestic and foreign markets at the plant–product level, the differences in unit values across markets imply that the markups in foreign markets were on average 11% lower than in the domestic market before the sudden stop, and that there was no significant difference in markup levels during the sudden stop period.[1] The latter finding is important in the context of evaluating changes in allocative efficiency up to the second order, as will become evident.

Second, 34% of the increase in aggregate export share during the sudden stop is explained by the expansion of sales in foreign markets at the plant–product level. My decomposition analysis reveals that the extensive margin at the firm and product levels plays a relatively minor role in this context. Applying a difference-in-difference analysis, I show that the quantity of production for foreign markets increased by 60% more than that for domestic markets during the sudden stop. This disparity in relative quantities of production triggered a plant–product-level reallocation of inputs toward product lines for foreign markets. Since product lines for foreign markets face lower distortions before the sudden stop, this reallocation of inputs toward them worsens allocative efficiency and reduces TFP.

Third, the relative expansion of maquiladoras, which are export-oriented plants benefiting from special tax incentives, accounts for 40% of the increase in aggregate export share during the sudden stop. Furthermore, applying a difference-in-difference analysis, I show that the number of worker in maquiladoras increased by 20% more than that in non-maquiladoras during the sudden stop. These specialized exporting plants, leveraged by both U.S. and foreign firms, serve as important hubs for assembling foreign intermediate inputs into final output products, utilizing Mexico's cost-effective labor force. Significantly, maquiladoras enjoy a range of advantageous tax treatments, including exemptions from tariffs when importing foreign intermediate inputs, full value added tax (VAT) exemptions, and exemption from corporate income taxes.

It is important to highlight that the production structure of maquiladoras differs significantly from that of non-maquiladoras, the standard manufacturing plants. Maquiladoras allocate 77.2% of their expenditure to foreign intermediate inputs, in stark contrast to non-

[1] This estimate is consistent with the results in Blum et al. [2023] who find that, on average, markups are 15% lower in foreign destinations than in the domestic markets within the same firm, product, and year. Similar evidence is observed by Bughin [1996], Moreno and Rodríguez [2004], Jaumandreu and Yin [2017], and Kikkawa et al. [2019], all of whom demonstrate that foreign markups tend to be lower than their domestic counterparts.

maquiladoras, where this allocation is a mere 20.4%. Conversely, non-maquiladoras allocate 58.8% of their spending toward domestic intermediate inputs, while maquiladoras allocate 8.3% to these inputs. The production of domestic intermediate inputs involves purchasing various inputs from the domestic economy such as labor, capital, and foreign and domestic intermediate inputs, often entailing distortions such as those arising from market power and tax in each transaction. These distortions accumulate throughout the production process, resulting in the supply chain for domestic intermediate inputs facing more distortions than that for the foreign intermediate inputs used by maquiladoras. As a result, the relative expansion of maquiladoras with less distorted supply chain worsens allocative efficiency and contributes to the decline in TFP and GDP.

Motivated by these empirical facts, I build a model of resource reallocations during a sudden stop and provide a sufficient statistics formula for the change in allocative efficiency up to the second order at the inefficient equilibrium. As shown by Baqaee et al. [2021], up to the first order, allocative efficiency decreases when there is a reallocation of resources from ex ante high-distortion to low-distortion firms. Up to the second-order, the change in allocative efficiency depends not only ex ante distortions but also ex post distortions. This second-order term is important in the context of the sudden stop because my empirical analysis shows that markups for foreign markets were on average 11% lower than domestic markets before the sudden stop, while there was no difference in markups during the sudden stop. If ex post distortions get closer across firms, this leads to a more favorable situation in terms of resource allocation because the achieved resource allocation gets closer to the one under the planner's problem. Consequently, the second-order effect mitigates the deterioration of allocative efficiency in the context of the sudden stop. By utilizing the sufficient statistics formula, I quantify the importance of these first-order and second-order effects. Up to the second order, reallocation toward product lines for foreign markets decline TFP by 0.36% and reallocation toward maquiladoras reduces TFP by 3.5%. Reallocation toward maquiladoras is quantitatively most important to explain the decline in TFP.

While the sufficient statistic analysis is useful for understanding how observed reallocations of resources contribute to the decline in TFP, it remains silent on the underlying mechanisms driving this decline in TFP. Also the results from the sufficient statistics analysis reflects not only the sudden stop shock but also other shocks, such as a financial crisis shock and the introduction of North American Free trade Agreement (NAFTA) which took effect at the beginning of 1994. Additionally, existing models of a sudden stop such as Kehoe and Ruhl [2009] cannot match moments of macroeconomic variables as well as generate endogenous decline in TFP. To assess how a sudden stop shock explains the decline in TFP through reallocation effects and how a sudden stop shock changes relevant macroeconomic variables, I conduct a quantitative analysis within an open economy New Keynesian model incorporating features such as heterogeneous firms with different distortions, input–output linkages, and sticky prices. My quantitative simulations reveal that the resource reallocation can account for approximately 50% of the decline in value added in the manufacturing sector in Mexico. Furthermore, considering changes in TFP and value added only up to the first order can result in an overestimation of the decline in TFP and value added. This also clarifies the significance of the second-order terms.

Related Literature

Using aggregate macro-level data, Meza and Quintin [2007], Kehoe and Ruhl [2009] and Mendoza [2010] investigate the dynamics of the 1994 Mexican sudden stop through the lens of dynamic stochastic general equilibrium (DSGE) models. Meza and Quintin [2007] and Kehoe and Ruhl [2009] focus on the role of capacity utilization. However, when attempting to fully account for the decline in TFP due to capacity utilization, their models fall short in matching crucial aggregate variables such as the trade balance and real exchange rate. Kehoe and Ruhl [2009] and Mendoza [2010] conclude that elucidating the mechanism behind the endogenous decline in TFP during the sudden stop remains an open research question. In my paper, I contribute to addressing this question by focusing on reallocations of resources utilizing the firm–product–destination-level microdata. Additionally, I shed light on maquiladoras, an important sector in Mexico often overlooked in TFP analysis.

Gopinath and Neiman [2014] consider the 2000 Argentina sudden stop, where the reduction in imported intermediate inputs of 70% provides a compelling rationale for the substantial decline in TFP. However, when we examine the 1994 Mexican sudden stop, the import of foreign intermediate inputs decreased by only a marginal 0.1%.[2] Consequently, attributing the decline in TFP in Mexico solely to the downturn in foreign intermediate

[2]See Figure C.1 in Appendix C.

inputs is an inadequate explanation. Sandleris and Wright [2014] focus on resource reallocation during the 2000 Argentina crisis using firm-level data. My research differs from theirs in several ways. First, I identify the specific types of firms and products that expanded or contracted relative to others during the sudden stop. Additionally, I pinpoint the wedge differences across firms and products. Moreover, I take into account the change in TFP up to the second order at the inefficient equilibrium, deepening the level of analysis relative to their paper's consideration of the change in TFP up to only the first order.

Castillo-Martınez [2018] explores the impact of a sudden stop on average TFPQ across various exchange rate regimes. However, the main focus of my paper is not average TFPQ but aggregate TFP in the context of growth accounting, a metric directly relevant to changes in real GDP. Blaum [2019] considers how the 1994 Mexican sudden stop affected the aggregate share of foreign intermediate inputs, focusing on resource reallocation toward import-intensive firms. My paper complements this paper by leveraging firm–product–destination-level data to provide new empirical insights.[3] Additionally, I shed light on the critical role of maquiladoras, a sector overlooked in this paper.

Baqaee and Farhi [2020] extend Hulten's theorem to distorted economies with disaggregated and interconnected production structures, offering a sufficient statistics formula for the change in TFP and real GDP. They show that the change in TFP can be decomposed into two crucial factors: the mechanical effect stemming from shifts in technology and the endogenous adjustments in allocative efficiency due to resource reallocation. Baqaee and Farhi [2019] extends Baqaee and Farhi [2020] in the context of open economies. The sufficient statistics formula used in my analysis is based on Baqaee and Farhi [2019]. Building on this sequence of papers, my paper empirically and quantitatively evaluates how important resource reallocation is in the context of a sudden stop. Furthermore, my paper emphasizes the importance of the second-order term of the change in allocative efficiency under a large shock such as a sudden stop shock.

My paper intersects with a body of literature exploring cross-sectional misallocation, in-

[3] To assess the impact of NAFTA on prices and competition, Kikkawa et al. [2019] employ the same firm–product–destination dataset as I do. Their primary focus lies in the long-term implications of NAFTA, and they do not specifically investigate the 1994 sudden stop. Leveraging unit value data across destinations, they also observe that markups in foreign markets are lower than those in domestic markets—a result that aligns with my findings. See Pratap and Urrutia [2004], Verhoogen [2008], Teshima [2008], and Meza et al. [2019] which employ firm-level microdata in Mexico. Note that these studies do not utilize the detailed product–destination–level dataset employed in my analysis.

cluding Hsieh and Klenow [2009], Restuccia and Rogerson [2008], and Edmond et al. [2023]. In the context of my quantitative analysis in response to a sudden stop shock, my research aligns with Bianchi [2011], Schmitt-Grohé and Uribe [2016], Ottonello [2021], Coulibaly [2021], Cugat [2022], and Benguria et al. [2022]. While previous studies have explored the significance of maquiladoras in labor markets and international trade, as exemplified by Feenstra and Hanson [1997], Hanson [2003], Burstein et al. [2008], Bergin et al. [2009], Utar and Ruiz [2013], and Estefan [2022], it is important to note that these studies do not address the impact of reallocation toward maquiladoras on TFP.

Outline

My paper is organized as follows. In Section 2, I present the empirical evidence illustrating the difference in distortions and resource reallocation at the plant–product–destination level. In Section 3, I measure the change in allocative efficiency from a sufficient statistics formula and develop a simple model of a sudden stop to characterize the underlying mechanism. In Section 4, I introduce the quantitative model to see the propagation effects of a sudden stop shock. In Section 5, I show the quantitative results. Finally, Section 6 concludes.

2. Empirical Analysis

This section provides new empirical evidence illustrating the difference in distortions and reallocations of resources at the plant–product–destination level during the 1994 Mexican sudden stop. First, I empirically show that export-oriented activities had lower distortions than domestic-oriented activities before the sudden stop. To be specific, I show that product lines for foreign markets had lower distortions than the ones for domestic markets at the plant–product level before the sudden stop. Additionally, I show that maquiladoras, specialized exporting plants, have less distorted supply chains than non-maquiladoras. Then, I illustrate that these export-oriented activities with lower distortions relatively expand by more than domestic-oriented activities during the sudden stop, which are expected to reduce TFP. The quantitative implications of these reallocations are explored in the subsequent sections.

2.1 Data

I use three surveys conducted and maintained by the Mexican Institute of Statistics and Geography (INEGI): the Monthly Industrial Survey (EIM), the Annual Industrial Survey (EIA), and Statistics on the Maquila Export Industry (EMIME). Both the EIM and the EIA categorize plants based on a unique 6-digit classification system aligned with the 1994 Mexican Classification of Activities and Products (CMAP94), which serves as a precursor to NAICS. Together, these surveys encompass a total of 206 6-digit classes within the manufacturing sector. The plants included in the EIA and EIM were purposefully selected to ensure comprehensive coverage, such that the samples encompass at least 85% of the value added within each class and all plants with more than 100 employees. As a result, my final sample of plants represents approximately 85% of the total value added in the manufacturing sector of Mexico.

The EIM provides monthly data pertaining to employment, the wage bill at the plant level, and detailed information on product quantities and sales values. Notably, it distinguishes between products designated for the domestic market and those intended for export—a distinctive feature of the EIM dataset. While the data do not specify export destinations, it is worth noting that Mexico's exports are predominantly directed to the United States, which was the destination of over 85% of total exports during the examined period. Given this concentration, I assume that all exported products are destined for the United States. The product data are disaggregated to the 8-digit level, which essentially represents individual product lines. This level of granularity allows calculation of unit values, which serve as a measure of prices. Another noteworthy feature of the EIM is its request that firms adjust their product units to ensure equivalence across domestic and foreign markets. This adjustment ensures that unit values can be accurately compared and evaluated across different markets, adding a valuable feature to the dataset.

The EIA provides annual, plant-level data encompassing a wide range of information, including inputs, total production, and details regarding plant operations. With the exception of quantities and sales data at the product level, the majority of the manufacturing plant data employed in my estimation is sourced from this survey. Specifically, I rely on the survey data related to domestic and foreign intermediate input expenditures, wage bills, total employment, capital, and export status.

Maquiladoras are manufacturing or assembly plants used by foreign companies to produce goods for export, utilizing Mexico's cost-effective labor force. Maquiladoras are often owned and operated by foreign companies, especially ones from the United States. When the maquiladora program began in 1965, maquiladoras were required to export 100% of their output. Although this requirement has gradually been loosened since 1989, maquiladora plants continue to export nearly all of their output.[4] The program allows tax-free temporary imports of raw materials from the U.S. and Canada for final assembly in Mexico and posterior export in the form of finalized products to their countries of origin. The program attracts manufacturing operations of foreign companies by offering full VAT exemptions, zero trade duties on the temporary input imports brought into the country, and simplification of administrative procedures, together with the infrastructure needed to support the companies' opening of new industrial parks or operation of existing manufacturing plants.

In 1994, the sales share of maquiladoras was 28.8%, and maquiladoras contributed 43.1% of the country's total exports and 52.7% of manufacturing exports.

The EMIME survey includes detailed plant-level information about maquiladoras at monthly frequency. I use the number of workers, wage bills, foreign intermediate input usage, domestic intermediate input usage, and value added.

2.2 Unit Values across Domestic and Foreign Markets

I conduct a comparative analysis of unit values in both the domestic and foreign markets. In most cases, the unit measurement for products varies between these markets. However, the EIM asks each firm to adjust its product units for equivalence across the two markets. This ensures that the unit values can be compared across markets. The foreign unit value is measured by dividing the free-on-board export value in Mexican pesos by the corresponding export quantity. On the other hand, the domestic unit value is measured by dividing the sales value charged to customers by the corresponding quantity, with the exclusion of the value added tax. Unit values are measured on a quarterly basis. My empirical specification takes the following form:

$$\log p_{i,j,d,t} = \alpha_{i,j,t} + \beta \times \mathbf{1}_{\{i,j,d \in \text{Foreign},t\}} + \epsilon_{i,j,d,t} \tag{2.1}$$

[4] Verhoogen [2008] notes that these maquiladoras tend to sell less than 5% of their products within the domestic market.

where i is the plant index, j is the product index, d is the destination index, and t is the time index. The term $\alpha_{i,j,t}$ is the plant–product–time fixed effect, and $\mathbf{1}_{\{i,j,d \in \text{Foreign},t\}}$ is a dummy variable that takes 1 if a product j produced by plant i at time t is sold in foreign markets. With the inclusion of plant–product–time fixed effects, my analysis compares the unit values between the domestic and foreign markets at the plant–product level within the same time frame. The standard errors are clustered at the plant–product level.

Table 1 reports estimates of β for different time periods and weighting schemes. For the year 1994, prior to the sudden stop, the estimates of β consistently fall within the range of -0.11 to -0.13 with high statistical significance. This result suggests that, at the plant–product level, the unit values were, on average, 11% to 13% lower in foreign markets than in domestic markets prior to the sudden stop. Conversely, for the year 1995, during the sudden stop, the estimates of β are approximately -0.01 without statistical significance. This suggests no clear difference in unit values between domestic and foreign markets during the sudden stop. Last, for the year 1996, subsequent to the sudden stop, the estimates of β settle around -0.07 with high statistical significance. This implies that the unit values tended to be approximately 7% lower in foreign markets than in domestic markets after the sudden stop.

Assuming that the marginal cost of production is the same at the plant–product level across domestic and foreign markets, these disparities in unit values result in differences in markups across destinations. It is important to note that these numbers could be viewed as a conservative estimate representing the minimum discrepancy in markups between the two markets. Verhoogen [2008] highlights that exporting plants produce higher-quality products for foreign than for domestic markets. Higher-quality products require superior inputs, thereby elevating production costs. Consequently, the marginal cost of exported products is higher. If I consider the possibility of higher marginal cost for exports, the disparity in markups between foreign and domestic markets is further magnified.

My results are consistent with those of Blum et al. [2023] who use the Chilean manufacturing survey and customs data. Similar evidence is observed by Bughin [1996], Moreno and Rodríguez [2004], Jaumandreu and Yin [2017], and Kikkawa et al. [2019], all of whom demonstrate that foreign markups tend to be lower than their domestic counterparts.

	(i)	*(ii)*	*(iii)*	*(iv)*	*(v)*	*(vi)*
β	-0.129	-0.113	-0.0152	-0.008	-0.072	-0.071
	[0.014]	[0.013]	[0.011]	[0.011]	[0.010]	[0.010]
Plant—Product–Time Fixed Effect	✓	✓	✓	✓	✓	✓
Weighted by Sales		✓		✓		✓
Sample Period	1994	1994	1995	1995	1996	1996
Observations	14,042	14,042	16,198	16,198	19,028	19,028
Adjusted R^2	0.967	0.971	0.971	0.974	0.975	0.978

Table 2.1: Unit Values Difference between Domestic Markets and Foreign Markets

Notes: This table displays estimates of β in equation (2.1). The first and second column use the samples in 1994. The third and fourth column use the samples in 1995. The fifth and sixth column use the samples in 1996. In the first, third, and fifth column, β is estimated without incorporating weights, whereas the second, fourth, and sixth column use weights derived from sales data. These weights are based on sales value of each product within each market. Across all specifications, plant–product–time fixed effects are included and the standard errors are clustered at the plant–product level.

I summarize the findings as follows:

Fact 1. *At the plant–product level, prior to the sudden stop, unit values were, on average,* 11% *to* 13% *lower in foreign markets than in domestic markets. However, during the sudden stop, there was no clear difference in unit values. After the sudden stop, unit values in foreign markets were, on average,* 7% *lower.*

2.3 Distortions across Maquiladoras and Non-Maquiladoras

I compare the distortions faced by maquiladoras and non-maquiladoras. The specific distortions faced by maquiladoras are illustrated on the left side of Figure 2.1. Maquiladoras are exempt from paying tariffs on foreign intermediate inputs. They are subject to a 25% payroll tax on labor. When products produced by maquiladoras are exported, they are not subject to VAT charges. Additionally, if domestic intermediate good producers possess market power, maquiladoras face non–tax–related distortion when purchasing domestically produced intermediate inputs.

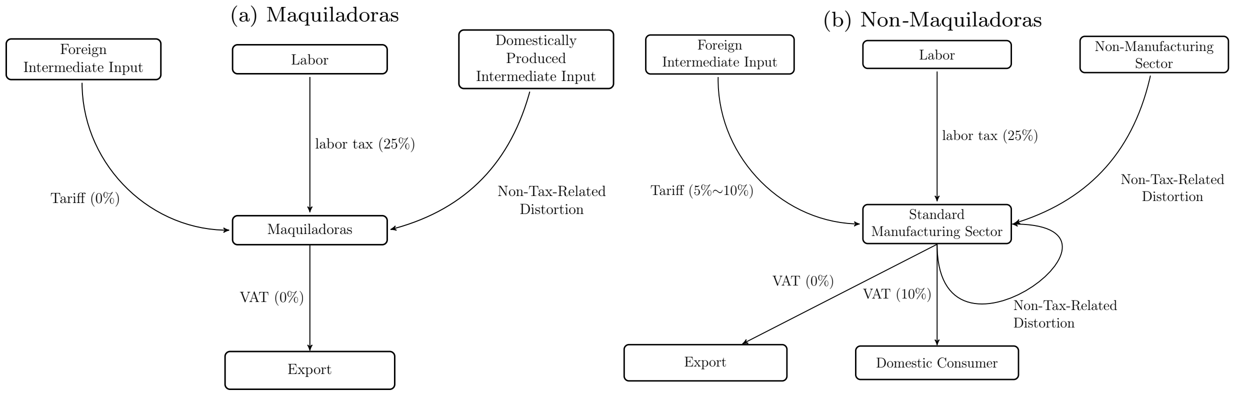

Figure 2.1: Distortions faced by Maquiladoras and Non-Maquiladoras

The expenditure share of maquiladoras for domestically produced intermediate inputs amounts to 8.3%. In contrast, the expenditure share of maquiladoras for foreign intermediate inputs amounts to 77.2%. This highlights that maquiladoras rely less on domestically produced intermediate inputs and have a stronger dependence on foreign intermediate inputs.

On the other hand, the distortions faced by standard producers (non-maquiladoras) are depicted on the right side of Figure 2.1. Standard producers are subject to tariffs, which are, on average, from 5% to 10% on foreign intermediate inputs. They also face a 25% payroll tax and a 10% VAT charge when selling goods to domestic consumers. However, when their products are exported, VAT is not applied. Similarly to maquiladoras, standard producers face non–tax–related distortions such as market power among domestic intermediate goods suppliers –when purchasing domestically produced intermediate inputs.

The expenditure share of standard producers for domestically produced intermediate inputs is considerably higher at 58.8% than that of maquiladoras. In contrast, the expenditure share of standard producers for foreign intermediate inputs amounts to 20.4%. This indicates that standard producers heavily rely on domestically produced intermediate inputs and have a weaker dependence on foreign intermediate inputs.

Production of domestic intermediate inputs involves purchasing various inputs from the domestic economy such as labor, capital, and foreign and domestic intermediate inputs, often entailing distortions such as market power and tax in each transaction. These distortions accumulate throughout the production process, resulting in the supply chain for domestic intermediate inputs facing more distortions than the supply chain for the foreign intermediate inputs used by maquiladoras.

I summarize the findings as follows:

Fact 2. *Maquiladoras have less distorted supply chains than non-maquiladoras.*

2.4 Decomposition of Aggregate Export Growth

During a sudden stop, export-oriented activities expand by more than domestic oriented-activities. This is because domestic aggregate demand shrinks during a sudden stop, while foreign aggregate demand is stable and the depreciation of the domestic nominal exchange is advantageous for export-oriented activities. In case of the 1994 Mexican sudden stop, aggregate manufacturing export as a fraction of aggregate manufacturing sales increased from 17.3% in 1994 to 27.2% in 1995. To understand which intensive or extensive margins contribute to this increase, and to unravel the underlying reallocations of resources, I consider the following three decompositions.

First, to see how the relative expansion by maquiladoras contribute to this increase in aggregate manufacturing export share, I decompose the change in the ratio of aggregate export to aggregate sales as follows:

$$\begin{aligned}
\underbrace{\Delta \frac{\text{Aggregate Export}}{\text{Aggregate Sales}}_{1994-1995}}_{9.9\%\,(=27.2\%-17.3\%)} &= \underbrace{\sum_{i\in\{\text{Maquiladoras,Non-Maquiladoras}\}} S_{i,1994}\left(E_{i,1995}-E_{i,1994}\right)}_{\text{Within Effect}\,(6.2\%)} \\
&+ \underbrace{\sum_{i\in\{\text{Maquiladoras,Non-Maquiladoras}\}} E_{i,1994}\left(S_{i,1995}-S_{i,1994}\right)}_{\text{Between Effect}\,(4.0\%)} \\
&+ \underbrace{\sum_{i\in\{\text{Maquiladoras,Non-Maquiladoras}\}} \left(E_{i,1995}-E_{i,1994}\right)\left(S_{i,1995}-S_{i,1994}\right)}_{\text{Covariance}\,(-0.3\%)}
\end{aligned}$$

where i is the sectoral index, $S_{i,t}$ is the total sales in sector i as a fraction of aggregate sales at time t, and $E_{i,t}$ is export as a fraction of total sales in sector i at time t. The first term is the within effect, fixing the sales share across maquiladoras and non-maquiladoras, thereby reflecting shifts in the export shares within sectors. The second term is the between effect, fixing the export share of each sector, thereby reflecting the compositional changes across maquiladoras and non-maquiladoras. The third term is the covariance term, which captures the contribution of sectors that experience expansion while altering their export shares.

The decomposition result shows that the within effect explains 62.6% and the between effect 40.4% of the change in export share. I have $E_{\text{Maquiladoras},1994} = E_{\text{Maquiladoras},1995} = 1$ by assumption; therefore, the within effect comes from the increase in export share within non-maquiladoras. The positive between effect suggests the potential for resource reallocation across maquiladoras and non-maquiladoras during the sudden stop. This finding, however, does not conclusively imply resource reallocation, as an increase in maquiladoras's sales share due to an increase in price given the quantities of sales could have a similar effect. To ascertain the extent of resource reallocation, I analyze inputs at the plant level. Before delving into this analysis, I decompose the change in export share within non-maquiladoras through microdata at the plant level.

I summarize our finding as follows:

Fact 3. *The compositional shift toward maquiladoras explains* 40.4% *of the increase in aggregate export shares. The increase in export share within non-maquiladoras explains the rest of the increase in aggregate export shares.*

Second, I consider the decomposition of the increases in the export share within non-maquiladoras. Aggregate non-maquiladoras export as a fraction of aggregate non-maquiladoras sales increased from 9.0% in 1994 to 15.9% in 1995. Within my microdata, it increased from 10.5% in 1994 to 20.1% in 1995. I evaluate what portion of this increase can be attributed to various factors, such as within-plant effects, between-plant effects, covariance effects, and plant entry into and exit from export status:

$$\underbrace{\Delta \frac{\text{Non-Maquiladoras Aggregate Export}}{\text{Non-Maquiladoras Aggregate Sales}}_{1994-1995}}_{9.6\%\,(=20.1\%-10.5\%)} = \underbrace{\sum_{i\in C} \frac{s_{i,1994}}{\sum_{i\in C} s_{i,1994}} (e_{i,1995} - e_{i,1994})}_{\text{Within Effect}\,(6.5\%)}$$
$$+ \underbrace{\sum_{i\in C} e_{i,1994} \left(\frac{s_{i,1995}}{\sum_{i\in C} s_{i,1995}} - \frac{s_{i,1994}}{\sum_{i\in C} s_{i,1994}} \right)}_{\text{Between Effect}\,(2.3\%)}$$
$$+ \underbrace{\left(\sum_{i\in N} s_{i,1995} e_{i,1995} - \frac{1 - \sum_{i\in C} s_{i,1995}}{\sum_{i\in C} s_{i,1995}} \sum_{i\in C} s_{i,1995} e_{i,1995} \right)}_{\text{Entry Effect}\ (-0.6\%)}$$

$$
+ \underbrace{\left(\frac{1 - \sum_{i \in C} s_{i,1994}}{\sum_{i \in C} s_{i,1994}} \sum_{i \in C} s_{i,1994} e_{i,1994} - \sum_{i \in E} s_{i,1994} e_{i,1994} \right)}_{\text{Exit Effect (0.7\%)}}
$$

$$
+ \underbrace{\sum_{i \in C} \left(\frac{s_{i,1995}}{\sum_{i \in C} s_{i,1995}} - \frac{s_{i,1994}}{\sum_{i \in C} s_{i,1994}} \right) (e_{i,1995} - e_{i,1994})}_{\text{Residual (0.7\%)}}
$$

where C is a set of plants whose export status did not change from 1994 to 1995, N is a set of plants that did not export in 1994 but started to export in 1995, and E is a set of plants that exported in 1994 but stopped exporting in 1995. $s_{i,t}$ is the share of total sales by plant i as a fraction of aggregate sales at time t, and $e_{i,t}$ is the share of export as a fraction of total sales by plant i at time t. The first term is the within effect, fixing the sales share across plants, thereby reflecting the changes in export share within plants. The second term is the between effect, fixing the export share of each plant, thereby reflecting the compositional changes across plants with different export shares. The third and fourth terms are the contribution from entrants into the export market and exits from the export market. The fifth term is the residual.

The decomposition results show that the within-plant increase in export share explains 67.7% and the between-plant reallocation 24.0% of the increase in export share. In addition, plant entries into or exists from export markets attribute only a small share of the change in export share.

I summarize my finding as follows:

Fact 4. *Within-plant expansion toward export markets explains* 67.7% *of the increase in export share among non-maquiladoras. Compositional change across plants with different export shares explains* 24.0% *of the increase in export share among non-maquiladoras.*

Last, I decompose the within-plant effect by using the plant–product–destination information. I decompose the within-plant effect as follows:

$$
\underbrace{\sum_{i \in C} \frac{s_{i,1994}}{\sum_{i \in C} s_{i,1994}} (e_{i,1995} - e_{i,1994})}_{\text{Within-Plant Effect (6.5\%)}} = \underbrace{\sum_{i \in C} \frac{s_{i,1994}}{\sum_{i \in C} s_{i,1994}} \sum_{p \in C^{i,P}} s_{i,p,1994} (e_{i,p,1995} - e_{i,p,1994})}_{\text{Within-Plant-Product Effect (5.3\%)}}
$$

$$+\underbrace{\sum_{i\in C}\frac{s_{i,1994}}{\sum_{i\in C}s_{i,1994}}\sum_{p\in C^{i,P}}e_{i,p,1994}\left(s_{i,p,1995}-s_{i,p,1994}\right)}_{\text{Within-Plant across Product Effect (0.8\%)}}$$

$$+\underbrace{\sum_{i\in C}\frac{s_{i,1994}}{\sum_{i\in C}s_{i,1994}}\left(\sum_{p\in N^{i,p}}s_{i,p,1995}e_{i,p,1995}-\sum_{p\in E^{i,p}}s_{i,p,1994}e_{i,p,1994}\right)}_{\text{Within-Plant Extensive Margin (0.4\%)}}$$

$$+\underbrace{\sum_{i\in C}\frac{s_{i,1994}}{\sum_{i\in C}s_{i,1994}}\sum_{p\in C^{i,P}}\left(s_{i,p,1995}-s_{i,p,1994}\right)\left(e_{i,p,1995}-e_{i,p,1994}\right)}_{\text{Within-Plant Residual (0.03\%)}}$$

where p is the product index, $s_{i,p,t}$ is the ratio of sales of product p by plant i as a fraction of total sales by plant i at time t, and $e_{i,p,t}$ is the ratio of export of product p by plant i as a fraction of total sales of product p by plant i. $C^{i,p}$ is a set of products that were available in both 1994 and 1995 in plant i. $N^{i,p}$ is a set of products that did not exist in 1994 but existed in 1995 in plant i. $E^{i,p}$ is a set of products that existed in 1994 but disappeared in 1995 in plant i. The sub-within effect measures changes at the within–plant–product level toward or away from foreign markets. The sub-between effect measures the contribution of compositional change in products with different export shares within plants. The sub-covariance measures the contribution of products that expanded and experienced a change in export share. The sub-extensive margin measures the contribution of newly added products or removed products.

This decomposition shows that the within–plant–product reallocation toward export markets explains 81.5% of the within-plant increase in export shares. The addition of products to or subtraction of products from export baskets explains a small fraction of the change in the within-plant increase in export shares.

Fact 5. *The sales expansion in foreign market within plant–product level explains* 81.5% *of the increase in export at the plant level.*

2.5 Quantity Expansion at the Plant–Product–Destination Level

The previous analysis shows that product lines for foreign markets have lower distortions than the ones for domestic markets. Furthermore, the preceding decomposition analysis reveals the importance of the sales expansion in foreign market within plant–product level.

A crucial factor in my assessing changes in allocative efficiency and TFP is whether I observe shifts in relative input usage among products for different destinations. When I detect a change in the relative quantity of sales among products across destinations, it implies a change in the relative utilization of inputs across destinations. To investigate whether there was a shift in the quantity of sales between domestic and foreign markets before and after the sudden stop, I employ a difference-in-differences strategy. If quantities of production for foreign markets with lower distortions relatively increase by more than the ones for domestic markets, this is expected to worsen the allocative efficiency and decline TFP.

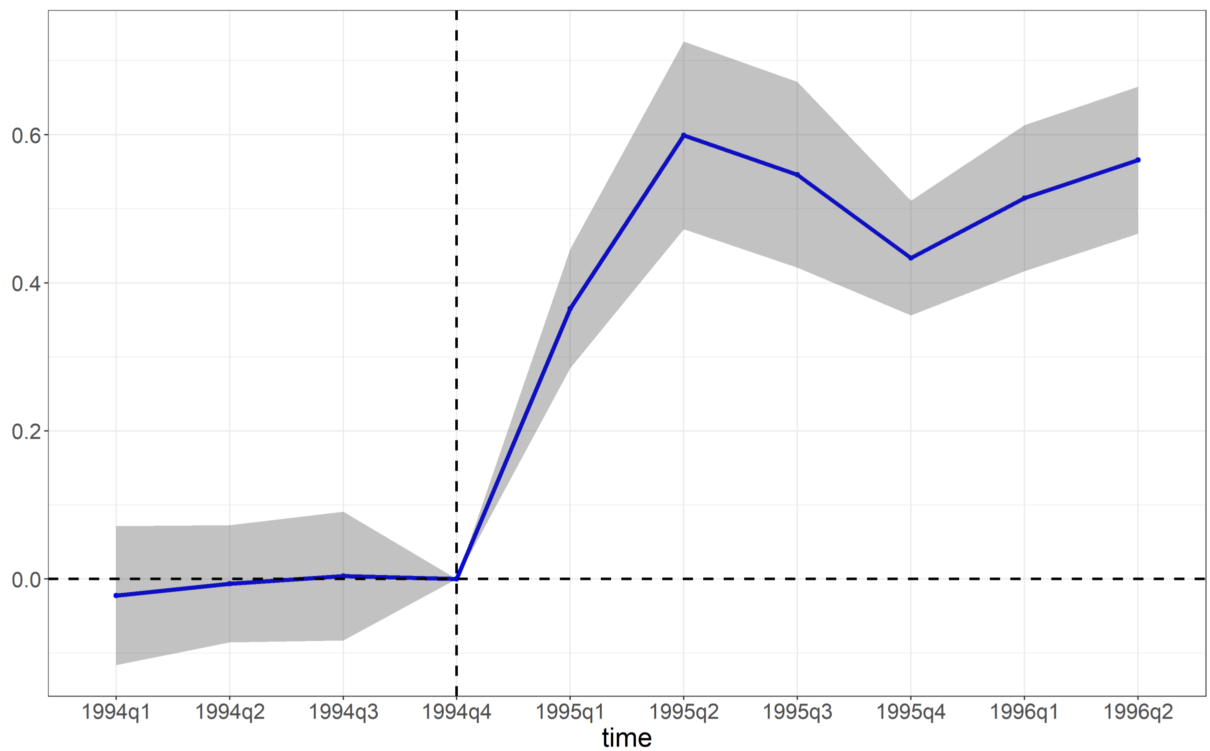

Figure 2.2: Changes in Quantity of Sales by Destination

Notes: This figure reports the event study graph, depicting the average effect of the sudden stop on the sales quantity of products. The dependent variable is expressed in logarithmic terms. The sudden stop occured in the fourth quarter of 1994. Each data point represents the coefficient on the interaction between being observed t quarters after the sudden stop and being exported to foreign markets. The confidence interval is at the 95% level.

I define $q_{i,j,d,t}$ as the quantity of sales of product j sold by plant i in destination d during period t. The period coinciding with the sudden stop, in this case, is denoted as $1994\,Q4$. I focus on products sold in both domestic and foreign markets prior to the sudden stop. I consider a panel regression of the form

$$\log\left(q_{i,j,d,t}\right) - \log\left(q_{i,j,d,1994\,Q4}\right) = \sum_{s\neq 1994\,Q4} \gamma_s \left(\mathbf{1}_{s=t}\cdot \mathbf{1}_{\{d\in\text{Foreign}\}}\right) + \alpha_{i,j,d} + \beta_{i,j,t} + \epsilon_{i,j,d,t}$$

over the period $t = 1994\,Q1, \cdots, 1996\,Q2$, where $\mathbf{1}_{s=t}$ is the time period indicator function, $\mathbf{1}_{\{d\in\text{Foreign}\}} = 1\,(=0)$ if the destination is foreign markets (domestic markets), $\alpha_{i,j,d}$ is the plant–product–destination fixed effect, and $\beta_{i,j,t}$ is the plant–product–time fixed effect. As the specification is in stacked differences, the fixed effects absorb not only the constant, but also plant–product–destination-level secular trends over the entire period. Standard errors are two-way clustered at the product and time level to account for any possible bias from serial correlation.

Figure 2.2 presents an event study graph illustrating the average effects of the sudden stop on sales quantity. It reports quarterly effects for products being exported to foreign markets before and after the sudden stop. In line with the absence of differential pretrends, I observe no effect in terms of products being exported to foreign markets before the sudden stop occurred. For the post–sudden stop period, I observe a substantially greater increase in the sales quantity in foreign markets than in the sales quantity in domestic markets. The average difference in sales quantity change reached approximately 60% by the second quarter of 1995.

Fact 6. *Following the sudden stop, the sales quantity in foreign markets increased by as much as* 60% *more than did that in domestic markets.*

2.6 Relative Expansion by Maquiladoras

The previous analysis shows that maquiladoras have less distorted supply chains than non-maquiladoras. Additionally, the previous decomposition analysis shows that the relative expansion of maquiladoras explains 40.4% of the increase in aggregate export share during the sudden stop in 1994. A crucial factor in my assessing changes in allocative efficiency and TFP is whether I observe shifts in relative input usage across maquiladoras and non-maquiladoras. If inputs of maquiladoras with less distorted supply chains relatively increase by more than the ones of non-maquiladoras, this is expected to worsen the allocative efficiency and decline TFP.

To measure the effect of the sudden stop on the relative usage of inputs across maquiladoras and non-maquiladoras, I estimate the following equation:

$$\log\left(L_{i,j,t}\right) - \log\left(L_{i,j,1994\,Q4}\right) = \alpha_j + \gamma_{i,t} + \sum_{s \neq 1994\,Q4} \psi_s \left(\mathbf{1}_{s=t} \cdot \text{Maquiladora Dummy}_{i,j}\right) + \epsilon_{i,j,t}$$

for the period $t = 1994\,Q1, \cdots, 1996\,Q2$, where $L_{i,j,t}$ is number of workers in plant j in industry i at time t, α_j is the plant fixed effect, $\gamma_{i,t}$ is the industry $\times$ time $\times$ region fixed effect, $\mathbf{1}_{s=t}$ is a time indicator function, and Maquiladora Dummy$_{i,j}$ is 1(0) if firm j in industry i is a maquiladora (non-maquiladora). Standard errors are two-way clustered at the industry and time level to account for any possible bias from serial correlation.

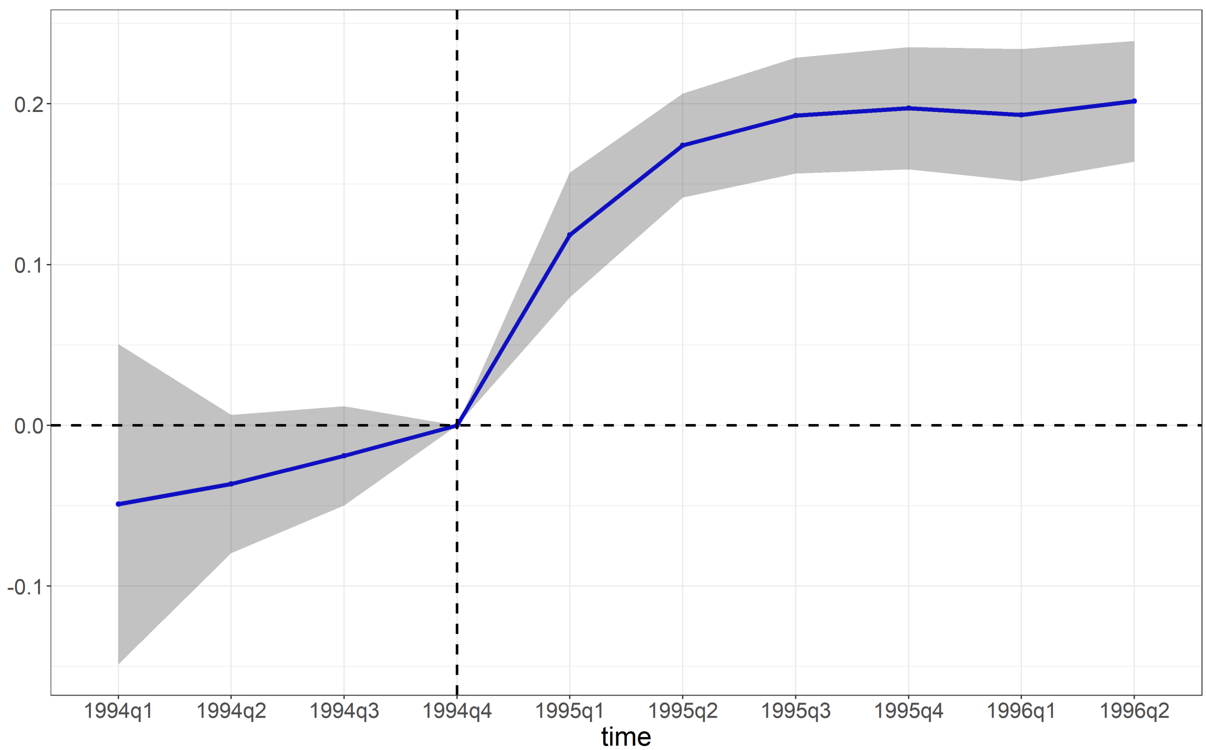

Figure 2.3: Changes in Number of Workers in Maquiladoras and Non-Maquiladoras

Notes: This figure reports the event study graph, depicting the average effect of the sudden stop on the number of workers. The dependent variable is expressed in logarithmic terms. The sudden stop occured in the fourth quarter of 1994. Each data point represents the coefficient on the interaction between being observed t quarters after the sudden stop and being maquiladora. The confidence interval is at the 95% level.

Figure 2.3 presents the event study graph of the average effects of the sudden stop on the number of workers. It reports quarterly effects in terms of the relative change in the number of workers across maquiladoras and non-maquiladoras before and after the sudden stop. In line with the absence of differential pretrends, I observe no differential effect for maquiladoras before the sudden stop occurred. For the post–sudden stop periods, I observe a substantially greater increase in number of workers in maquiladoras than in non-maquiladoras. The average difference in the change in number of workers reaches approximately 20% for the third quarter of 1995.

Fact 7. *Following the sudden stop, the number of workers increased by as much as* 20% *more in maquiladoras than in non-maquiladoras.*

3. Sufficient Statistic Approach and A Stylized Model

In the previous section, I show that export-oriented activities have smaller distortions than domestic-oriented activities from both market power and tax reasons. Additionally, there was a reallocation of resources from domestic-oriented activities toward export-oriented activities during the 1994 sudden stop. These empirical findings are expected to worsen alloactive efficiency and reduce TFP.

To quantify the reallocation effects, I provide a sufficient statistics analysis following Baqaee and Farhi [2019]. While the sufficient statistic analysis is useful for understanding how reallocations of resources contribute to the decline in TFP, it remains silent on the underlying mechanisms driving this decline in TFP. To understand the underlying mechanisms, I provide a stylized model of resource reallocations during a sudden stop after the sufficient statistic analysis.

3.1 Sufficient Statistics Approach

I consider a small open economy following Baqaee and Farhi [2019]. A set of plants is denoted as $\mathcal{N}$. I assume that each plant produces one type of product. Some plants produce a product for both domestic and foreign markets. To produce a product, plants use labor and intermediate inputs produced by domestic plants and foreign plants.

Producers

Good $i \in \mathcal{N}$ is produced using a constant-returns-to-scale production function:

$$y_i = A_i F_i \left(l_i, \{x_{ij}\}_{j \in \mathcal{N} \cup \mathcal{F}} \right)$$

where A_i is an exogenous Hicks-neutral productivity shifter of plant i, l_i is the labor input of plant i, x_{ij} is intermediate inputs from plant j. Plants may use foreign intermediate input $j \in \mathcal{F}$ to produce outputs. Importantly, the ideal markup by plant i could be different across destinations. $\mu_{i,d}$ is exogenously determined ideal markup of plant i for destination $d \in \{\mathcal{D}, \mathcal{F}^*\}$. The destination is either the domestic market ($\mathcal{D}$) or the foreign market ($\mathcal{F}^*$). This ideal markup, $\mu_{i,d}$, incorporates all distortions stemming from various sources such as tax distortions, financial frictions, market power, and other relevant factors. Plant i chooses inputs to minimize costs and set a destination specific price $p_{i,d} = \mu_{i,d} mc_i$ equal to an ideal markup $\mu_{i,d}$ times marginal cost mc_i. I assume that marginal cost of production is the same across destinations within plant i.

Nominal GDP, Input–Output Matrices and Sales Shares

The expression for domestic nominal GDP, which equals aggregate value added, is given as follows:

$$\sum_{i \in \mathcal{N}} p_i y_i - \sum_{i \in \mathcal{N}} \sum_{j \in \mathcal{N}} p_j x_{ij} - \sum_{i \in \mathcal{N}} \sum_{j \in \mathcal{F}} p_j x_{ij} = \text{GDP}$$

The first term is aggregate gross output, the second term is the aggregate expenditure on domestically produced intermediate inputs, and the third term is the aggregate expenditure on foreign-produced intermediate inputs.

I define Ω as a revenue-based input–output matrix with dimensions $(\mathcal{N} + 1 + \mathcal{F}) \times (\mathcal{N} + 1 + \mathcal{F})$. Each element (i, j) of Ω represents the share of i's expenditures on inputs from j relative to its total revenue:

$$\Omega_{ij} = \frac{p_j x_{ij}}{p_i y_i}$$

The last $(1 + \mathcal{F})$ rows of Ω are filled with zeros because the factors require no inputs, and the expenditure shares of the foreign intermediate input on domestically produced products are zeros due to the small open economy assumption.

The revenue-based Leontief inverse matrix is given by

$$\Psi = (I - \Omega)^{-1}$$

I denote the diagonal matrix of markups as μ, and the cost-based input–output matrix is represented as:

$$\begin{aligned}\tilde{\Omega} &= \mu\Omega \\ &= \frac{p_j x_{ij}}{\sum_{j=1}^{\mathcal{N}+1+\mathcal{F}} p_j x_{ij}}\end{aligned}$$

The cost-based Leontief inverse matrix is represented as

$$\tilde{\Psi} = \left(I - \tilde{\Omega}\right)^{-1}$$

Ψ_{ij} measures how expenditures on i impact the sales of j through production network, while $\tilde{\Psi}_{ij}$ captures how the price of j affects the marginal cost of i.

I define the forward and backward exposure of GDP as:

$$\lambda_k = \int_{i \in \mathcal{N}} \Omega_{Y,i} \Psi_{i,k} di$$

$$\tilde{\lambda}_k = \int_{i \in \mathcal{N}} \Omega_{Y,i} \tilde{\Psi}_{i,k} di$$

where $\Omega_{Y,i} = \frac{p_i q_i}{GDP}$ is the final output share of a good i in GDP, with $q_i = y_i - \sum_{j \in \mathcal{N}} x_{ji}$ representing the final output of good i in the domestic economy. Notice that $q_i < 0$ holds for the foreign intermediate inputs $i \in \mathcal{F}$. For the labor share and the share of the foreign intermediate input $i \in \mathcal{F}$, I write Λ_L, Λ_i^* and $\tilde{\Lambda}_L$, $\tilde{\Lambda}_i^*$.

Harmonic average markup by plant i across destinations is denoted by

$$\mu_i = \left(\frac{\lambda_{i,\mathcal{D}}}{\mu_{i.\mathcal{D}}} + \frac{\lambda_{i,\mathcal{F}^*}}{\mu_{i,\mathcal{F}^*}}\right)^{-1}$$

Real GDP

I employ Divisia indices to define the local change in the aggregate price index at time t as

$$d \log P_{Y,t} \equiv \sum_{i \in \mathcal{N} \cup \mathcal{F}^*} \Omega_{Y,i,t} d \log p_{i,t}$$

Then, the local change in real GDP in this economy at time t can be expressed as

$$d \log Y_t = d \log (\text{GDP}_t) - d \log P_{Y,t}$$

The Change in Allocative Efficiency

For any variable X, the global change of variable X from time t to $t+1$ is defined by integrating local changes in X over the interval $[t, t+1]$, which can be expressed as

$$\Delta \log X_t = \int_{s=t}^{t+1} d \log X_s$$

The global change in real GDP up to the second order is given by the following lemma.

Lemma 1. *The global change in real GDP at an inefficient equilibrium from time t to $t+1$, can be approximated up to the second order by the following equation:*

$$\begin{aligned}\Delta \log Y_t \approx & \underbrace{\int_{k \in \mathcal{N}} \left(\frac{\tilde{\lambda}_{k,t} + \tilde{\lambda}_{k,t+1}}{2} \right) \Delta \log A_{k,t} dk}_{\textit{Change in Technology}} + \underbrace{\left(\frac{\tilde{\Lambda}_{L,t} + \tilde{\Lambda}_{L,t+1}}{2} \right) \Delta \log L_t}_{\textit{Change in Factor}} + \underbrace{\sum_{i \in \mathcal{F}} \left(\frac{\tilde{\Lambda}^*_{i,t} + \tilde{\Lambda}^*_{i,t+1} - \Lambda^*_{i,t} - \Lambda^*_{i,t+1}}{2} \right) \Delta \log X_{i,t}}_{\textit{Change in External Inputs}} \\ & \underbrace{- \int_{k \in \mathcal{N}} \left(\frac{\tilde{\lambda}_{k,t} + \tilde{\lambda}_{k,t+1}}{2} \right) \Delta \log \mu_{k,t} dk - \left(\frac{\tilde{\Lambda}_{L,t} + \tilde{\Lambda}_{L,t+1}}{2} \right) \Delta \log \Lambda_{L,t} - \sum_{i \in \mathcal{F}} \left(\frac{\tilde{\Lambda}^*_{i,t} + \tilde{\Lambda}^*_{i,t+1} - \Lambda^*_{i,t} - \Lambda^*_{i,t+1}}{2} \right) \Delta \log \Lambda^*_{i,t}}_{\textit{Change in Allocative Efficiency}}\end{aligned}$$

where $X_{i,t} = \sum_{j \in \mathcal{N}} x_{ji,t}$ for $i \in \mathcal{F}$ is the total quantity of imported intermediate good i.

Lemma 1 is the second-order approximation version of theorem 1 in Baqaee and Farhi [2019]. As shown by Baqaee and Farhi [2019], the change in real GDP consists of the change in pure technology, change in factor inputs, change in external inputs, and change in allocative efficiency. The change in TFP is the sum of the change in technology, the change in external inputs, and the change in allocative efficiency. The change in allocative efficiency captures how reallocation effects contribute to the change in TFP on real GDP. Up to the second order, I need to average the t and $t+1$ coefficients for each term. For example, up to the second order, I weigh $\Delta \log L_t$, the change in the quantity of labor from t to $t+1$, using the average of $\tilde{\Lambda}_{L,t}$ and $\tilde{\Lambda}_{L,t+1}$.

Reallocation across Maquiladoras and Non-Maquiladoras

I use lemma 1 to see how reallocation across maquiladoras and non-maquiladoras contribute to the change in TFP.[5] To calculate the change in allocative efficiency, I need to know the input–output relationship, the cost structure of production and markup of each producer. I rely on the World Input-Output Database (WIOD) to measure the input–output linkages and the final output share in the manufacturing sector. The cost structure of production can be obtained directly from the dataset. I calculate markups as total sales relative to total variable costs.[6]

The change in allocative efficiency across maquiladoras and non-maquiladoras amounts to -3.50%. This clarifies the quantitative importance of reallocation effects across maquiladoras and non-maquiladoras. As shown in section 2.3, maquiladoras have less distorted supply chain and reallocation toward maquiladoras worsen the allocative efficiency.

When I measure markups in the data, it incorporates all the distortions such as market power and tax distortions. In the quantitative analysis in the subsequent section, I explicitly distinguish between market power and tax distortions. To be specific, I assume that market power on the foreign markets is the same across maquiladoras and exporters among non-maquiladoras. In the quantitative analysis, the difference in distortions across maquiladoras and non-maquiladoras arise from tax distortions and the difference in the production structure. I quantify how this difference in tax distortions and production structure contributes to the change in allocative efficiency in the quantitative analysis. The obtained

[5] To be specific, I subtract the sales-weighted change in average markup of maquiladoras and non-maquiladoras from the weighted change in factor shares.

[6] Total variable costs consist of total remuneration, raw materials of national origin, imported raw materials, containers and packaging used, electrical energy consumed, fuels and lubricants consumed, expenses for maquila services, and the cost of capital. The cost of capital is calculated by the product of the capital stock and user cost of capital. The capital stock is reported by plants in the EIA. The user cost of capital is the sum of the rental rate of capital and the capital-specific depreciation rates. See Appendix C-2 for these capital-specific depreciation rates. The rental rate of capital is set to 8.8% for 1994 and 17.3% for 1995, which is the annualized international interest rate faced by Mexico from Neumeyer and Perri [2005] computed as the 90-day U.S. T-bill rate plus the emerging market bond index (EMBI) for Mexico, adjusted by U.S. inflation. As for maquiladoras, I cannot observe the value of capital stock. Hence, I use rental expenditures on various capital items, including machinery, equipment, buildings, and office space reported in EMIME, as a proxy for the cost of capital.

reallocation effects in the quantitative analysis is consistent with the reallocation effects obtained in the sufficient statistics analysis.

Reallocation toward Product Lines for Foreign Markets

Next, I explore how the reallocation toward product lines for foreign markets contribute to the change in TFP. When the markup for the foreign market is lower at the plant-product level, the reallocation toward the product line for the foreign market is expected to reduce the plant-product level TFPQ. The reason is that gross output of the product for the foreign market is lower than the one of the product for the domestic market. Due to the composition effect, reallocation of resources toward the product line for the foreign market reduces gross output at the plant-product level and TFPQ decreases at the plant-product level.

To calculate the change in TFPQ at the plant-product level, I define the price deflator at the plant-product level. The price deflator of product j at time t is denoted as

$$d \log P_{j,t} = \sum_{d} \lambda_{jd,t} d \log p_{jd,t}$$

where d is the destination index and $\lambda_{jd,t} = \frac{p_{jd,t} y_{jd,t}}{P_{j,t} Y_{j,t}}$ is the sales share of product j at destination d as a fraction of gross output of product j. Then, the change in plant-product-level real output is given by the change in nominal gross output minus the change in the price deflator at the plant-product level:

$$d \log Y_{j,t} = d \log P_{j,t} Y_{j,t} - d \log P_{j,t}$$

I assume that production structure is the same for different destinations at the plant-product level. In such a case, the change in TFPQ at the plant-product level is given by the following lemma.

Lemma 2. *The global change in TFPQ at the plant-product level up to the first order is given by*

$$\Delta \log A_{j,t} \approx \underbrace{\sum_{d} \lambda_{jd,t} \Delta \log A_{jd,t}}_{\textit{Change in Technology}_{j,t}} \underbrace{- Cov_{\lambda_{jd,t}} \left(\frac{\mu_{j,t}}{\mu_{jd,t}}, \Delta \log y_{jd,t} \right)}_{\textit{Reallocation Effect}_{j,t}}$$

where $A_{jd,t}$ is Hicks-neutral productivity shifter at the plant-product-destination level, $\mu_{j,t}$ is the harmonic average markup of product j, $\mu_{ijd,t}$ is the markup of product j for destination d, and $d\log y_{j,t}$ is the change in quantity of output of product j for destination d. This expression is a version of lemma 2 of Baqaee et al. [2021] at the plant-product level. The second term captures how the reallocation of resources across destinations at the plant-product level contributes to the change in TFPQ at the plant-product level. An immediate observation is that if the product is only sold at the domestic market, the reallocation effect is 0 because there is no way to reallocate resources.

The empirical evidence shows that the change in the quantity of product for the foreign market is larger and the product lines for the foreign market have smaller markup. Therefore, $Cov_{\lambda_{jd,t}}\left(\frac{\mu_{j,t}}{\mu_{jd,t}}, d\log y_{jd,t}\right)$ is expected to be positive and the reallocation effect is expected to be negative. In the stylized model, I analytically show that this reallocation effect is negative.

I measure this reallocation effect by using the plant-product-destination level data. The sales share and the change in the quantity of output at the plant-product-destination level can be directly observable from the dataset. The markup of plant i is calculated by using the accounting approach as described before.[7] Once I calculate the change in TFPQ at the plant-product level due to the reallocation effect, I can calculate its effect on the change in aggregate TFP up to the first order by calculating

$$\sum_j \tilde{\lambda}_{j,t} \text{Reallocation Effect}_{j,t}$$

where $\tilde{\lambda}_{j,t}$ is the cost-based sales share of product j of plant i. The calculated effect on the change in aggregate TFP is -0.63%.

The empirical evidence shows that the markup difference across destinations disappeared during the sudden stop. This has an implication when I consider the global change in TFPQ up to the second order.

Lemma 3. *The global change in TFPQ at the plant-product level up to the second order is*

[7] In case plants manufacture multiple products, I proceed with the assumption that they charge the identical markup across products in the domestic market.

given by

$$\Delta \log A_{j,t} \approx \underbrace{\sum_d \frac{1}{2}\left(\lambda_{jd,t} + \lambda_{jd,t+1}\right) \Delta \log A_{jd,t}}_{\textit{Change in Technology}} \underbrace{- Cov_{\lambda_{jd,t}}\left(\frac{\mu_{j,t}}{\mu_{jd,t}}, \Delta \log y_{jd,t}\right)}_{\textit{First-Order Effect}_{j,t}}$$

$$\underbrace{+\frac{1}{2}\left(Cov_{\lambda_{jd,t}}\left(\frac{\mu_{j,t}}{\mu_{jd,t}}, \Delta \log y_{jd,t}\right) - Cov_{\lambda_{jd,t+1}}\left(\frac{\mu_{j,t+1}}{\mu_{jd,t+1}}, \Delta \log y_{jd,t}\right)\right)}_{\textit{Second-Order Effect}_{j,t}}$$

The second term captures the first-order effect and the sum of the third and fourth terms capture the second-order effect in allocative efficiency. Lemma 3 implies that when the sales share and markup remain constant from time t to $t+1$ at the plant-product-destination level ($\mu_{jd,t} = \mu_{jd,t+1}$, $\lambda_{jd,t} = \lambda_{jd,t+1} \, \forall d$), the second-order effect is 0. When the magnitude of the shock is substantial, as is the case with a sudden stop shock, the second-order effect cannot be ignored. As my empirical analysis has revealed, the sales share and markup of product lines for foreign markets experienced a remarkable increase during the Mexican sudden stop. In essence, this translates to $\lambda_{jd,t} \neq \lambda_{jd,t+1}$ and $\mu_{jd,t} \neq \mu_{jd,t+1}$.

$Cov_{\lambda_{jd,t}}\left(\frac{\mu_{j,t}}{\mu_{jd,t}}, \Delta \log y_{jd,t}\right)$ is expected to be positive because product lines for the foreign market had lower markup before the sudden stop and they expanded their production during the sudden stop. My empirical evidence shows that there was no markup difference across destinations during the sudden stop, which is likely to make the markup ratio $\frac{\overline{\mu}_{j,t+1}}{\mu_{jd,t+1}}$ closer to 1 and $Cov_{\lambda_{jd,t+1}}\left(\frac{\mu_{j,t+1}}{\mu_{jd,t+1}}, \Delta \log y_{jd,t}\right)$ closer to 0. Therefore, the second-order effect is expected to be positive. In the stylized model, I analytically show that this second-order effect is positive.

Once I calculate the change in TFPQ at the plant-product level due to the reallocation effect, I can calculate its effect on the change in aggregate TFP up to the second order by using Lemma 1. The calculated reallocation effect on the change in aggregate TFP is -0.34% which is bigger than -0.63% which is the reallocation effect on aggregate TFP up to the first order. The increase in markup by product lines for the foreign markets with ex ante lower markup is better in terms of the resource allocation because ex post distortion gets similar across destinations. This is why the second-order effect mitigates worsening the allocative efficiency.

3.2 A Stylized Model of a Sudden Stop

The previous sufficient statistics analysis is useful to measure how reallocations of resources contribute to the decline in TFP. However, it says nothing about the underlying mechanism about the changes in markups and sales shares during the sudden stop. Also the result from the sufficient statistics analysis reflects not only the sudden stop shock but also other shocks such as a financial crisis shock and the introduction of NAFTA. Now I add the following four structures to the previous model in order to understand how a sudden stop shock impacts allocative efficiency and TFP through the changes in sales shares, nominal exchange rate, and markups: (i) household's budget constraint is introduced to capture a sudden stop shock; (ii) household has a Cobb-Douglas utility function over domestic and foreign consumption goods; (iii) there are two types of producers: domestic producers and exporters and there is no distinction across maquiladoras and exporters in non-maquiladoras; (iv) I assume that producers face fully sticky prices in foreign currency in foreign markets while produces face flexible prices in domestic markets; (v) labor is the only factor of production; (vi) domestic nominal wage is perfectly rigid; and, (vii) domestic monetary policy controls domestic nominal GDP. Assumptions (ii)–(vii) will be relaxed in the subsequent quantitative analysis.

First, the household budget constraint is introduced as follows:

$$P_{\mathcal{D}}C_{\mathcal{D}} + \epsilon P_{\mathcal{F}}C_{F} + \epsilon\Theta = WL + \Pi$$

where $P_{\mathcal{D}}C_{\mathcal{D}}$ is the total spending on domestically-produced consumption goods, $\epsilon P_{\mathcal{F}}C_{\mathcal{F}}$ is the total spending on foreign-produced consumption goods in domestic currency, and ϵ is the nominal exchange rate, defined as the units of home currency for one unit of foreign currency.[8] Θ captures exogenously determined net foreign repayment in foreign currency. For the sake of simplicity, I abstract from the household's borrowing and saving behaviors. A sudden stop is characterized by an exogenous increase in Θ.[9]

[8] An increase in ϵ implies depreciation of the home currency.

[9] If I consider the household's borrowing and saving behavior, Θ can be expressed as $\Theta = b^{'} - (1 + r^*)\, b$ where $b^{'}$ is the amount of borrowing in foreign currency, r^* is the foreign interest rate, and $b\,(1 + r^*)$ is the payment on a foreign bond. A sudden stop is described by an increase in the foreign interest rate (r^*) or a tightening of the borrowing constraint, which entails a decrease in $b^{'}$. In my paper, I do not specify the cause of the increase in Θ. Instead, I focus on the response of each variable with respect to this exogenous increase in Θ.

Second, I assume that household has a Cobb-Douglas utility function over domestic and foreign consumption goods:

$$U\left(C_{\mathcal{D}}, C_{\mathcal{F}}\right) = C_{\mathcal{D}}^{1-\gamma} C_{\mathcal{F}}^{\gamma}$$

In the quantitative analysis, this assumption is relaxed and a CES utility function is introduced.

Third, I assume that there are two types of producers: domestic producers with index $\mathcal{D}$ and exporters with index $\mathcal{F}^*$. There is no distinction across maquiladoras and exporters among non-maquiladoras.

Fourth, I assume that producers face fully sticky prices in foreign currency in foreign markets while produces face flexible prices in domestic markets. The empirical findings show that, prior to the sudden stop, the markup on foreign market was lower than that for the domestic market. However, this disparity in markup level disappeared during the sudden stop period. Furthermore, the export price index in US dollars remained stable during the sudden stop period.[10] Based on this empirical evidence, I assume that producers face sticky prices in foreign currency in foreign markets. When considering a menu-cost model, such as the one proposed by Golosov and Lucas Jr [2007], what matters for the frequency of price changes is the relative price compared to the aggregate price index. During the 1994 sudden stop, the domestic aggregate price index in Pesos experienced a significant increase, whereas the foreign aggregate price index in foreign currency remained stable. Consequently, this resulted in a substantial relative price shift within domestic markets, while foreign markets saw only a marginal change in relative prices.

In this respect, Gagnon [2009] provides compelling evidence based on a comprehensive dataset of Mexican consumer prices during the sudden stop. His finding indicates that the frequency of price changes in the domestic market peaked in April 1995, when a remarkable 64.3% of goods experienced price adjustments over the month. Considering that I simulate the model at annual frequency in my quantitative analysis, I assume that producers face flexible prices in domestic markets.

Fifth, I assume that labor is the only factor of production. The production function of

[10] See Figure C.2.

producers is linear in labor and denoted as:

$$Y_i = A_i L_i$$

where Y_i is the output of producer i, A_i is the technology level of producer i, and L_i is the labor input of producer i.

Sixth, I assume that there is the nominal wage is perfectly rigid to simplify the analysis. I will weaken these extreme assumptions about price stickiness in the quantitative analysis.

Now the change in markup of an exporter is equal to the change in price minus the change in marginal cost, expressed as:

$$\begin{aligned} d\log \mu_{\mathcal{F}^*} &= d\log \epsilon P_{\mathcal{F}^*} - d\log\left(\frac{W}{A_{\mathcal{F}^*}}\right) \\ &= d\log \epsilon \end{aligned}$$

I assume that technology level remains constant throughout the analysis. The change in markup is equivalent to the change in nominal exchange rate under the assumptions about price stickiness.

Last, I assume that monetary authority perfectly controls domestic nominal GDP, i.e., $d\log GDP = 0$ to simplify the analysis.

The equilibrium condition is the same as the previous model except that current account identity equation is expressed as:

$$\epsilon P_{\mathcal{F}^*} Y_{\mathcal{F}^*} - \epsilon P_{\mathcal{F}} C_{\mathcal{F}} = \epsilon \Theta$$

The left-hand side is net export in domestic currency and the right-hand side is net capital out flow in domestic currency.

The local change in aggregate TFP can be calculated as

$$d\log \mathrm{TFP} = d\log Y - d\log L$$

where $L = L_{\mathcal{D}} + L_{\mathcal{F}^*}$ is the total labor hired in this economy.

The harmonic average markup charged by domestic producers and exporters is given by

$$\overline{\mu} = \left(\frac{\mu_{\mathcal{D}}}{\lambda_{\mathcal{D}}} + \frac{\mu_{\mathcal{F}^*}}{\lambda_{\mathcal{F}^*}}\right)^{-1}$$

The sales share by domestic producer is represented by $\lambda_{\mathcal{D}} = \frac{P_{\mathcal{D}} Y_{\mathcal{D}}}{GDP}$ and the sales share by exporters is represented by $\lambda_{\mathcal{F}^*} = \frac{P_{\mathcal{F}^*} Y_{\mathcal{F}^*}}{GDP}$.

Now I consider the local changes in the nominal exchange rate and aggregate productivity in response to a positive net capital outflow shock.

Proposition 1. *In response to a positive net capital outflow shock, the local changes in the nominal exchange rate, labor across domestic producers and exporters, and aggregate TFP are as follows:*

$$d \log \epsilon = \frac{P_{\mathcal{D}} C_{\mathcal{D}}}{P_{\mathcal{F}} C_{\mathcal{F}}} \frac{\Theta}{GDP} > 0$$

$$d \log L_{\mathcal{D}} = -\frac{\lambda_{\mathcal{F}^*}}{\lambda_{\mathcal{D}}} d \log \epsilon < 0$$

$$d \log L_{\mathcal{F}^*} = 0$$

$$d \log TFP = \lambda_{\mathcal{D}} \left(1 - \frac{\overline{\mu}}{\mu_{\mathcal{D}}}\right) d \log L_{\mathcal{D}}$$

If $\mu_{\mathcal{D}} > \overline{\mu}$ holds, $d \log TFP < 0$, and vice versa.

In response to a positive net capital outflow shock, net export needs to increase to balance the current account. This adjustment occurs through a reduction in foreign consumption goods since exports remain unchanged due to the fully sticky prices in foreign currency. To facilitate this adjustment, total income in foreign currency must decrease. As the domestic monetary authority perfectly controls nominal GDP, it effectively controls nominal total income in domestic currency. Consequently, the adjustment occurs through the depreciation of the domestic currency. The increase in net capital outflow and the depreciation of the domestic currency leads to a reduction in domestic disposable income and, consequently, decreases domestic consumption. This deceases demand for products by domestic producers. Since nominal wage is perfectly sticky, all the adjustments take place through the quantity of labor and domestic producers reduce employment. On the other hand, exporters don't change their employment because demand for exported products does not change due to the perfect rigid price in foreign currency and constant aggregate foreign demand. Consequently, in relative term, exporters expand by more, while producers for the domestic market shrink. In essence, I observe a reallocation of labor toward exporters from producers for domestic markets.

The direction in which this resource reallocation impacts TFP at the local level depends on the relative markup charged in the domestic market, represented as $\left(\frac{\overline{\mu}}{\mu_{\mathcal{D}}}\right)$. From a social planner's perspective, producers with a higher markup underproduce. My empirical analysis reveals that the markup for foreign markets was lower than the markup for domestic markets before the sudden stop, represented as $\mu_{\mathcal{D}} > \overline{\mu}$. If $\mu_{\mathcal{D}} > \overline{\mu}$ holds, this implies that producers for the domestic market underproduce from a social planner's perspective. Consequently, this resource reallocation toward exporters and away from producers for the domestic market worsens allocative efficiency locally, leading to a local decline in aggregate TFP.

The global change in TFP up to the second order in this model can be shown in the following theorem:

Theorem 1. *The global change in TFP ($\int_{s=t}^{t+1} d\log A(s)$) up to the second order is given by*

$$\underbrace{\lambda_{\mathcal{D},t}\left(1-\frac{\overline{\mu}_t}{\mu_{\mathcal{D},t}}\right)\Delta\log L_{\mathcal{D},t}}_{\text{First-Order Effect}}+\underbrace{\frac{1}{2}\left(\lambda_{\mathcal{D},t+1}\left(1-\frac{\overline{\mu}_{t+1}}{\mu_{\mathcal{D},t+1}}\right)-\lambda_{\mathcal{D},t}\left(1-\frac{\overline{\mu}_t}{\mu_{\mathcal{D},t}}\right)\right)\Delta\log L_{\mathcal{D},t}}_{\text{Second-Order Effect}}$$

If $\mu_{\mathcal{D},t} > \overline{\mu}_t$ holds, the first-order effect is always negative while the second-order effect is always positive.

The interpretation of the first-order effect is the same as the one in Proposition 1. In response to a sudden stop shock, the markup by exporters increases ($\Delta\log\mu_{\mathcal{F}^*} = \Delta\log\epsilon_t > 0$), and the ex post markup difference across destinations shrinks if $\mu_{\mathcal{D},t} > \overline{\mu}_t$ holds, leading to a more favorable situation in terms of resource allocation because the ex post distortions faced by all producers become more similar. Consequently, the second-order effect mitigates the deterioration of allocative efficiency.

4. Quantitative Model

The result from the sufficient statistics analysis reflects not only the sudden stop shock but also other shocks such as a financial crisis shock and the introduction of NAFTA. Also existing models of a sudden stop cannot match movements of macroeconomic variables as well as generate endogenous decline in TFP. To assess how a sudden stop shock explains the decline in TFP through reallocation effects and how a sudden stop shock changes relevant macroeconomic variables, I conduct a quantitative analysis within a small-open economy New Keynesian model incorporating features such as heterogeneous firms with different distortions, input–output linkages, and sticky prices. The simple model described in the previous section is a special version of the quantitative model presented here.

4.1 Household

A representative domestic household maximizes the discounted expected utility over consumption and labor:

$$\sum_{t=0}^{\infty} E_t \left[\beta^t \left(U\left(C_t, L_t\right)\right)\right]$$

where aggregate consumption (C_t) consists of manufacturing consumption goods ($C_{M,t}$) and nonmanufacturing consumption goods ($C_{NM,t}$):

$$C_t = \left[\phi^{1/\zeta} C_{M,t}^{(\zeta-1)/\zeta} + (1-\phi)^{1/\zeta} C_{NM,H,t}^{(\zeta-1)/\zeta}\right]^{\zeta/(\zeta-1)}$$

ζ captures the elasticity of substitution between manufacturing and nonmanufacturing consumption goods. Manufacturing consumption goods ($C_{M,t}$) consist of domestically produced ($C_{M,H,t}$) and foreign-produced manufacturing consumption goods ($C_{M,F,t}$).

$$C_{M,t} = \left[\gamma^{1/\eta} C_{M,F,t}^{(\eta-1)/\eta} + (1-\gamma)^{1/\eta} C_{M,H,t}^{(\eta-1)/\eta}\right]^{\eta/(\eta-1)}$$

I allow for home bias in preferences and γ denotes the expenditure share of foreign-produced manufacturing goods. η captures the elasticity of substitution between domestically produced and foreign-produced manufacturing consumption goods.

The household is subject to the following nominal budget constraint:

$$P_{M,H,t}C_{M,H,t} + \epsilon_t P^*_{M,F,t}C_{M,F,t} + P_{NM,H,t}C_{NM,H,t} + \epsilon_t\Theta_t = W_tL_t + \Pi_t$$

where $P_{M,H,t}$ is the price index of domestically produced manufacturing products; ϵ_t is the nominal exchange rate, defined as the units of home currency for one unit of foreign currency[11]; $P^*_{M,F,t}$ is the price index of foreign-produced manufacturing products in foreign currency, which is exogenously given due to the small open economy assumption; and $P_{NM,H,t}$ is the price index of nonmanufacturing products. Θ_t captures exogenously determined net foreign repayment in foreign currency. As is the case with the simple model, I abstract from the household's borrowing and saving behaviors. A sudden stop is characterized by an exogenous increase in Θ_t. Additionally, W_tL_t is labor income, and Π_t is the sum of profits generated by all firms operating within the domestic economy.

Consumers have homothetic preferences over domestically produced manufacturing consumption goods and nonmanufacturing consumption goods. Consumption bundles $C_{M,H,t}$ and $C_{NM,H,t}$ are defined by the following CES aggregators:

$$\left(\int_{\theta=0}^{1} c_{M,H,\theta,t}^{\frac{\sigma-1}{\sigma}} d\theta\right)^{\frac{\sigma}{\sigma-1}} = C_{M,H,t}$$

$$\left(\int_{\theta=0}^{1} c_{NM,H,\theta,t}^{\frac{\sigma-1}{\sigma}} d\theta\right)^{\frac{\sigma}{\sigma-1}} = C_{NM,H,t}$$

Consumption bundles consist of various varieties of goods indexed by $\theta \in [0, 1]$. $c_{M,H,\theta,t}$ and $c_{NM,H,\theta,t}$ are the consumption of variety θ among domestically produced manufacturing and nonmanufacturing consumption goods, respectively.

By solving the household's maximization problem, I obtain the demand curve for variety θ:

$$c_{M,H,\theta,t} = \left(\frac{p_{M,H,\theta,t}}{P_{M,H,t}}\right)^{-\sigma} C_{M,H,t}$$

$$c_{NM,H,\theta,t} = \left(\frac{p_{NM,H,\theta,t}}{P_{NM,H,t}}\right)^{-\sigma} C_{NM,H,t}$$

The household supplies labor through a continuum of labor unions, represented by $l \in$

[11] An increase in ϵ_t implies depreciation of the home currency.

$[0,1]$. Each union transforms the household's labor L_t into specialized labor services denoted as $n_t(l)$. The total labor supply of the household L_t is the integral of $n_t(l)$ across the continuum of l. The labor types $n_t(l)$ enter the production function of firms through the CES basket:

$$n_t = \left(\int_0^1 n_t(l)^{\frac{\epsilon_w - 1}{\epsilon_w}} dl \right)^{\frac{\epsilon_w}{\epsilon_w - 1}}$$

where $\epsilon_w > 1$ is the elasticity of substitution between the labor types. Cost minimization by firms results in each union facing a downward-sloping labor demand curve:

$$n_t(l) = \left(\frac{W_t(l)}{W_t} \right)^{-\epsilon_w} n_t$$

where W_t denotes the nominal wage index and is defined as

$$W_t = \left(\int_0^1 W_t(l)^{1-\epsilon_w} dl \right)^{\frac{1}{1-\epsilon_w}}$$

In line with the approach of Erceg et al. [2000], each labor union l chooses the wage $W_t(l)$ to maximize household utility. Union l can optimize the wage with probability δ_w. Union l chooses $\{W_t(l), N_t(l)\}$ to maximize the objective function:

$$\sum_{s=0}^{\infty} E_t (\beta(1-\delta_w))^s [u(C_{t+s}, L_{t+s})]$$

where $L_{t+s} = \int_0^1 n_{t+s}(l)\, dl$ and the constraints are

$$n_{t+s}(l) = \left(\frac{W_t(l)}{W_{t+s}} \right)^{-\epsilon_w} n_{t+s}$$

$$P_{M,H,t+s}C_{M,H,t+s} + \epsilon_{t+s}P^*_{M,F,t+s}C_{M,F,t+s} + P_{NM,H,t+s}C_{NM,H,t+s} + \epsilon_{t+s}\Theta_{t+s} = W_{t+s}L_{t+s} + \Pi_{t+s}$$

The solution to this problem can be found in Appendix D.

Additionally, I assume that the foreign household's problem is symmetric; variables for the foreign country are denoted with an asterisk (*).

4.2 Firms

There are two sectors in this economy: the manufacturing sector and the nonmanufacturing sector. Inside the manufacturing sector, there are maquiladoras and non-maquiladoras. Non-maquiladoras in the manufacturing sector produce products for both domestic and foreign markets, while maquiladoras produce products only for foreign markets. I assume that the production technology is the same within non-maquiladoras, maquiladoras, and, non-manufacturing sector. The production function for sector i is expressed as:

$$\frac{y_{i,t}}{\overline{y}_i} = A_{i,t}\left(\omega_i\left(\frac{n_{i,t}}{\overline{n}_i}\right)^{\frac{\xi^{\mathrm{l,ii}}-1}{\xi^{\mathrm{l,ii}}}} + (1-\omega_i)\left(\frac{ii_{i,t}}{\overline{ii}_{i,t}}\right)^{\frac{\xi^{\mathrm{l,ii}}-1}{\xi^{\mathrm{l,ii}}}}\right)^{\frac{\xi^{\mathrm{l,ii}}}{\xi^{\mathrm{l,ii}}-1}}$$

where $n_{i,t}$ is the labor input, $ii_{i,t}$ is the aggregated intermediate input, ω_i is the share parameter for how intensely sector i uses labor, and $\xi^{\mathrm{l,ii}}$ is the elasticity of substitution among labor and the aggregated intermediate input. The aggregated intermediate input is given by:

$$\frac{ii_{i,t}}{\overline{ii}_i} = \left(\nu_i\left(\frac{x_{i,m,t}}{\overline{x}_{i,m}}\right)^{\frac{\xi^{\mathrm{m,nm}}-1}{\xi^{\mathrm{m,nm}}}} + (1-\nu_i)\left(\frac{x_{i,nm,t}}{\overline{x}_{i,nm}}\right)^{\frac{\xi^{\mathrm{m,nm}}-1}{\xi^{\mathrm{m,nm}}}}\right)^{\frac{\xi^{\mathrm{m,nm}}}{\xi^{\mathrm{m,nm}}-1}}$$

where $x_{i,m,t}$ is the intermediate input from the manufacturing sector, including foreign intermediate input; $x_{i,nm,t}$ is the intermediate input from the nonmanufacturing sector; ν_i is the share parameter for how sector i uses intermediate input from the manufacturing sector; and $\xi^{\text{manu,non-manu}}$ is the elasticity of substitution among intermediate inputs from the manufacturing sector and nonmanufacturing sector. The intermediate input from the manufacturing sector is given by

$$\frac{x_{i,m,t}}{\overline{x}_{i,m}} = \left((1-\varsigma_i)\left(\frac{x_{i,m,d,t}}{\overline{x}_{i,m,d}}\right)^{\frac{\xi^{\mathrm{f,d}}-1}{\xi^{\mathrm{f,d}}}} + \varsigma_i\left(\frac{x_{i,m,f,t}}{\overline{x}_{i,m,f}}\right)^{\frac{\xi^{\mathrm{f,d}}-1}{\xi^{\mathrm{f,d}}}}\right)^{\frac{\xi^{\mathrm{f,d}}}{\xi^{\mathrm{f,d}}-1}}$$

where $x_{i,m,d,t}$ is the domestically produced intermediate input from the manufacturing sector; $x_{i,m,f,t}$ is the foreign-produced intermediate input from the manufacturing sector; ς_i is the share parameter for how sector i uses the domestically produced intermediate input from the manufacturing sector; and $\xi^{\mathrm{f,d}}$ is the elasticity of substitution among domestically produced and foreign-produced intermediate inputs from the manufacturing sector.

As in the simple model, I assume that exporters among non-maquiladoras face sticky prices in foreign currency in foreign markets while producers face flexible prices in domestic markets. I assume that maquiladoras face flexible prices because maquiladoras' markup measured by the accounting approach did not change from 1994 to 1995.

Following Calvo [1983], I assume that exporters in the manufacturing sector set prices with a probability of changing prices in the next period equal to δ_p. An exporter in the manufacturing sector θ sets its price in foreign currency $\left(p^*_{M,H,\theta,t}\right)$ so as to maximize

$$\sum_{s=0}^{\infty} \left(\beta\left(1-\delta_p\right)\right)^s E_t\left[Q_{t,t+s} y^*_{M,H,\theta,t}\left(p^*_{M,H,\theta,t} - mc^*_{M,H,\theta,t}\right)\right]$$

subject to the demand for the product in foreign countries:

$$y^*_{M,F,\theta,t} = \left(\frac{p^*_{M,H,\theta,t}}{P^*_{M,F,t}}\right)^{-\sigma} Y^*_{M,F,t}$$

where $Q_{t,t+s}$ is the stochastic discount factor from time t to $t+s$ by domestic households, $P^*_{M,F,t}$ and $Y^*_{M,F,t}$ are exogenously given due to the small open economy assumption. The solution to this maximization problem can be found in Appendix D. The maximization problem for maquiladoras is identical to that for exporters in the manufacturing sector except that maquiladoras face flexible prices in foreign currency in foreign markets.

4.3 Distortions

To account for variations in tax rates across sectors, particularly between maquiladoras and non-maquiladoras, I introduce intermediaries who act as intermediaries between goods or labor suppliers and buyers, which apply a markup of $1+\tau$, where τ is the tax rate. I consider three distinct tax distortions: the payroll tax (τ_{labor}), a tariff on foreign goods (τ_{tariff}), and value-added tax (τ_{vat}). For example, when a manufacturing producer sells its product to domestic consumers at a price p, an intermediary purchases the product at the same price p and subsequently sells it to domestic consumers at a price of $(1+\tau_{vat})\,p$. In essence, this intermediary transfers the product from the producer to the consumer with a markup of $(1+\tau_{vat})$.

4.4 Nominal GDP, Current Account, and Monetary Regime

Domestic nominal GDP is given by the following equation:

$$\begin{aligned} & P_{M,H,t}C_{M,H,t} + \epsilon_t P^*_{M,F,t}C_{M,F,t} + P_{NM,H,t}C_{NM,H,t} \\ + \int_0^1 \epsilon_t p^*_{M,H,\theta,t} y^*_{M,H,\theta,t} d\theta + \int_0^1 \epsilon_t p^*_{M,M,\theta,t} y^*_{M,M,\theta,t} d\theta - P^*_{M,F,t}C_{M,F,t} - \epsilon_t X_t P^*_{X,t} \\ &= \mathrm{GDP}_t \end{aligned}$$

where $X_t = \int_0^1 x_{M,H,\theta,m,f,t} d\theta + \int_0^1 x^*_{M,H,\theta,m,f,t} d\theta + \int_0^1 x^*_{M,M,\theta,m,f,t} d\theta + \int_0^1 x_{NT,H,\theta,m,f,t} d\theta$ is the total quantity of imports of the foreign intermediate input, and $P^*_{X,t}$ is the price of foreign intermediate input in foreign currency.

According to the current account identity, net export is equal to net capital outflow:

$$\begin{aligned} \int_0^1 \epsilon_t p^*_{M,H,\theta,t} y^*_{M,H,\theta,t} d\theta + \int_0^1 \epsilon_t p^*_{M,M,\theta,t} y^*_{M,M,\theta,t} d\theta - P^*_{M,F,t}C_{M,F,t} - \epsilon_t X_t P^*_{X,t} \\ = \epsilon_t \Theta_t \end{aligned}$$

For any variable X_t, I denote its first-order change from its steady state as $\Delta \log X_t$.

The primary objectives of the monetary authority are to stabilize the labor market and price levels:

$$\Xi \Delta \log P_c + (1 - \Xi) \Delta \log L_t = 0$$

where P_c is the domestic consumer index and Ξ determines the extent to which the monetary authority prioritizes stabilization of the domestic consumer price index (CPI). When $\Xi = 1$, the monetary authority fully focuses on stabilizing the domestic CPI, while $\Xi = 0$ signifies a complete focus on stabilizing the domestic labor market.

I assume that the pass-through of nominal exchange rate on the price of foreign intermediate good is not equal to 1:

$$\Delta \log P^*_{X,t} = \varrho \Delta \log \epsilon_t$$

where ϱ captures the pass-through rate from the change in nominal exchange rate to the change in the price of foreign intermediate input.

I define the equilibrium in Appendix D and the way to calculate the steady state of the model is explained in Appendix E.

5. Quantitative Analysis

5.1 Calibration

I assign standard values to most of the parameters in my model, with a detailed list available in Appendix B. Here, we highlight the key parameters. The input shares for production are derived from the EIA and EMIME. The elasticity of substitution across foreign-produced and domestically-produced manufacturing intermediate inputs is 0.76, in accordance with Boehm et al. [2023]. For the elasticity of substitution between manufacturing and nonmanufacturing intermediate inputs, I adopt a value of 0.2, following Baqaee and Farhi [2022]. Likewise, the elasticity of substitution between labor and the entire bundle of intermediate input is set to 0.6, based on Baqaee and Farhi [2022].

When I measure markups in the data, it includes all distortions such as market power, financial frictions, and tax distortions. Here, I explicitly distinguish between tax distortions and other distortions. I assume that all distortions except tax distortions, including market power and financial frictions, are captured by the markup. Following the empirical evidence, I assume that the initial markup for the foreign market is 11.3% lower than the markup for the domestic market. I assume that the markups charged by maquiladoras and exporters in non-maquiladoras are the same. In addition, I assume that average markups for the manufacturing and nonmanufacturing sectors are equivalent. The level of markup charged by manufacturing producers producing for domestic markets is calibrated to achieve the net export to GDP ratio of -4.82% before the sudden stop. Markup influences this ratio as a higher markup widens the gap between export prices and input prices, resulting in a higher net export to GDP ratio. The calibrated average markup in the manufacturing sector is 1.16. Regarding the price stickiness of exporters among non-maquiladoras, I set the degree of price stickiness to ensure that there is no markup difference across destinations among non-maquiladoras during the sudden stop shock. In the benchmark calibration, I assume that the goods markets are perfectly competitive, and the aggregator for final demand takes a CES function with the elasticity of substitution 1.85.[12] This number is calibrated so that real exchange rate depreciates by 31.7% in response to the sudden stop shock.

The elasticity of substitution across manufacturing and non-manufacturing goods calibrated at 0.4, as indicated by Burstein et al. [2007]. The consumption share of foreign manufacturing good is set to 0.11 following Blaum [2019]. Labor elasticity is set to 1.84 from Mendoza [2010]. The wage stickiness is set to 0.08, in alignment with Fukui et al. [2023]. The discount factor is set to 0.91 from Cugat [2022].

The monetary authority adjusts its weights on stabilizing the CPI and labor. Also the pass-through rate of nominal exchange rate on the price of foreign intermediate good is not equal to 1. The weighting by the monetary authority and this pass-through rate are designed to match the 2.8% decline in employment numbers within the manufacturing sector, as seen in the data. Tax distortions are incorporated, with values set at $\tau_{VAT} = 0.1$, $\tau_{labor} = 0.25$, and $\tau_{tariff} = 0.08$. The size of the sudden stop shock is calibrated so that the increase in a net export to GDP ratio is 156.3%, in line with the observed data.

5.2 Impulse Response Functions

Figure 5.1 and 5.2 show the impulse response functions.[13] The change in allocative efficiency up to the first order is -4.62%, while the change in allocative efficiency up to the second order is -3.70%. This discrepancy arises from the difference between the ex ante sales shares and markup and the ex post sales shares and markup. Prior to the sudden stop, the markup for foreign markets is lower than the markup for domestic markets. However, the markup

[12] When I introduce a monopolistic competition under the Kimball demand or an oligopolistic competition with the nested CES demand, the implied demand elasticity is bigger than this number. For example, average demand elasticity is calculated to be 5.66 in Edmond et al. [2023] who estimate the Kimball demand by using the US Census data. If I set demand elasticity to be higher, it results in a smaller degree of real exchange depreciation than what is observed in the data. This occurs because lesser exchange rate devaluation is sufficient to increase export and satisfy the current account balance. To avoid this issue and ensure consistency with the observed data, I consider the CES demand function with perfect competition in my benchmark analysis.

[13] I observe hump-shaped impulse response functions for the markup ratio across domestic and foreign markets, labor in the manufacturing sector, and foreign intermediate inputs in the manufacturing sector. This pattern arises from the fact that producers face sticky prices in foreign markets in foreign currency. When a sudden stop happens, flexible producers reduce their prices in foreign currency because the marginal cost of production in foreign currency decreases. In the subsequent period, some producers maintain these lower prices, leading to increased demand and higher input utilization. The marginal cost of production in foreign currency recovers quickly after the sudden stop, but some producers continue to offer lower prices due to the price stickiness, resulting in a decline in the markup on foreign markets.

for foreign markets increases during the sudden stop because of sticky prices in foreign markets, closing the markup difference between the two markets. Considering up to the second order, the ex post markup difference of zero is better in terms of resource allocation because the distortions that producers face become closer to each other. Consequently, if I consider the change in allocatove efficiency up to the second order, the change is mitigated.

The change in allocative efficiency is primarily driven by the relative expansion of maquiladoras. Up to the second order, reallocation within non-maquiladoras contributes to 0.34% of the decline in TFP in the manufacturing sector, while the reallocation across maquiladoras and non-maquiladoras contributes to 3.36% of the decline in TFP in the manufacturing sector. This result is consistent with the one from the sufficient statistic analysis. As explained in section 2.3, maquiladoras face less distorted supply chain because they rely less on domestically produced intermediate inputs which accumulates distortions throughout the production process.

This result shows the quantitative importance of maquiladoras and producers in special economic zones in general when analyzing TFP and GDP. The entire reallocation effects explain about 50% of the decline in value added in the manufacturing sector.

Overall, the model quantitatively matches the data well. The sales share of maquiladoras increased up to 45.3% in the data, while it increases up to 44.3% in the simulation. The sales share of exporters among non-maquiladoras increased up to 46.0% in the data, while it increases up to 39.3% in the simulation. A part of this discrepancy could be explained by NAFTA, which I don't incorporate in this analysis and was expected to be beneficial for exporters among non-maquiladoras.[14] Import of foreign intermediate inputs declined by 0.1% in the data, while it increases by 0.22% in the simulation. In the data, real value added in the manufacturing sector declined by 5.2% and the contribution of capital on real value added was 1.5% during the sudden stop. This implies that the decline in TFP and the reduction in labor contributed to the decline in real value added by 6.7% in the data. The simulation result from the model without capital shows that real value added declines by 7.2%.

[14]Maquiladoras enjoyed tax benefits to begin with before the introduction of NAFTA. Therefore, the impact of NAFTA on maquiladoras was expected to be small.

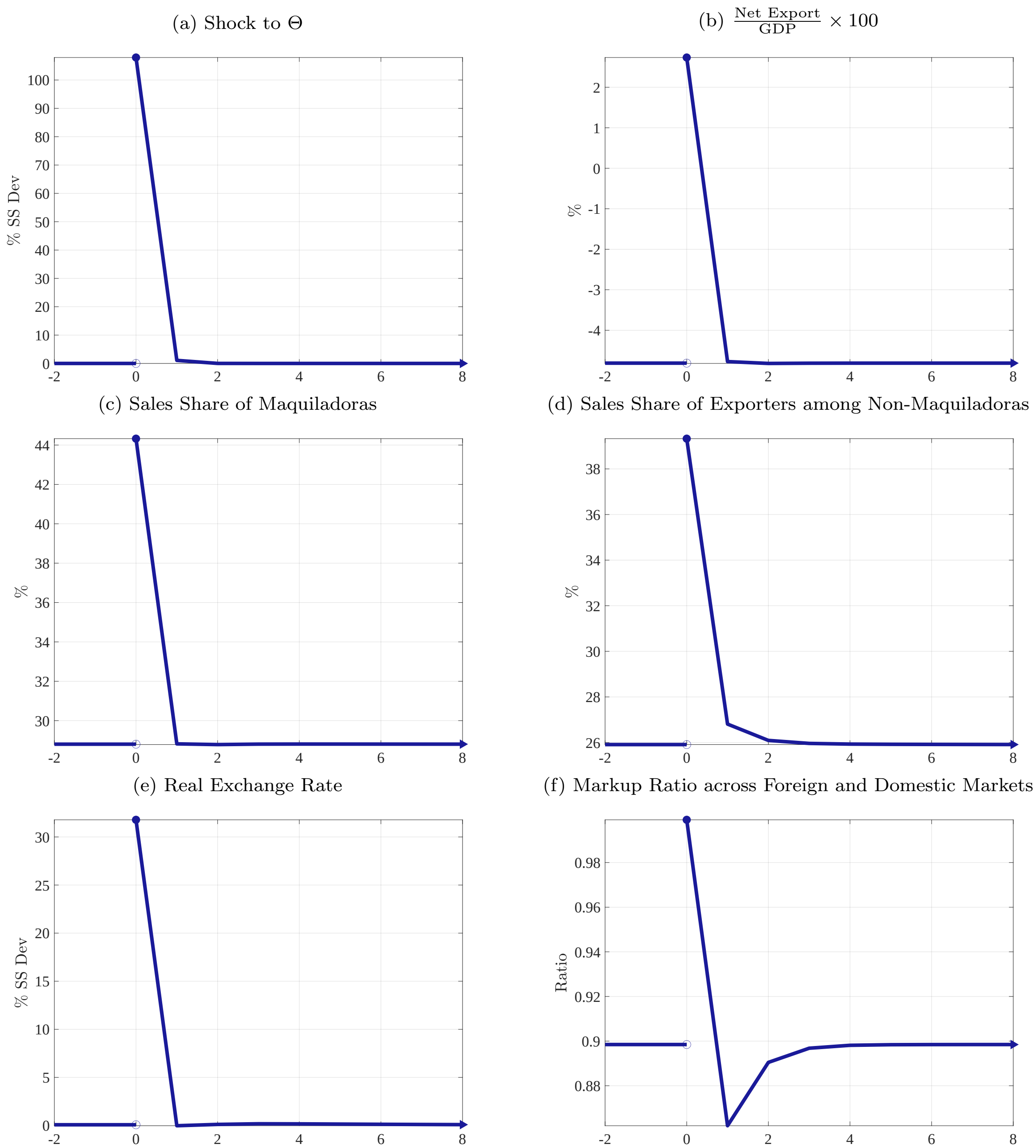

Figure 5.1: Transition Dynamics during a Sudden Stop.

Note: The figure reports the impulse response functions. Panel (a) reports the magnitude of the sudden stop shock, which is unanticipated at time zero. Panel (b) reports the net export to nominal GDP ratio. Panel (c) reports the sales share of maquiladoras as a percentage of value-added in the manufacturing sector. Panel (d) reports the sales share of exporters excluding maquiladoras as a percentage of value-added in the manufacturing sector. Panel (e) reports the impulse response function of real exchange rate, expressed as a percentage deviation from the steady state. Panel (f) reports the ratio of markup for the foreign market to that for the domestic market.

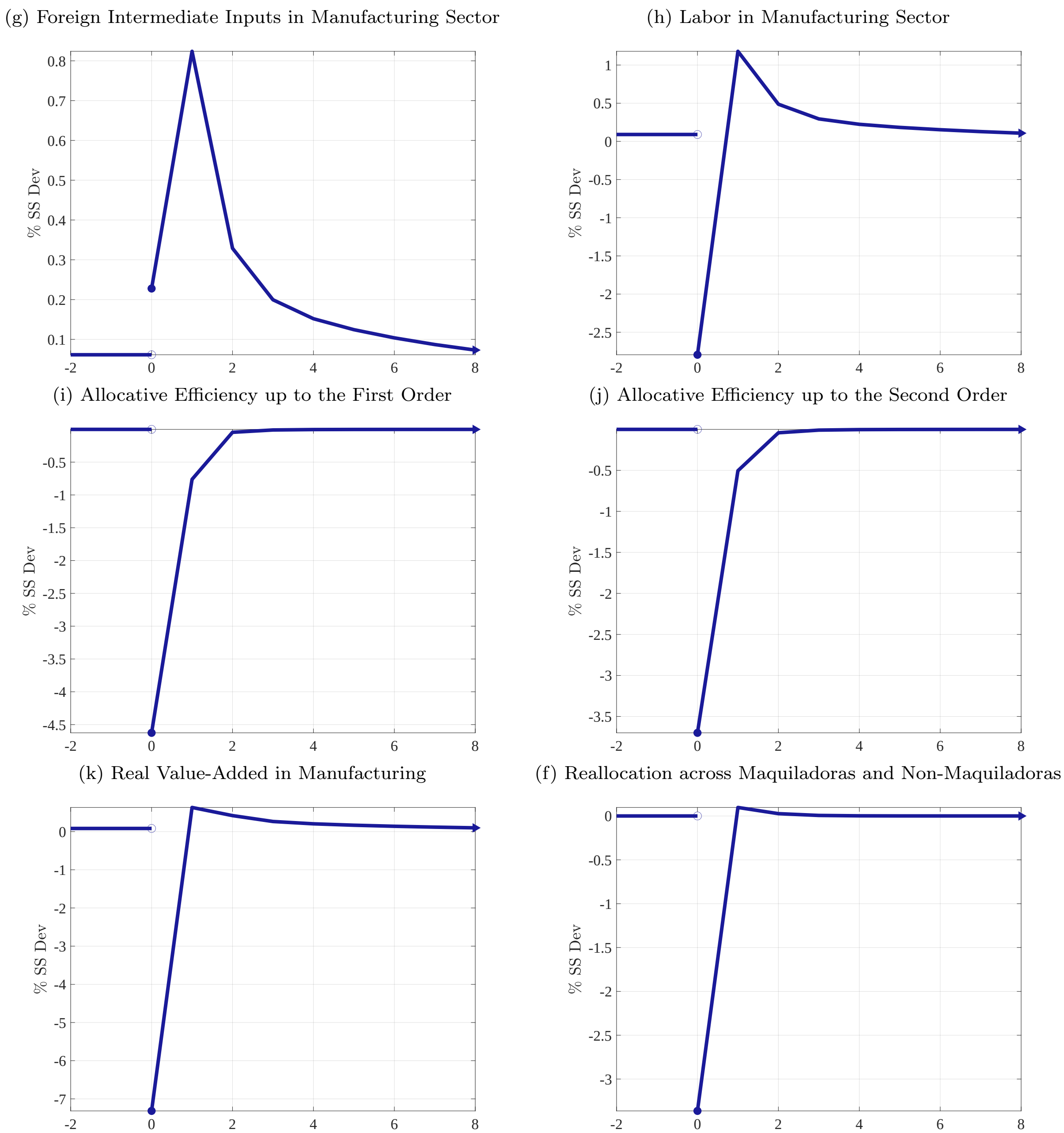

Figure 5.2: Transition Dynamics during a Sudden Stop.

Note: The figure reports the impulse response functions. Panel (g) reports the impulse response function of the quantity of foreign intermediate inputs in the manufacturing sector, expressed as a percentage deviation from the steady state. Panel (h) reports reports the impulse response function of the number of workers in the manufacturing sector. Panel (i) reports the percentage change in allocative efficiency up to the first order. Panel (j) reports the percentage change in allocative efficiency up to the second order. Panel (k) reports the percentage change in real value-added in the manufacturing sector up to the second order. Last, panel (f) reports the reallocation effect up to the second order across maquiladoras and non-maquiladoras in percentage terms.

6. Conclusion

I analyze the impact of a sudden stop on allocative efficiency, TFP, and real GDP. During a sudden stop, reallocation of resources from non-export activities with larger distortions to export-oriented activities with smaller distortions cause a decline in TFP. I provide empirical, theoretical, and quantitative analysis of this effect. Leveraging detailed microdata from Mexico, I provide new empirical evidence illustrating the difference in distortions and reallocations of resources at the plant–product–destination level during the sudden stop. Using a sufficient statistics formula, I analyze the contribution of these reallocations on TFP. Then, I construct a model of a sudden stop to understand the underlying mechanism. From a quantitative perspective, my analysis demonstrates that the resource reallocations explain about 50% reduction in value added in the manufacturing sector during the 1994 Mexican sudden stop.

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A. Appendix A: Proofs

Proof of Lemma 1

According to Baqaee and Farhi [2019], the local change in real GDP is expressed as:

$$\begin{aligned}
&\int_{k\in\mathcal{N}} \tilde{\lambda}_{k,t} d\log A_{k,t} dk + \tilde{\Lambda}_{L,t} d\log L_t + \sum_{i\in\mathcal{F}} \left(\tilde{\Lambda}^*_{i,t} - \Lambda^*_{i,t}\right) d\log X_{i,t} \\
&- \int_{k\in\mathcal{N}} \tilde{\lambda}_{k,t} d\log \mu_{k,t} dk - \tilde{\Lambda}_{L,t} d\log \Lambda_{L,t} - \sum_{i\in\mathcal{F}} \left(\tilde{\Lambda}^*_{i,t} - \Lambda^*_{i,t}\right) d\log \Lambda^*_{i,t}
\end{aligned} \tag{A.1}$$

Now I think about a function $\int_{s=t}^{t+1} x_s d\log y_s$. The first-order logarithmic approximation of x_s for this function can be expressed as:

$$\int_{s=t}^{t+1} x_s d\log y_s \approx \left(x_t + \frac{1}{2}\left(x_{t+1} - x_t\right)\right) \Delta \log y_t$$

By integrating equation (A.1) from $s = t$ to $s = t + 1$ and applying this formula to each term, I obtain the desired equation.

Proof of Lemma 3

The global change in TFP up to the second-order is expressed as:

$$\begin{aligned}
\int_{s=t}^{t+1} d\log TFP_{j,s} &\approx \Delta \log \mu_{j,t} - \int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}} \left(\lambda_{j\theta,t} + \frac{1}{2}\left(\lambda_{j\theta,t+1} - \lambda_{j\theta,t}\right)\right) \Delta \log \mu_{j\theta,t} d\theta \\
&= \Delta \log \mu_{j,t} - \int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}} \lambda_{j\theta,t} \Delta \log \mu_{j\theta,t} d\theta - \frac{1}{2}\int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}} \left(\lambda_{j\theta,t+1} - \lambda_{j\theta,t}\right) \Delta \log \mu_{j\theta,t} d\theta
\end{aligned} \tag{A.2}$$

Now I narrow my attention to $\Delta \log \mu_{j,t}$, which is denoted as $\int_{s=t}^{t+1} d\log \mu_j(s)$.

$$\begin{aligned}
\int_{s=t}^{t+1} d\log \mu_j(s) &= \int_{s=t}^{t+1} -\mu_{j,s} \int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}} \frac{\lambda_{j\theta,s}}{\mu_{j\theta,s}} \left(d\log \lambda_{j\theta,s} - d\log \mu_{j\theta,s}\right) d\theta \\
&= \int_{s=t}^{t+1} \int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}} \mu_{j,s} \frac{\lambda_{j\theta,s}}{\mu_{j\theta,s}} \left(d\log \mu_{j\theta,s} - d\log \lambda_{j\theta,s}\right) d\theta
\end{aligned}$$

$$= \int_{\theta \in \{\mathcal{D}, \mathcal{F}^*\}} \int_{s=t}^{t+1} \underbrace{\mu_{j,s} \frac{\lambda_{j\theta,s}}{\mu_{j\theta,s}}}_{\equiv x_{j\theta,s}} \left(d \log \mu_{j\theta,s} - d \log \lambda_{j\theta,s} \right) d\theta$$

By performing the first-order log approximation of $x_{j\theta,s}$, I get

$$\int_{s=t}^{t+1} x_{j\theta,s} \left(d \log \mu_{j\theta,s} - d \log \lambda_{j\theta,s} \right) \approx x_{j\theta,t} \left(\Delta \log \mu_{j\theta,t} - \Delta \log \lambda_{j\theta,t} \right) + \frac{1}{2} \left(x_{j\theta,t+1} - x_{j\theta,t} \right) \left(\Delta \log \mu_{j\theta,t} - \Delta \log \lambda_{j\theta,t} \right)$$

Therefore, I get

$$\begin{aligned} \Delta \log \mu_{j,t} &\approx \int_{\theta \in \{\mathcal{D}, \mathcal{F}^*\}} \left(x_{j\theta,t} \left(\Delta \log \mu_{j\theta,t} - \Delta \log \lambda_{j\theta,t} \right) + \frac{1}{2} \left(x_{j\theta,t+1} - x_{j\theta,t} \right) \left(\Delta \log \mu_{j\theta,t} - \Delta \log \lambda_{j\theta,t} \right) \right) d\theta \\ &= \int_{\theta \in \{\mathcal{D}, \mathcal{F}^*\}} \mu_{j,s} \frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}} \left(\Delta \log \mu_{j\theta,t} - \Delta \log \lambda_{j\theta,t} \right) \\ &+ \frac{1}{2} \left(\mu_{j,t+1} \frac{\lambda_{j\theta,t+1}}{\mu_{j\theta,t+1}} - \mu_{j,t} \frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}} \right) \left(\Delta \log \mu_{j\theta,t} - \Delta \log \lambda_{j\theta,t} \right) d\theta \end{aligned}$$

By substituting the approximated $\Delta \log \mu_{j,t}$ into equation (A.2), I get

$$\begin{aligned} \int_{s=t}^{t+1} d \log TFP_s \approx & \int_{\theta \in \{\mathcal{D}, \mathcal{F}^*\}} \mu_{j,s} \frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}} \left(\Delta \log \mu_{j\theta,t} - \Delta \log \lambda_{j\theta,t} \right) d\theta \\ & + \frac{1}{2} \int_{\theta \in \{\mathcal{D}, \mathcal{F}^*\}} \left(\mu_{j,t+1} \frac{\lambda_{j\theta,t+1}}{\mu_{j\theta,t+1}} - \mu_{j,t} \frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}} \right) \left(\Delta \log \mu_{j\theta,t} - \Delta \log \lambda_{j\theta,t} \right) d\theta \\ & - \int_{\theta \in \{\mathcal{D}, \mathcal{F}^*\}} \lambda_{j\theta,t} \Delta \log \mu_{j\theta,t} d\theta - \frac{1}{2} \int_{\theta \in \{\mathcal{D}, \mathcal{F}^*\}} \left(\lambda_{j\theta,t+1} - \lambda_{j\theta,t} \right) \Delta \log \mu_{j\theta,t} d\theta \end{aligned}$$

$$\begin{aligned} \iff \int_{s=t}^{t+1} d \log TFP_s \approx & \underbrace{\int_{\theta \in \{\mathcal{D}, \mathcal{F}^*\}} \mu_{ij,s} \frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}} \left(\Delta \log \mu_{j\theta,t} - \Delta \log \lambda_{j\theta,t} \right) d\theta - \int_{\theta \in \{\mathcal{D}, \mathcal{F}^*\}} \lambda_{j\theta,t} \Delta \log \mu_{j\theta,t} d\theta}_{\equiv A} \\ & + \frac{1}{2} \left\{ \underbrace{\int_{\theta \in \{\mathcal{D}, \mathcal{F}^*\}} \left(\mu_{j,t+1} \frac{\lambda_{j\theta,t+1}}{\mu_{j\theta,t+1}} - \mu_{j,t} \frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}} \right) \left(\Delta \log \mu_{j\theta,t} - \Delta \log \lambda_{j\theta,t} \right) - \left(\lambda_{j\theta,t+1} - \lambda_{j\theta,t} \right) \Delta \log \mu_{j\theta,t} d\theta}_{\equiv B} \right\} \end{aligned}$$

I focus on term A.

$$A = \int_{\theta \in \{\mathcal{D}, \mathcal{F}^*\}} \mu_{j,s} \frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}} \left(\Delta \log \mu_{j\theta,t} - \Delta \log \lambda_{j\theta,t} \right) d\theta - \int_{\theta \in \{\mathcal{D}, \mathcal{F}^*\}} \lambda_{j\theta,t} \Delta \log \mu_{j\theta,t} d\theta$$

$$
\begin{aligned}
&= E_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}}\Delta\log\mu_{j\theta,t}\right] - E_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}}\Delta\log\lambda_{j\theta,t}\right] - E_{\lambda_{j\theta,t}}\left[\Delta\log\mu_{j\theta,t}\right] \\
&= Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}},\Delta\log\mu_{j\theta,t}\right] + \underbrace{E_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}}\right]}_{=1} E_{\lambda_{j\theta,t}}\left[\Delta\log\mu_{j\theta,t}\right] \\
&- \left(Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}},\Delta\log\lambda_{j\theta,t}\right] + E_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}}\right] \underbrace{E_{\lambda_{j\theta,t}}\left[\Delta\log\lambda_{j\theta,t}\right]}_{=0}\right) - E_{\lambda_{j\theta,t}}\left[\Delta\log\mu_{j\theta,t}\right] \\
&= Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}},\Delta\log\mu_{j\theta,t}\right] - Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}},\Delta\log\lambda_{j\theta,t}\right] \\
&= -Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}},\Delta\log\left(\frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}}\right)\right]
\end{aligned}
$$

Next, I focus on term B.

$$
\begin{aligned}
B &= \int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}}\left(\mu_{j,t+1}\frac{\lambda_{j\theta,t+1}}{\mu_{j\theta,t+1}} - \mu_{j,t}\frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}}\right)\left(\Delta\log\mu_{j\theta,t} - \Delta\log\lambda_{j\theta,t}\right)d\theta \\
&- \int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}}\left(\lambda_{j\theta,t+1} - \lambda_{j\theta,t}\right)\Delta\log\mu_{j\theta,t}d\theta \\
&= \int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}}\left(\mu_{j,t+1}\frac{\lambda_{j\theta,t+1}}{\mu_{j\theta,t+1}}\right)\left(\Delta\log\mu_{j\theta,t} - \Delta\log\lambda_{j\theta,t}\right)d\theta - \int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}}\lambda_{j\theta,t+1}\Delta\log\mu_{j\theta,t}d\theta \\
&- \left\{\int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}}\left(\mu_{j,t}\frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}}\right)\left(\Delta\log\mu_{j\theta,t} - \Delta\log\lambda_{j\theta,t}\right)d\theta - \int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}}\lambda_{j\theta,t}\Delta\log\mu_{j\theta,t}d\theta\right\} \\
&= -Cov_{\lambda_{j\theta,t+1}}\left[\frac{\mu_{j,t+1}}{\mu_{j\theta,t+1}},\Delta\log\left(\frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}}\right)\right] + Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,t}}{\mu_{j\theta,t}},\Delta\log\left(\frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}}\right)\right]
\end{aligned}
$$

I know that $\Delta\log\left(\frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}}\right) = \Delta\log y_{j\theta,t} + \Delta\log mc_{j,t} - \Delta\log p_{j,t}y_{j,t}$. In the end, the global up to the second order is given by

$$
\begin{aligned}
&-Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,t}}{\mu_{j\theta,t}},\Delta\log y_{j\theta,t}\right] \\
&+\frac{1}{2}\left(-Cov_{\lambda_{j\theta,t+1}}\left[\frac{\mu_{j,t+1}}{\mu_{j\theta,t+1}},\Delta\log y_{j\theta,t}\right] + Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,t}}{\mu_{j\theta,t}},\Delta\log y_{j\theta,t}\right]\right)
\end{aligned}
$$

which concludes the proof of Lemma 3.

B. Appendix B: Parameters

Parameter	Description	Value	Note/Source
A. Parameters for Producers			
$\omega_{M,H}$	Labor Input Share of Non-Maquiladoras	0.21	INEGI
$\nu_{M,H}$	Manufacture Input Share of Non-Maquiladoras	0.59	INEGI
$\varsigma_{M,H}$	Foreign Manufacture Input Share of Non-Maquiladoras	0.44	INEGI
$\omega_{M,M}$	Labor Input Share of Maquiladoras	0.14	INEGI
$\nu_{M,M}$	Manufacturing Input Share of Maquiladoras	0.95	INEGI
$\varsigma_{M,M}$	Foreign Manufacturing Input Share of Maquiladoras	0.95	INEGI
$\omega_{NM,H}$	Labor Input Share of Nonmanufacturing	0.54	INEGI
$\nu_{NM,H}$	Manufacture Input Share of Nonmanufacturing	0.31	INEGI
$\varsigma_{NM,H}$	Foreign Manufacture Input Share of Nonmanufacturing	0.05	INEGI
$\mu_{M,H}$	Average Markup of Non-Maquiladoras for Domestic Markets	1.17	Read the Main Text
$\mu^*_{M,H}$	Average Markup of Exporters	1.05	Read the Main Text
$\mu^*_{M,M}$	Average Markup of Maquiladoras	1.05	Read the Main Text
$\mu_{NM,H}$	Average Markup of Nonmanufacturing	1.16	Read the Main Text
δ_p	Price Change Probability of Exporters	0.78	Read the Main Text
$\lambda^*_{M,H}$	Sales Share of Exporters in Value-Added	0.26	INEGI
$\lambda^*_{M,M}$	Sales Share of Maquiladoras in Value-Added	0.29	INEGI
$\xi^{\mathrm{f,d}}$	Elasticity (Foreign vs Domestic Manufacturing Intermediate Input)	0.76	Boehm et al. [2023]
$\xi^{\mathrm{m,nm}}$	Elasticity (Manufacturing vs Nonmanufacturing Intermediate Input)	0.2	Baqaee and Farhi [2022]
$\xi^{\mathrm{l,ii}}$	Elasticity (Value Added vs Intermediate Input)	0.6	Baqaee and Farhi [2022]
σ	Trade Elasticity for Exporters and Maquiladoras	1.85	Read the Main Text

Table B.1: Calibration of Parameters (1/2)

Parameter	Description	Value	Note/Source
B. Parameters for Households			
ϕ	Consumption Share of Manufactured Good	0.21	Inegi
ζ	Elasticity (Manufacturing Good & Nonmanufacturing Good)	0.4	Burstein et al. [2007]
γ	Consumption Share of Foreign Good	0.11	Blaum [2019]
β	Discount Rate	0.91	Cugat [2022]
ι	Labor Supply Elasticity	1.84	Mendoza [2010]
δ_w	Probability of Changing Wage	0.08	Fukui et al. [2023]
C. Other Parameters			
Ξ	Weight Placed on CPI by Monetary Authority	0.842	Read the Main Text
ϱ	Pass-Through Rate	0.53	Read the Main Text
τ_{VAT}	Value-Added Tax	0.1	
τ_{labor}	Payroll Tax	0.25	
τ_{tariff}	Tariff on Foreign Intermediate Inputs	0.08	

Table B.2: Calibration of Parameters (2/2)

C. Appendix C: Additional Figures and Tables

C.1 Import of Foreign Intermediate Inputs

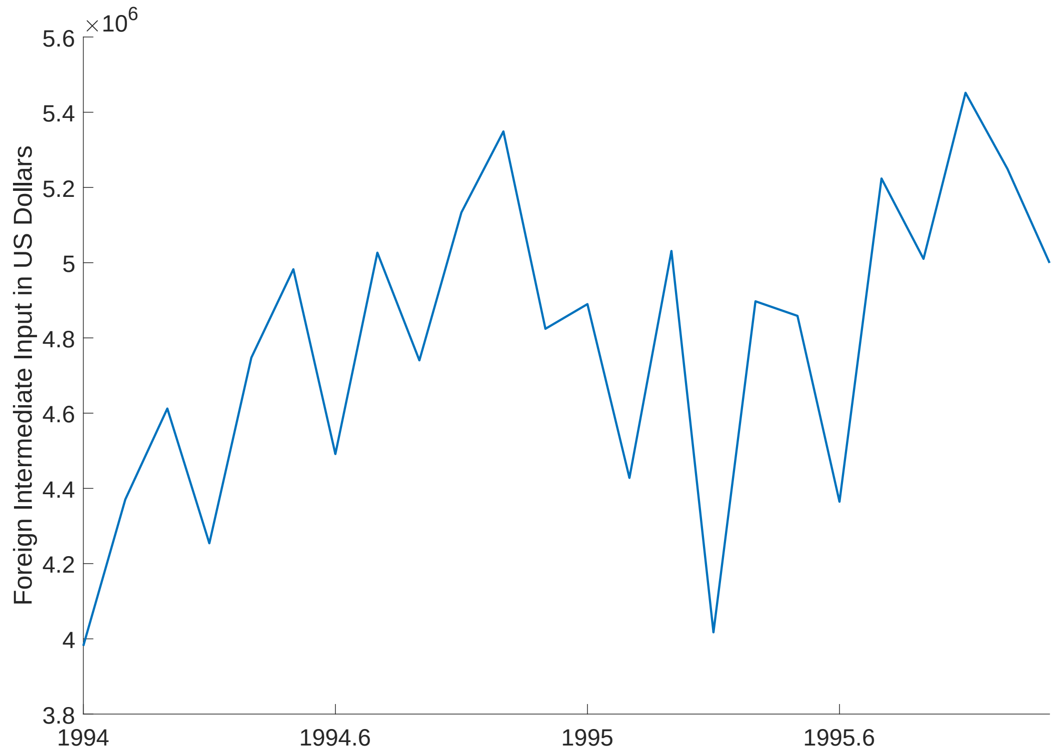

Figure C.1: Foreign Intermediate Inputs in US Dollars

Notes: This figure illustrates the import of foreign intermediate inputs in US dollars from 1994 to 1995. The data is sourced from the balance of payments records at the Bank of Mexico.

C.2 Export Price Index

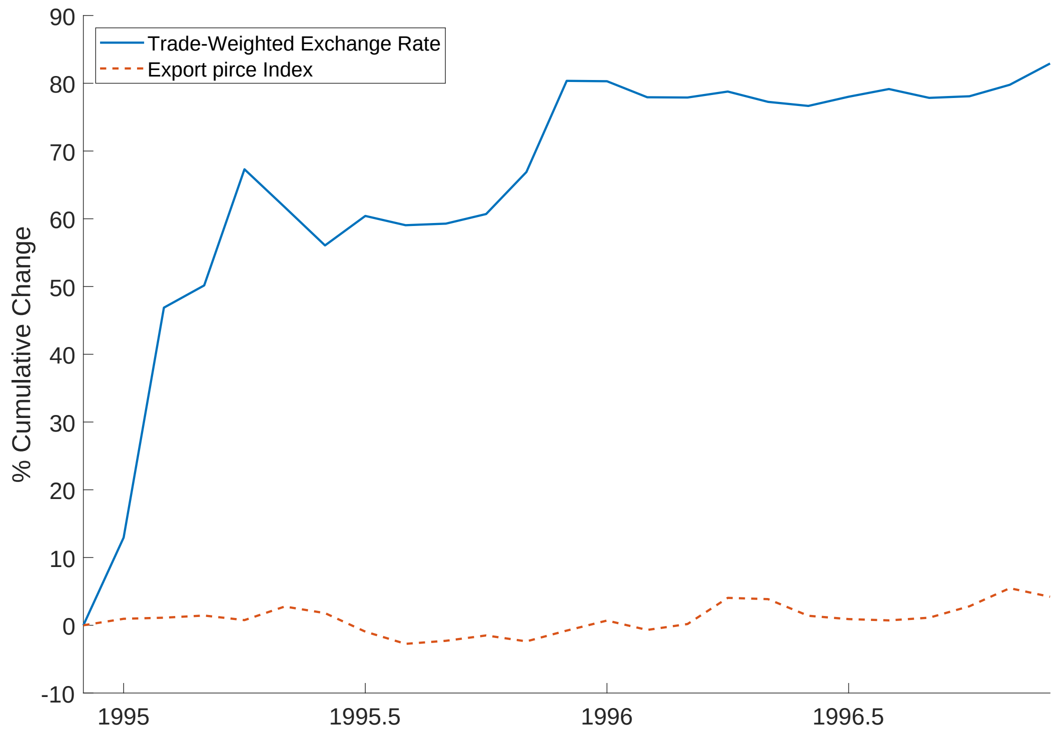

Figure C.2: Trade-Weighted Exchange Rate and Export Price Index

Notes: This figure illustrates cumulative logarithmic changes in trade-weighted nominal exchange rates and export price indices relative to the month preceding the sudden stop. To calculate the export price index, we subtract the the cumulative logarithmic change in trade-weighted nominal exchange rate from the cumulative logarithmic change in export price index in local currency. The data source is credited to Burstein et al. [2005].

C.3 Depreciation Rate

There exist four distinct categories of capital: machinery and production equipment, transportation equipment, construction of buildings and land, and other fixed assets, including office equipment and others such as computers. In accordance with Iacovone [2008] and Kikkawa et al. [2019], the depreciation rates for these capital assets are provided in the subsequent table.

Type of Fixed Assets	Depreciation Rate
Machinery and Equipment	10%
Buildings	5.5%
Transportation Equipment	20%
Office Equipment and Others	21%

Table C.1: Depreciation Rates of Capital

D. Appendix D: System of Equations

In this appendix, I describe the system of equations used in the quantitative exercise.

Household

(i) Consumption Expenditure Shares

The change in the consumption expenditure share of foreign-produced manufacturing goods (γ) can be expressed as follows:

$$\Delta \log \gamma_t = (1-\eta)(1-\gamma)\left(\Delta \log\left(\epsilon_t P^*_{M,F,t}\right) - \Delta \log P_{M,H,t}\right) \tag{D.1}$$

It is important to note that due to the small open economy assumption, $\Delta \log P^*_{M,F,t} = 0$. The change in the price of domestically produced manufacturing consumption goods ($P_{M,H,t}$) is given by

$$\begin{aligned}\Delta \log P_{M,H,t} &= \omega_{M,H}\Delta \log W_t + (1-\omega_{M,H})(1-\nu_{M,H})\Delta \log p_{NM,ii,t} \\ &\quad + (1-\omega_{M,H})\nu_{M,H}\left(\varsigma_{M,H}\Delta \log \epsilon_t + (1-\varsigma_{M,H})\Delta \log p_{M,ii,t}\right)\end{aligned} \tag{D.2}$$

The change in the price of manufacturing intermediate input ($p_{M,ii,t}$) is given by

$$\begin{aligned}\Delta \log p_{M,ii,t} &= \omega_{M,H}\Delta \log W_t + (1-\omega_{M,H})(1-\nu_{M,H})\Delta \log p_{NM,ii,t} \\ &\quad + (1-\omega_{M,H})\nu_{M,H}\left(\varsigma_{M,H}\Delta \log \epsilon_t + (1-\varsigma_{M,H})\Delta \log p_{M,ii,t}\right)\end{aligned} \tag{D.3}$$

The change in the price of non-manufacturing intermediate input ($p_{NM,ii,t}$) is given by

$$\begin{aligned}\Delta \log p_{NM,ii,t} &= \omega_{NM,H}\Delta \log W_t + (1-\omega_{NM,H})(1-\nu_{NM,H})\Delta \log p_{NM,ii,t} \\ &\quad + (1-\omega_{NM,H})\nu_{NM,H}\left(\varsigma_{NM,H}\Delta \log \epsilon_t + (1-\varsigma_{NM,H})\Delta \log p_{M,ii,t}\right)\end{aligned} \tag{D.4}$$

The change in the consumption expenditure share of manufacturing goods (ϕ) is given by

$$\Delta \log \phi_t = (1-\zeta)(1-\phi)\left(\Delta \log P_{M,t} - \Delta \log P_{NM,H,t}\right) \tag{D.5}$$

The change in the price of manufacturing consumption goods ($P_{M,t}$) is given by

$$\Delta \log P_{M,t} = \gamma \Delta \log \left(\epsilon_t P^*_{M,F,t} \right) + (1-\gamma) \Delta \log P_{M,H,t} \tag{D.6}$$

Lastly, the change in the price of non-manufacturing consumption goods ($P_{NM,H,t}$) is given by

$$\begin{aligned} \Delta \log p_{NM,H,t} &= \omega_{NM,H} \Delta \log W_t + (1-\omega_{NM,H})(1-\nu_{NM,H}) \Delta \log p_{NM,ii,t} \\ &\quad + (1-\omega_{NM,H}) \nu_{NM,H} \left(\varsigma_{NM,H} \Delta \log \epsilon_t + (1-\varsigma_{NM,H}) \Delta \log p_{M,ii,t} \right) \end{aligned} \tag{D.7}$$

(ii) Aggregate Consumption and Consumer Price Index

We need an equation which pins down the change in aggregate consumption, as this is needed for calculating marginal utility from consumption, a factor that plays a role in the New Keynesian Wage Phillips Curve derived in the next section. The definition of nominal GDP can be expressed as

$$\text{Aggregate Consumption} + \text{Net Export} = GDP_t$$

$$\Longleftrightarrow P^C_t C_t + \epsilon_t \Theta_t = GDP_t$$

By log-linearizing this equation, we get

$$\Delta \log P^C_t + \Delta \log C_t = \frac{\Delta \log GDP_t - \frac{\epsilon \Delta}{GDP} \left(\Delta \log \epsilon_t + \Delta \log \Theta_t \right)}{1 - \frac{\epsilon \Theta}{GDP}} \tag{D.8}$$

The change in the consumer price index, represented as $\Delta \log P^C_t$, can be expressed as follows

$$\Delta \log P^C_t = \phi \Delta \log P_{M,t} + (1-\phi) \Delta \log P_{NM,H,t} \tag{D.9}$$

(iii) New Keynesian Wage Phillips Curve

Union l chooses $\{W_t(l), N_t(l)\}$ to maximize the objective function:

$$\sum_{s=0}^{\infty} E_t (\beta (1-\delta_w))^s [u(C_{t+s}, L_{t+s})]$$

where $L_{t+s} = \int_0^1 n_{t+s}(l)\, dl$ and the constraints are

$$n_{t+s}(l) = \left(\frac{W_t(l)}{W_{t+s}}\right)^{-\epsilon_w} n_{t+s}$$

$$P_t^C C_t + \epsilon_{t+s}\Theta_{t+s} = W_{t+s}L_{t+s} + \Pi_{t+s}$$

The first order condition with respect to $W_t(l)$ gives us

$$\sum_{s=0}^{\infty} (\beta(1-\delta_w))^s \left[-u_{2,t+s}\epsilon_w \frac{N_{t+s}}{W_{t+s}}\left(\frac{W_t(l)}{W_{t+s}}\right)^{-\epsilon_w - 1} + \lambda_{t+s}\left(N_{t+s}(l) - W_t(l)\,\epsilon_w \frac{N_{t+s}}{W_{t+s}}\left(\frac{W_t(l)}{W_{t+s}}\right)^{-\epsilon_w-1}\right)\right] = 0$$

where $u_{2,t+s} = \frac{\partial u(C_{t+s}, L_{t+s})}{\partial L_{t+s}}$. The household's optimization implies $\lambda_{t+s} = \frac{u_{1,t+s}}{P_{t+s}^C}$. By defining $\mu_w \equiv \frac{\epsilon_w}{\epsilon_w - 1}$, $u_{1,t+s} \equiv MU_{t+s}$, and $-u_{2,t+s} \equiv MD_{i,t+s}$, we can simplify this expression further:

$$W_t^{\text{flex}}(l) = \frac{\sum_{s=0}^{\infty} (\beta(1-\delta_w))^s N_{t+s}(l)\, \mu_w MD_{t+s}}{\sum_{s=0}^{\infty} (\beta(1-\delta_w))^s N_{t+s}(l)\, MU_{t+s}\left(\frac{1}{P_{t+s}}\right)}$$

Log-linearizing this equation, we obtain:

$$\Delta \log W_t^{\text{flex}}(l) = (1-\beta(1-\delta_w)) \sum_{s=0} (\beta(1-\delta_w))^s \left(\Delta \log P_{t+s}^C - \Delta \log MU_{t+s} + \Delta \log MD_{t+s}\right)$$

Log-linearization of the wage index equation represented by $W_t = \left(\int_0^1 W_t(l)^{1-\epsilon_w} dl\right)^{\frac{1}{1-\epsilon_w}}$, we obtain

$$\Delta \log W_{t+1} = \delta_w \Delta \log W_{t+1}^{\text{flex}}(l) + (1-\delta_w)\, \Delta \log W_t$$

Combining these two equations and using the , we arrive at:

$$\begin{aligned}&(\Delta\log W_t-\Delta\log W_{t-1})-\beta\left(\Delta\log W_{t+1}-\Delta\log W_t\right)\\&=\varphi_w\left[-\Delta\log W_t+\left\{\Delta\log P_t^C+\Delta\log\left(\frac{MD_t}{MU_t}\right)\right\}\right]\end{aligned}\tag{D.10}$$

where $\varphi_w=\frac{\delta_w}{1-\delta_w}\left(1-\beta\left(1-\delta_w\right)\right)$. Utility function is given by $u\left(C_t,L_t\right)=\frac{\left[C-\frac{L^\iota}{\iota}\right]^{1-\gamma_{HH}}-1}{1-\gamma_{HH}}$. $\Delta\log\left(\frac{MD_t}{MU_t}\right)$ can be expressed as

$$\begin{aligned}\Delta\log\left(\frac{MD_t}{MU_t}\right)&=\Delta\log\left(\frac{W}{P^C}\right)\\&=(\iota-1)\,\Delta\log L\end{aligned}\tag{D.11}$$

Producers in Manufacturing Sector

(i) Sales Share

The sales share of an exporter of type θ can be expressed as:

$$\lambda^*_{M,H,\theta,t}=\frac{\epsilon_t p^*_{M,H,\theta,t}y^*_{M,H,\theta,t}}{VA_{M,t}}$$

$$\iff\Delta\log\lambda^*_{M,H,\theta,t}=\Delta\log\epsilon_t+\Delta\log p^*_{M,H,\theta,t}+\Delta\log\left(\frac{y^*_{M,H,\theta,t}}{Y^*_{M,F,t}}\right)+\Delta\log Y^*_{M,F,t}-\Delta\log VA_{M,t}$$

where $Y^*_{T,F,t}$ is the total imported manufacturing consumption by foreigners. Importantly, foreign aggregate demand remains unaffected during a sudden stop ($\Delta\log Y^*_{T,M,t}=0$). Additionally, we know

$$\Delta\log\frac{y^*_{M,H,\theta,t}}{Y^*_{M,F,t}}=-\sigma^*_{M,H,\theta}\Delta\log p^*_{M,H,\theta,t}+\sigma^*_{M,H,\theta}\Delta\log P^*_{M,F,t}$$

where $P^*_{M,F,t}$ is the aggregate import manufacturing price index in foreign countries. Small open economy assumption leads to $\Delta\log P^*_{M,F,t}=0$. This leads us to the simplified equation:

$$\Delta\log\lambda^*_{M,H,\theta,t}=\Delta\log\epsilon_t+\left(1-\sigma^*_{M,H,\theta}\right)\Delta\log p^*_{M,H,\theta,t}-\Delta\log VA_{M,t}\tag{D.12}$$

We denote the expectation over producers of type θ, some of which can adjust their prices while others cannot, with the symbol E. The expected sales share for an exporter of type θ is given by

$$E\left[\Delta \log \lambda^*_{M,H,\theta,t}\right] = \Delta \log \epsilon_t + E\left[\left(1-\sigma^*_{M,H,\theta}\right)\Delta \log p^*_{M,H,\theta,t}\right] - \Delta \log VA_{M,t} \tag{D.13}$$

Taking the sales-weighted expectation of (D.13), we can derive the change in the total sales share by exporters in manufacturing sectoras follows:

$$\begin{aligned}
\Delta \log \lambda^*_{M,H,t} &= E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\Delta \log \lambda^*_{M,H,\theta,t}\right]\right] \\
\iff \Delta \log \lambda^*_{M,H,t} &= \Delta \log \epsilon_t + E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\left(1-\sigma^*_{M,H,\theta}\right)\Delta \log p^*_{M,H,\theta,t}\right]\right] \\
&\quad - \Delta \log VA_{M,t}
\end{aligned} \tag{D.14}$$

$E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\left(1-\sigma^*_{M,H,\theta}\right)\Delta \log p^*_{M,H,\theta,t}\right]\right]$ can be derived by solving the price-setting problem in the next section.

(ii) Price and Markup

Exporter in manufacturing sector θ sets its price in foreign currency $\left(p^*_{M,H,\theta,t}\right)$ so as to maximize

$$\sum_{s=0}^{\infty} \left(\beta\left(1-\delta_p\right)\right)^s E_t\left[Q_{t,t+s} y^*_{M,H,\theta,t}\left(p^*_{M,H,\theta,t} - mc^*_{M,H,\theta,t}\right)\right]$$

subject to

$$y^*_{M,F,\theta,t} = \left(\frac{p^*_{M,H,\theta,t}}{P^*_{M,F,t}}\right)^{-\sigma} Y^*_{M,F,t}$$

The first order condition with respect to $p^*_{M,H,\theta,t}$ is given by

$$\sum_{s=0}^{\infty} \left(\beta\left(1-\delta_p\right)\right)^s \left[u_1\left(C_{t+s}, L_{t+s}\right)\frac{\epsilon_{t+s}}{P_{t+s}} y^*_{M,H,\theta,t+s}\left(1 + \frac{\partial y^*_{M,H,\theta,t+s}/y^*_{M,H,\theta,t+s}}{\partial p^*_{M,H,\theta,t}/p^*_{M,H,\theta,t}}\left(\frac{p^*_{M,H,\theta,t} - \frac{mc^*_{M,H,\theta,t+s}}{\epsilon_{t+s}}}{p^*_{M,H,\theta,t}}\right)\right)\right] = 0$$

where $u_1(C_{t+s}, L_{t+s}) = \frac{\partial u(C_{t+s}, L_{t+s})}{\partial C_{t+s}}$. By using $\sigma^*_{M,H,\theta,t} = -\frac{\partial y^*_{M,H,\theta,t}/y^*_{M,H,\theta,t}}{\partial p^*_{M,H,\theta,t}/p^*_{M,H,\theta,t}}$, we get

$$\frac{\hat{mc}^*_{M,H,\theta,t}}{p^{*,flex}_{M,H,\theta,t}} = \frac{\sum_{s=0}^{\infty} (\beta(1-\delta_p))^s \left[u_1(C_{t+s}, L_{t+s}) \frac{\epsilon_{t+s}}{P_{t+s}} y^*_{M,H,\theta,t+s} \left(-\sigma^*_{M,H,\theta,t+s} \frac{\hat{mc}^*_{M,H,\theta,t+s}}{\hat{mc}^*_{M,H,\theta,t}}\right)\right]}{\sum_{s=0}^{\infty} (\beta(1-\delta_p))^s \left[u_1(C_{t+s}, L_{t+s}) \frac{\epsilon_{t+s}}{P_{t+s}} y^*_{M,H,\theta,t+s} \left(1-\sigma^*_{M,H,\theta,t+s}\right)\right]} \tag{D.15}$$

where $\hat{mc}^*_{M,H,\theta,t} = \frac{mc^*_{M,H,\theta,t+s}}{\epsilon_{t+s}}$. By log-linearizing equation (D.15) and using $\Delta \log \mu^*_{M,H,\theta,t+s} = \frac{1-\rho^*_{M,H,\theta}}{\rho^*_{M,H,\theta}} \frac{1}{\sigma^*_{M,H,\theta}} \Delta \log \left(\frac{y^*_{M,H,\theta,t+s}}{Y^*_{M,H,t+s}}\right)$, we get

$$\begin{aligned}\Delta \log p^{*,flex}_{M,H,\theta,t} = (1-\beta(1-\delta_p)) &\left[\rho^*_{M,H,\theta} \Delta \log \hat{mc}^*_{M,H,\theta,t} + \left(1-\rho^*_{M,H,\theta}\right) \underbrace{\Delta \log P^*_{M,F,t}}_{=0}\right] \\ &+ \beta(1-\delta_p) \Delta \log p^{*,flex}_{M,H,\theta,t+1}\end{aligned}$$

The expected price for an exporter of type θ are given by

$$E\left[\Delta \log p^*_{M,H,\theta,t+1}\right] = \delta_p \Delta \log p^{*,\text{flex}}_{M,H,\theta,t+1} + (1-\delta_p) \Delta \log p^*_{M,H,\theta,t}$$

By combining these two equations, we get

$$\begin{aligned}E\left[\Delta \log p^*_{M,H,\theta,t} - \Delta \log p^*_{M,H,\theta,t-1}\right] - \beta E\left[\Delta \log p^*_{M,H,\theta,t+1} - \Delta \log p^*_{M,H,\theta,t}\right] \\ = \varphi_p \left[-E\left[\Delta \log p^*_{M,H,\theta,t}\right] + \rho^*_{M,H,\theta} \Delta \log \left(\hat{mc}^*_{M,H,\theta,t}\right)\right]\end{aligned} \tag{D.16}$$

where $\varphi_p = \frac{\delta_p}{1-\delta_p}(1-\beta(1-\delta_p))$.

By subtracting $E\left[\Delta \log \hat{mc}^*_{M,H,\theta,t} - \Delta \log \hat{mc}^*_{M,H,\theta,t-1}\right] - \beta E\left[\Delta \log \hat{mc}^*_{M,H,\theta,t+1} - \Delta \log \hat{mc}^*_{M,H,\theta,t}\right]$ from both sides of equation (D.16), we get the difference equation for $E\left[\Delta \log \mu^*_{M,H,\theta,t}\right]$:

$$\begin{aligned}E\left[\Delta \log \mu^*_{M,H,\theta,t} - \Delta \log \mu^*_{M,H,\theta,t-1}\right] - \beta E\left[\Delta \log \mu^*_{M,H,\theta,t+1} - \Delta \log \mu^*_{M,H,\theta,t}\right] \\ = -E\left[\Delta \log \left(\hat{mc}^*_{M,H,\theta,t}\right) - \Delta \log \left(\hat{mc}^*_{M,H,\theta,t-1}\right)\right] + \beta E\left[\Delta \log \left(\hat{mc}^*_{M,H,\theta,t+1}\right) - \Delta \log \left(\hat{mc}^*_{M,H,\theta,t}\right)\right] \\ + \varphi \left[-E\left[\Delta \log \mu^*_{M,H,\theta,t}\right] + \left(\rho^*_{M,H,\theta,t} - 1\right) \Delta \log \left(\hat{mc}^*_{M,H,\theta,t+1}\right)\right]\end{aligned} \tag{D.17}$$

From equation (D.16), we can calculate the dynamics of $E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\left(1-\sigma^*_{M,H,\theta}\right) \Delta \log p^*_{M,H,\theta,t}\right]\right]$

which shows up in equation (D.14).

$$
\begin{aligned}
&E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\left(1-\sigma^*_{M,H,\theta}\right)\Delta\log p^*_{M,H,\theta,t}-\left(1-\sigma^*_{M,H,\theta}\right)\Delta\log p^*_{M,H,\theta,t-1}\right]\right]\\
&-\beta E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\left(1-\sigma^*_{M,H,\theta}\right)\Delta\log p^*_{M,H,\theta,t+1}-\left(1-\sigma^*_{M,H,\theta}\right)\Delta\log p^*_{M,H,\theta,t}\right]\right]\\
=\ &\varphi\left[-E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\left(1-\sigma^*_{M,H,\theta}\right)\Delta\log p^*_{M,H,\theta,t}\right]\right]+E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[\rho^*_{M,H,\theta}\left(1-\sigma^*_{M,H,\theta}\right)\Delta\log\left(\hat{mc}^*_{M,H,\theta,t}\right)\right]\right]
\end{aligned}
\tag{D.18}
$$

The change in marginal cost of production for exporters in foreign currency is given by

$$
\begin{aligned}
\Delta\log\hat{mc}^*_{M,H,\theta,t}=\ &\omega^*_{M,H}\Delta\log W_t+\left(1-\omega^*_{M,H}\right)\left(1-\nu^*_{M,H}\right)\Delta\log p_{NM,ii,t}\\
&+\left(1-\omega^*_{M,H}\right)\nu^*_{M,H}\left(\varsigma^*_{M,H}\Delta\log\epsilon_t+\left(1-\varsigma^*_{M,H}\right)\Delta\log p_{M,ii,t}\right)-\Delta\log\epsilon_t
\end{aligned}
\tag{D.19}
$$

(iii) Input Shares

The change in foreign intermediate input share can be expressed by

$$
\Delta\log\varsigma_{M,H,t}=\left(1-\xi^{\mathrm{f,d}}\right)\left(1-\varsigma_{T,M}\right)\left(\Delta\log\epsilon_t-\Delta\log p_{M,ii,t}\right)\tag{D.20}
$$

$$
\Delta\log\varsigma^*_{M,H,t}=\left(1-\xi^{\mathrm{f,d}}\right)\left(1-\varsigma^*_{T,M}\right)\left(\Delta\log\epsilon_t-\Delta\log p_{M,ii,t}\right)\tag{D.21}
$$

The change in manufacturing input share can be expressed by

$$
\begin{aligned}
\Delta\log\nu_{M,H,t}=\ &\left(1-\xi^{\mathrm{m,nm}}\right)\left(1-\nu_{M,H}\right)\\
&\left(\varsigma_{M,H}\Delta\log\epsilon_t+\left(1-\varsigma_{M,H}\right)\Delta\log p_{M,ii,t}-\Delta\log p_{NM,ii,t}\right)
\end{aligned}
\tag{D.22}
$$

$$
\begin{aligned}
\Delta\log\nu^*_{M,H,t}=\ &\left(1-\xi^{\mathrm{m,nm}}\right)\left(1-\nu^*_{M,H}\right)\\
&\left(\varsigma^*_{M,H}\Delta\log\epsilon_t+\left(1-\varsigma^*_{M,H}\right)\Delta\log p_{M,ii,t}-\Delta\log p_{NM,ii,t}\right)
\end{aligned}
\tag{D.23}
$$

The changes in labor input share can be expressed by

$$\Delta \log \omega_{M,H,t} = \left(1-\xi^{\mathrm{l,ii}}\right)\left(1-\omega_{M,H}\right)$$
$$\left(\Delta \log W_t - \left(\nu_{M,H}\left(\varsigma_{M,H}\Delta \log \epsilon_t + \left(1-\varsigma_{M,H}\right)\Delta \log p_{M,ii,t}\right) + \left(1-\nu_{M,H}\right)\Delta \log p_{NM,ii,t}\right)\right) \tag{D.24}$$

$$\Delta \log \omega^*_{M,H,t} = \left(1-\xi^{\mathrm{l,ii}}\right)\left(1-\omega^*_{M,H}\right)$$
$$\left(\Delta \log W_t - \left(\nu^*_{M,H}\left(\varsigma^*_{M,H}\Delta \log \epsilon_t + \left(1-\varsigma^*_{M,H}\right)\Delta \log p_{M,ii,t}\right) + \left(1-\nu^*_{M,H}\right)\Delta \log p_{NM,ii,t}\right)\right) \tag{D.25}$$

Producers in Maquiladoras

The equations for the sales share, price, and input shares for maquiladoras parallel the derivation for producers in the manufacturing sector.

(i) Sales Share

The change in the total sales share for maquiladoras is given by

$$\Delta \log \lambda^*_{M,M,t} = \Delta \log \epsilon_t + E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\left(1-\sigma^*_{M,M,\theta}\right)\Delta \log p^*_{M,M,\theta,t}\right]\right]$$
$$- \Delta \log VA_{M,t} \tag{D.26}$$

(ii) Price and Markup

The difference equation for $E\left[\Delta \log p^*_{M,M,\theta,t}\right]$ is given by

$$E\left[\Delta \log p^*_{M,M,\theta,t} - \Delta \log p^*_{M,M,\theta,t-1}\right] - \beta E\left[\Delta \log p^*_{M,M,\theta,t+1} - \Delta \log p^*_{M,M,\theta,t}\right]$$
$$= \varphi_p\left[-E\left[\Delta \log p^*_{M,M,\theta,t}\right] + \rho^*_{M,M,\theta}\Delta \log\left(\hat{mc}^*_{M,M,\theta,t}\right)\right] \tag{D.27}$$

The difference equation for $E\left[\Delta \log \mu^*_{M,M,\theta,t}\right]$ is given by

$$E\left[\Delta \log \mu^*_{M,M,\theta,t} - \Delta \log \mu^*_{M,M,\theta,t-1}\right] - \beta E\left[\Delta \log \mu^*_{M,M,\theta,t+1} - \Delta \log \mu^*_{M,M,\theta,t}\right]$$
$$= -E\left[\Delta \log\left(\hat{mc}^*_{M,M,\theta,t}\right) - \Delta \log\left(\hat{mc}^*_{M,M,\theta,t-1}\right)\right] + \beta E\left[\Delta \log\left(\hat{mc}^*_{M,M,\theta,t+1}\right) - \Delta \log\left(\hat{mc}^*_{M,M,\theta,t}\right)\right]$$

$$+\varphi\left[-E\left[\Delta\log\mu^*_{M,M,\theta,t}\right]+\left(\rho^*_{M,M,\theta,t}-1\right)\Delta\log\left(\hat{mc}^*_{M,M,\theta,t+1}\right)\right] \tag{D.28}$$

$E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\left(1-\sigma^*_{M,M,\theta}\right)\Delta\log p^*_{M,M,\theta,t}\right]\right]$ satisfies the following difference equation:

$$\begin{aligned}
&E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\left(1-\sigma^*_{M,M,\theta}\right)\Delta\log p^*_{M,M,\theta,t}-\left(1-\sigma^*_{M,M,\theta}\right)\Delta\log p^*_{M,M,\theta,t-1}\right]\right]\\
&-\beta E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\left(1-\sigma^*_{M,M,\theta}\right)\Delta\log p^*_{M,M,\theta,t+1}-\left(1-\sigma^*_{M,M,\theta}\right)\Delta\log p^*_{M,M,\theta,t}\right]\right]\\
&=\varphi\left[-E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\left(1-\sigma^*_{M,M,\theta}\right)\Delta\log p^*_{M,M,\theta,t}\right]\right]+E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[\rho^*_{M,M,\theta}\left(1-\sigma^*_{M,M,\theta}\right)\Delta\log\left(\hat{mc}^*_{M,M,\theta,t}\right)\right]\right]
\end{aligned} \tag{D.29}$$

The change in marginal cost in foreign currency for maquiladoras is given by

$$\begin{aligned}
\Delta\log\hat{mc}^*_{M,M,\theta,t}&=\omega^*_{M,M}\Delta\log W_t+\left(1-\omega^*_{M,M}\right)\left(1-\nu^*_{M,M}\right)\Delta\log p_{NM,ii,t}\\
&+\left(1-\omega^*_{M,M}\right)\nu^*_{M,M}\left(\varsigma^*_{M,M}\Delta\log\epsilon_t+\left(1-\varsigma^*_{M,M}\right)\Delta\log p_{M,ii,t}\right)-\Delta\log\epsilon_t
\end{aligned} \tag{D.30}$$

(iii) Input Shares

The change in foreign intermediate input share can be expressed by

$$\Delta\log\varsigma^*_{M,M,t}=\left(1-\xi^{\mathrm{f,d}}\right)\left(1-\varsigma^*_{M,M}\right)\left(\Delta\log\epsilon_t-\Delta\log p_{M,ii,t}\right) \tag{D.31}$$

The change in manufacturing input share can be expressed by

$$\begin{aligned}
\Delta\log\nu^*_{M,M,t}&=\left(1-\xi^{\mathrm{m,nm}}\right)\left(1-\nu^*_{M,M}\right)\\
&\left(\varsigma^*_{M,M}\Delta\log\epsilon_t+\left(1-\varsigma^*_{M,M}\right)\Delta\log p_{M,ii,t}-\Delta\log p_{NM,ii,t}\right)
\end{aligned} \tag{D.32}$$

The changes in labor input share can be expressed by

$$\Delta\log\omega^*_{M,M,t}=\left(1-\xi^{\mathrm{l,ii}}\right)\left(1-\omega^*_{M,M}\right)$$

$$\left(\Delta \log W_t - \left(\nu^*_{M,M}\left(\varsigma^*_{M,M}\Delta \log \epsilon_t + \left(1-\varsigma^*_{M,M}\right)\Delta \log p_{M,ii,t}\right) + \left(1-\nu^*_{M,M}\right)\Delta \log p_{NM,ii,t}\right)\right) \tag{D.33}$$

Producers in Non-Manufacturing Sector

The equations for the input shares for non-manufacturing sector parallel the derivation for producers in the manufacturing sector.

(i) Input Shares

The change in foreign intermediate input share can be expressed by

$$\Delta \log \varsigma_{NM,H,t} = \left(1-\xi^{\mathrm{f,d}}\right)\left(1-\varsigma_{NM,H}\right)\left(\Delta \log \epsilon_t - \Delta \log p_{M,ii,t}\right) \tag{D.34}$$

The change in manufacturing input share can be expressed by

$$\Delta \log \nu_{NM,H,t} = \left(1-\xi^{\mathrm{m,nm}}\right)\left(1-\nu_{NM,H}\right) \left(\varsigma_{NM,H}\Delta \log \epsilon_t + \left(1-\varsigma_{NM,H}\right)\Delta \log p_{M,ii,t} - \Delta \log p_{NM,ii,t}\right) \tag{D.35}$$

The changes in labor input share can be expressed by

$$\Delta \log \omega_{NM,H,t} = \left(1-\xi^{\mathrm{l,ii}}\right)\left(1-\omega_{NM,H}\right) \left(\Delta \log W_t - \left(\nu^*_{NM,H}\left(\varsigma^*_{NM,H}\Delta \log \epsilon_t + \left(1-\varsigma^*_{NM,H}\right)\Delta \log p_{M,ii,t}\right) + \left(1-\nu^*_{NM,H}\right)\Delta \log p_{NM,ii,t}\right)\right) \tag{D.36}$$

Intermediaries Aggregating Domestically Produced Manufacturing Products

(i) Sales Share

There are five distinct intermediaries that aggregates domestically produced manufacturing products and distribute them to manufacturing producers for domestic markets, manufacturing exporters, maquiladoras, non-manufacturing producers, and final consumers. These intermediaries have the same aggregating function as the final consumers. We denote the sales share of these intermediaries by $\lambda_{M,H,A_M,t}$, $\lambda^*_{M,H,A_M,t}$, $\lambda^*_{M,M,A_M,t}$, $\lambda_{NM,H,A_M,t}$, and $b_{M,H,t}$.

First, we consider a market clearing condition for manufacturing product θ produced for domestic market:

$$y_{M,H,\theta,t} = c_{M,H,\theta,t} + \int x_{M,H,\theta',ii_T(\theta)} d\theta' + \int x^*_{M,H,\theta',ii_T(\theta)} d\theta' + \int x^*_{M,M,\theta',ii_T(\theta)} d\theta' + \int x_{NM,H,\theta',ii_T(\theta)} d\theta'$$

where $c_{M,H,\theta,t}$ is the quantity of consumption by domestic households, $x_{M,H,\theta',ii_T(\theta)}$ is the quantity of spending by manufacturing producer θ' for the domestic market, $x^*_{M,H,\theta',ii_T(\theta)}$ is the spending by manufacturing exporter θ', $x^*_{M,M,\theta',ii_T(\theta)}$ is the spending by maquiladoras θ', and $x_{NM,H,\theta',ii_T(\theta)}$ is the spending by non-manufacturing producer θ'. By integrating over all manufacturing products $\theta \in [0, 1]$ for domestic markets, we get

$$\begin{aligned} \int y_{M,H,\theta,t} d\theta = &\int c_{M,H,\theta,t} d\theta + \int\int x_{M,H,\theta',ii_T(\theta)} d\theta' d\theta \\ &+ \int\int x^*_{M,H,\theta',ii_T(\theta)} d\theta' d\theta + \int\int x^*_{M,M,\theta',ii_T(\theta)} d\theta' d\theta + \int\int x_{NM,H,\theta',ii_T(\theta)} d\theta' d\theta \end{aligned} \tag{D.37}$$

Due to the presence of VAT denoted by τ_{VAT}, the intermediary for the final consumers charges a markup with $1 + \tau_{VAT}$ on the final consumer prices. Consequently, the sales share of this intermediary is given by $b_{M,H,t} = \frac{\int (1+\tau_{VAT}) p_{M,H,\theta,t} c_{M,H,\theta,t} d\theta}{VA_M}$ where $p_{M,H,\theta,t}$ is the original price set by manufacturing producer θ for the domestic market. By transforming equation (D.37), we get

$$\lambda_{M,H,t} = \frac{b_{M,H,t}}{(1 + \tau_{VAT})} + \lambda_{M,H,A_M,t} + \lambda^*_{M,H,A_M,t} + \lambda^*_{M,M,A_M,t} + \lambda_{NM,H,A_M,t}$$

Log-linearizing this equation, we get

$$\begin{aligned} \lambda_{M,H} \Delta \log \lambda_{M,H,t} = &\frac{b_{M,H}}{(1 + \tau_{VAT})} \Delta \log b_{M,H,t} + \lambda_{M,H,A_M} \Delta \log \lambda_{M,H,A_M,t} + \lambda^*_{M,H,A_M} \Delta \log \lambda^*_{M,H,A_M,t} \\ &+ \lambda^*_{M,M,A_M} \Delta \log \lambda^*_{M,M,A_M,t} + \lambda_{NM,H,A_M} \Delta \log \lambda_{NM,H,A_M,t} \end{aligned} \tag{D.38}$$

We proceed to analyze the change in sales share by these intermediaries. We begin by examining λ_{M,H,A_M} which is the sales share of an intermediary that aggregates domestically produced manufacturing products intended for manufacturing producers who produce for domestic markets. This is expressed as follows:

$$\lambda_{M,H,A_M,t} = \frac{\int p_{M,ii,t} x_{M,H,\theta',ii_M,t} d\theta'}{VA_M}$$

The numerator on the right-hand side corresponds to the total expenditure on domestically produced manufacturing inputs by manufacturing producers for domestic markets. This equation can be transformed as follows:

$$\begin{aligned}\lambda_{M,H,A_M,t} &= \frac{\int sales_{M,H,\theta',t} \int \frac{sales_{M,H,\theta',t}}{\int sales_{M,H,\theta',t}} \frac{cost_{M,H,\theta',t}}{sales_{M,H,\theta',t}} \frac{p_{M,ii,t} x_{M,H,\theta',ii_M,t}}{cost_{M,H,\theta',t}} d\theta'}{VA_M} \\ &= \lambda_{M,H,t} \int \frac{\lambda_{M,H,\theta',t}}{\lambda_{M,H,t}} \frac{1}{\mu_{M,H,\theta',t}} \left(1-\omega_{M,H,t}\right) \nu_{M,H,t} \left(1-\varsigma_{M,H,t}\right) d\theta' \\ &= \lambda_{M,H,t} E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}} \left[\frac{1}{\mu_{M,H,\theta',t}}\right] \left(1-\omega_{M,H,t}\right) \nu_{M,H,t} \left(1-\varsigma_{M,H,t}\right)\end{aligned}$$

By log-linearizing this equation, we derive

$$\Delta \log \lambda_{M,H,A_M,t} = \Delta \log \lambda_{M,H,t} + \Delta \log E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}} \left[\frac{1}{\mu_{M,H,\theta',t}}\right] + \Delta \log \left(\left(1-\omega_{M,H,t}\right) \nu_{M,H,t} \left(1-\varsigma_{M,H,t}\right)\right)$$

Further, by transforming $\Delta \log E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}} \left[\frac{1}{\mu_{M,H,\theta',t}}\right]$, we obtain

$$\Delta \log E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}} \left[\frac{1}{\mu_{M,H,\theta',t}}\right] = -\Delta \log \lambda_{M,H,t} + \overline{\mu}_{M,H} E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}} \left[\frac{\Delta \log \lambda_{M,H,\theta',t}}{\mu_{M,H,\theta'}}\right] - \overline{\mu}_{M,H} E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}} \left[\frac{\Delta \log \mu_{M,H,\theta',t}}{\mu_{M,H,\theta'}}\right]$$

Subsequently, we get

$$\begin{aligned}\Delta \log \lambda_{M,H,A_M,t} = {} & \overline{\mu}_{M,H} E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}} \left[\frac{\Delta \log \lambda_{M,H,\theta',t}}{\mu_{M,H,\theta'}}\right] - \overline{\mu}_{M,H} E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}} \left[\frac{\Delta \log \mu_{M,H,\theta',t}}{\mu_{M,H,\theta'}}\right] \\ & + \Delta \log \left(\left(1-\omega_{M,H,t}\right) \nu_{M,H,t} \left(1-\varsigma_{M,H,t}\right)\right)\end{aligned}$$

Producers face flexible prices in the domestic markets, therefore changes in the sales share for the domestic markets are uniform across all producers even when considering if the Kimball function as the final demand function. This is because production function is the same within sector, resulting in the equivalence of the change in aggregate price and the change in individual price. As a result, we have $E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}}\left[\frac{\Delta\log\lambda_{M,H,\theta',t}}{\mu_{M,H,\theta'}}\right]=\frac{\Delta\log\lambda_{M,H,t}}{\overline{\mu}_{M,H}}$. Furthermore, even when employing the Kimball function as the final demand function, there is no change in markup for the domestic market since the relative sales share remains constant. This leads to $E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}}\left[\frac{\Delta\log\mu_{M,H,\theta',t}}{\mu_{M,H,\theta'}}\right]=0$. As a result, we get

$$\Delta\log\lambda_{M,H,A_M,t}=\Delta\log\lambda_{M,H,t}+\Delta\log\left(\left(1-\omega_{M,H,t}\right)\nu_{M,H,t}\left(1-\varsigma_{M,H,t}\right)\right) \tag{D.39}$$

In the same way, we can get the sales shares of intermediaries for exporters:

$$\begin{aligned}\Delta\log\lambda^*_{M,H,A_M,t}=&\,\overline{\mu}^*_{M,H}E_{\frac{\lambda^*_{M,H,\theta'}}{\lambda^*_{M,H}}}\left[\frac{\Delta\log\lambda^*_{M,H,\theta',t}}{\mu^*_{M,H,\theta'}}\right]-\overline{\mu}^*_{M,H}E_{\frac{\lambda^*_{M,H,\theta'}}{\lambda^*_{M,H}}}\left[\frac{\Delta\log\mu^*_{M,H,\theta',t}}{\mu^*_{M,H,\theta'}}\right]\\&+\Delta\log\left(\left(1-\omega^*_{M,H,t}\right)\nu^*_{M,H,t}\left(1-\varsigma^*_{M,H,t}\right)\right)\end{aligned} \tag{D.40}$$

The calculation of$E_{\frac{\lambda^*_{M,H,\theta'}}{\lambda^*_{M,H}}}\left[\frac{\Delta\log\lambda^*_{M,H,\theta',t}}{\mu^*_{M,H,\theta'}}\right]$ can be performed as follows:

$$\begin{aligned}E_{\frac{\lambda^*_{M,H,\theta'}}{\lambda^*_{M,H}}}\left[\frac{\Delta\log\lambda^*_{M,H,\theta',t}}{\mu^*_{M,H,\theta'}}\right]&=\int\frac{\lambda^*_{M,H,\theta'}}{\lambda^*_{M,H}}\frac{\Delta\log\lambda^*_{M,H,\theta',t}}{\mu^*_{M,H,\theta'}}d\theta'\\&=\int\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}\frac{E\left[\Delta\log\lambda^*_{M,H,\theta,t}\right]}{\mu^*_{M,H,\theta}}d\theta\\&=\int\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}\frac{\Delta\log\epsilon_t+E\left[\left(1-\sigma^*_{M,H,\theta}\right)\Delta\log p^*_{M,H,\theta,t}\right]-\Delta\log VA_{M,t}}{\mu^*_{M,H,\theta}}d\theta\\&=\frac{\Delta\log\epsilon_t-\Delta\log VA_{M,t}}{\overline{\mu}^*_{M,H}}+E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\frac{\left(1-\sigma^*_{M,H,\theta}\right)}{\mu^*_{M,H,\theta}}\Delta\log p^*_{M,H,\theta,t}\right]\right]\end{aligned} \tag{D.41}$$

Notice that measure θ' distinguishes between sticky and non-sticky firms, while measure θ does not make this distinction. We use equation (D.13) for the third transformation. Similarly to (D.29), $E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\frac{\left(1-\sigma^*_{M,H,\theta}\right)}{\mu^*_{M,H,\theta}}\Delta\log p^*_{M,H,\theta,t}\right]\right]$ satisfies the following difference equation:

$$
\begin{aligned}
&E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\frac{\left(1-\sigma^*_{M,H,\theta}\right)}{\mu^*_{M,H,\theta}}\Delta\log p^*_{M,H,\theta,t}-\frac{\left(1-\sigma^*_{M,H,\theta}\right)}{\mu^*_{M,H,\theta}}\Delta\log p^*_{M,H,\theta,t-1}\right]\right]\\
&-\beta E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\frac{\left(1-\sigma^*_{M,H,\theta}\right)}{\mu^*_{M,H,\theta}}\Delta\log p^*_{M,H,\theta,t+1}-\frac{\left(1-\sigma^*_{M,H,\theta}\right)}{\mu^*_{M,H,\theta}}\Delta\log p^*_{M,H,\theta,t}\right]\right]\\
&=\varphi\left[-E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\frac{\left(1-\sigma^*_{M,H,\theta}\right)}{\mu^*_{M,H,\theta}}\Delta\log p^*_{M,H,\theta,t}\right]\right]+E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[\frac{\rho^*_{M,H,\theta}\left(1-\sigma^*_{M,H,\theta}\right)}{\mu^*_{M,H,\theta}}\Delta\log\left(\hat{mc}^*_{M,H,\theta,t}\right)\right]\right]
\end{aligned}
\tag{D.42}
$$

From equation (D.17), $E_{\frac{\lambda^*_{M,H,\theta'}}{\lambda^*_{M,H}}}\left[\frac{\Delta\log\mu^*_{M,H,\theta,t}}{\mu^*_{M,H,\theta}}\right]$ satisfies the following difference equation :

$$
\begin{aligned}
&E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\frac{\Delta\log\mu^*_{M,H,\theta,t}}{\mu^*_{M,H,\theta}}-\frac{\Delta\log\mu^*_{M,H,\theta,t-1}}{\mu^*_{M,H,\theta}}\right]\right]\\
&-\beta E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\frac{\Delta\log\mu^*_{M,H,\theta,t+1}}{\mu^*_{M,H,\theta}}-\frac{\Delta\log\mu^*_{M,H,\theta,t}}{\mu^*_{M,H,\theta}}\right]\right]\\
&=-E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\frac{\Delta\log\left(\hat{mc}^*_{M,H,\theta,t}\right)}{\mu^*_{M,H,\theta}}-\frac{\Delta\log\left(\hat{mc}^*_{M,H,\theta,t-1}\right)}{\mu^*_{M,H,\theta}}\right]\right]\\
&+\beta E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\frac{\Delta\log\left(\hat{mc}^*_{M,H,\theta,t+1}\right)}{\mu^*_{M,H,\theta}}-\frac{\Delta\log\left(\hat{mc}^*_{M,H,\theta,t}\right)}{\mu^*_{M,H,\theta}}\right]\right]\\
&+\varphi\left[-E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\frac{\Delta\log\mu^*_{M,H,\theta,t}}{\mu^*_{M,H,\theta}}\right]\right]+E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[\frac{\left(\rho^*_{M,H,\theta,t}-1\right)}{\mu^*_{M,H,\theta}}\Delta\log\left(\hat{mc}^*_{M,H,\theta,t+1}\right)\right]\right]
\end{aligned}
\tag{D.43}
$$

We can derive the change in sales share of intermediaries for maquiladoras in the same way:

$$
\begin{aligned}
\Delta\log\lambda^*_{M,M,A_M,t}=&\ \overline{\mu}^*_{M,M}E_{\frac{\lambda^*_{M,M,\theta'}}{\lambda^*_{M,M}}}\left[\frac{\Delta\log\lambda^*_{M,M,\theta',t}}{\mu^*_{M,M,\theta'}}\right]-\overline{\mu}^*_{M,M}E_{\frac{\lambda^*_{M,M,\theta'}}{\lambda^*_{M,M}}}\left[\frac{\Delta\log\mu^*_{M,M,\theta',t}}{\mu^*_{M,M,\theta'}}\right]\\
&+\Delta\log\left(\left(1-\omega^*_{M,M,t}\right)\nu^*_{M,M,t}\left(1-\varsigma^*_{M,M,t}\right)\right)
\end{aligned}
\tag{D.44}
$$

where $E_{\frac{\lambda^*_{M,M,\theta'}}{\lambda^*_{M,M}}}\left[\frac{\Delta\log\lambda^*_{M,M,\theta',t}}{\mu^*_{M,M,\theta'}}\right]$ is given by

$$E_{\frac{\lambda^*_{M,H,\theta'}}{\lambda^*_{M,H}}}\left[\frac{\Delta\log\lambda^*_{M,H,\theta',t}}{\mu^*_{M,H,\theta'}}\right]=\frac{\Delta\log\epsilon_t-\Delta\log VA_{M,t}}{\overline{\mu}^*_{M,H}}+E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\frac{\left(1-\sigma^*_{M,M,\theta}\right)}{\mu^*_{M,M,\theta}}\Delta\log p^*_{M,M,\theta,t}\right]\right] \tag{D.45}$$

and $E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\frac{\left(1-\sigma^*_{M,M,\theta}\right)}{\mu^*_{M,M,\theta}}\Delta\log p^*_{M,M,\theta,t}\right]\right]$ satisfies the following difference equation:

$$\begin{aligned}
&E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\frac{\left(1-\sigma^*_{M,M,\theta}\right)}{\mu^*_{M,M,\theta}}\Delta\log p^*_{M,M,\theta,t}-\frac{\left(1-\sigma^*_{M,M,\theta}\right)}{\mu^*_{M,M,\theta}}\Delta\log p^*_{M,M,\theta,t-1}\right]\right]\\
&-\beta E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\frac{\left(1-\sigma^*_{M,M,\theta}\right)}{\mu^*_{M,M,\theta}}\Delta\log p^*_{M,M,\theta,t+1}-\frac{\left(1-\sigma^*_{M,M,\theta}\right)}{\mu^*_{M,M,\theta}}\Delta\log p^*_{M,M,\theta,t}\right]\right]\\
&=\varphi\left[-E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\frac{\left(1-\sigma^*_{M,M,\theta}\right)}{\mu^*_{M,M,\theta}}\Delta\log p^*_{M,M,\theta,t}\right]\right]+E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[\frac{\rho^*_{M,M,\theta}\left(1-\sigma^*_{M,M,\theta}\right)}{\mu^*_{M,M,\theta}}\Delta\log\left(\hat{mc}^*_{M,M,\theta,t}\right)\right]\right]
\end{aligned} \tag{D.46}$$

$E_{\frac{\lambda^*_{M,M,\theta'}}{\lambda^*_{M,M}}}\left[\frac{\Delta\log\lambda^*_{M,M,\theta',t}}{\mu^*_{M,M,\theta'}}\right]$ satisfies the following difference equation:

$$\begin{aligned}
&E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\frac{\Delta\log\mu^*_{M,M,\theta,t}}{\mu^*_{M,M,\theta}}-\frac{\Delta\log\mu^*_{M,M,\theta,t-1}}{\mu^*_{M,M,\theta}}\right]\right]\\
&-\beta E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\frac{\Delta\log\mu^*_{M,M,\theta,t+1}}{\mu^*_{M,M,\theta}}-\frac{\Delta\log\mu^*_{M,M,\theta,t}}{\mu^*_{M,M,\theta}}\right]\right]\\
&=-E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\frac{\Delta\log\left(\hat{mc}^*_{M,M,\theta,t}\right)}{\mu^*_{M,M,\theta}}-\frac{\Delta\log\left(\hat{mc}^*_{M,M,\theta,t-1}\right)}{\mu^*_{M,M,\theta}}\right]\right]\\
&+\beta E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\frac{\Delta\log\left(\hat{mc}^*_{M,M,\theta,t+1}\right)}{\mu^*_{M,M,\theta}}-\frac{\Delta\log\left(\hat{mc}^*_{M,M,\theta,t}\right)}{\mu^*_{M,M,\theta}}\right]\right]\\
&+\varphi\left[-E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\frac{\Delta\log\mu^*_{M,M,\theta,t}}{\mu^*_{M,M,\theta}}\right]\right]+E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[\frac{\left(\rho^*_{M,M,\theta,t}-1\right)}{\mu^*_{M,M,\theta}}\Delta\log\left(\hat{mc}^*_{M,M,\theta,t+1}\right)\right]\right]
\end{aligned} \tag{D.47}$$

The sales share of intermediaries for non-manufacturing sector, $\lambda_{NM,H,A_M,t}$, is given by

$$
\begin{aligned}
\lambda_{NM,H,A_M,t} &= \frac{\int p_{M,ii,t} x_{NM,H,\theta,ii_M,t} d\theta}{VA_{M,t}} \\
&= \frac{VA_{NM,t}}{VA_{M,t}} \frac{\int p_{M,ii,t} x_{NM,H,\theta,ii_M,t} d\theta}{VA_{NM,t}} \\
&= \frac{VA_{NM,t}}{VA_{M,t}} \frac{\int sales_{NM,H,\theta,t} \int \frac{sales_{NM,H,\theta,t}}{\int sales_{NM,H,\theta,t}} \frac{cost_{NM,H,\theta,t}}{sales_{NM,H,\theta,t}} \frac{p_{M,ii,t} x_{NM,H,\theta,ii_M,t}}{cost_{NM,H,\theta,t}} d\theta}{VA_{NM,t}} \\
&= \frac{VA_{NM,t}}{VA_{M,t}} \lambda_{NM,H,t} \int \frac{\lambda_{NM,H,\theta,t}}{\lambda_{NM,H,t}} \frac{1}{\mu_{NM,H,\theta,t}} \left(1 - \omega_{NM,H,t}\right) \nu_{NM,H,t} \left(1 - \varsigma_{NM,H,t}\right) d\theta
\end{aligned}
$$

By log-linearizing this equation, we get

$$
\begin{aligned}
\Delta \log \lambda_{NM,H,A_M,t} = &\Delta \log VA_{NM,t} - \Delta \log VA_{M,t} + \Delta \log \lambda_{NM,H,t} \\
&+ \Delta \log \left(E_{\frac{\lambda_{NM,H,\theta}}{\lambda_{NM,H}}} \left[\frac{1}{\mu_{NM,H,\theta,t}} \right] \right) + \Delta \log \left(\left(1 - \omega_{NM,H,t}\right) \nu_{NM,H,t} \left(1 - \varsigma_{NM,H,t}\right) \right)
\end{aligned}
\tag{D.48}
$$

We have $\Delta \log \left(E_{\frac{\lambda_{NM,H,\theta}}{\lambda_{NM,H}}} \left[\frac{1}{\mu_{NM,H,\theta,t}} \right] \right) = 0$ for the same reasons observed in the case of manufacturing producers for the domestic markets.

Intermediaries Aggregating Domestically Produced Non-Manufacturing Products

(i) Sales Share

There are five distinct intermediaries that aggregates domestically produced non-manufacturing products and distribute them to manufacturing producers for domestic markets, manufacturing exporters, maquiladoras, non-manufacturing producers, and final consumers. These intermediaries have the same aggregating function as the final consumers. We denote the sales share of these intermediaries by $\lambda_{M,H,A_{NM},t}$, $\lambda^*_{M,H,A_{NM},t}$, $\lambda^*_{M,M,A_{NM},t}$, $\lambda_{NM,H,A_{NM},t}$, and $b_{NM,H,t}$.

The calculation of changes in sales share for these intermediaries follows the same methodology as that applied to intermediaries aggregating manufacturing products for domestic markets.

$$\lambda_{NM,H}\Delta\log\lambda_{NM,H,t} = \frac{b_{NM,H}}{(1+\tau_{VAT})}\Delta\log b_{NM,H,t} + \lambda_{M,H,A_{NM}}\Delta\log\lambda_{M,H,A_{NM},t} + \lambda^*_{M,H,A_{NM}}\Delta\log\lambda^*_{M,H,A_{NM},t}$$
$$+ \lambda^*_{M,M,A_{NM}}\Delta\log\lambda^*_{M,M,A_{NM},t} + \lambda_{NM,H,A_{NM}}\Delta\log\lambda_{NM,H,A_{NM},t} \qquad (D.49)$$

$$\Delta\log\lambda_{M,H,A_{NM},t} = \Delta\log VA_{M,t} - \Delta\log VA_{NM,t}$$
$$+ \overline{\mu}_{M,H}E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}}\left[\frac{\Delta\log\lambda_{M,H,\theta',t}}{\mu_{M,H,\theta'}}\right] - \overline{\mu}_{M,H}E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}}\left[\frac{\Delta\log\mu_{M,H,\theta',t}}{\mu_{M,H,\theta'}}\right]$$
$$+ \Delta\log\left((1-\omega_{M,H,t})(1-\nu_{M,H,t})\right) \qquad (D.50)$$

$$\Delta\log\lambda^*_{M,H,A_{NM},t} = \Delta\log VA_{M,t} - \Delta\log VA_{NM,t}$$
$$+ \overline{\mu}^*_{M,H}E_{\frac{\lambda^*_{M,H,\theta'}}{\lambda^*_{M,H}}}\left[\frac{\Delta\log\lambda^*_{M,H,\theta',t}}{\mu^*_{M,H,\theta'}}\right] - \overline{\mu}^*_{M,H}E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[\frac{\Delta\log\mu^*_{M,H,\theta',t}}{\mu^*_{M,H,\theta'}}\right]$$
$$+ \Delta\log\left(\left(1-\omega^*_{M,H,t}\right)\left(1-\nu^*_{M,H,t}\right)\right) \qquad (D.51)$$

$$\Delta\log\lambda^*_{M,M,A_{NM},t} = \Delta\log VA_{M,t} - \Delta\log VA_{NM,t}$$
$$+ \overline{\mu}^*_{M,M}E_{\frac{\lambda^*_{M,M,\theta'}}{\lambda^*_{M,M}}}\left[\frac{\Delta\log\lambda^*_{M,M,\theta',t}}{\mu^*_{M,M,\theta'}}\right] - \overline{\mu}^*_{M,M}E_{\frac{\lambda^*_{M,M,\theta'}}{\lambda^*_{M,M}}}\left[\frac{\Delta\log\mu^*_{M,M,\theta',t}}{\mu^*_{M,M,\theta'}}\right]$$
$$+ \Delta\log\left(\left(1-\omega^*_{M,M,t}\right)\left(1-\nu^*_{M,M,t}\right)\right) \qquad (D.52)$$

$$\Delta\log\lambda_{NM,H,A_{NM},t} = \overline{\mu}_{NM,H}E_{\frac{\lambda_{NM,H,\theta'}}{\lambda_{NM,H}}}\left[\frac{\Delta\log\lambda_{NM,H,\theta',t}}{\mu_{NM,H,\theta'}}\right] - \overline{\mu}_{NM,H}E_{\frac{\lambda_{NM,H,\theta'}}{\lambda_{NM,H}}}\left[\frac{\Delta\log\mu_{NM,H,\theta',t}}{\mu_{NM,H,\theta'}}\right]$$
$$+ \Delta\log\left((1-\omega_{NM,H,t})(1-\nu_{NM,H,t})\right) \qquad (D.53)$$

Factor Shares in Manufacturing Sector

First, we consider the revenue-based labor share in manufacturing sector.

$$
\begin{aligned}
\Lambda_{M,L,t} &= \frac{W_t L_{M,t}}{VA_{M,t}} \\
&= \frac{W_t \left(\int_0^1 n_{M,H,\theta',t} d\theta' + \int_0^1 n^*_{M,H,\theta',t} d\theta' + \int_0^1 n^*_{M,M,\theta',t} d\theta' \right)}{VA_{M,t}} \\
&= \int_0^1 \frac{p_{M,H,\theta',t} y_{M,H,\theta',t}}{VA_{M,t}} \frac{\text{Expenditure on Labor}_{M,H,\theta',t}}{p_{M,H,\theta',t} y_{M,H,\theta',t}} \frac{W_t n_{M,H,\theta',t}}{\text{Expenditure on Labor}_{M,H,\theta',t}} d\theta' \\
&+ \int_0^1 \frac{\epsilon_t p^*_{T,H,\theta',t} y^*_{T,H,\theta',t}}{VA_{T,t}} \frac{\text{Expenditure on Labor}^*_{T,H,\theta',t}}{\epsilon_t p^*_{T,H,\theta'} y^*_{T,H,\theta'}} \frac{W_t n^*_{M,H,\theta',t}}{\text{Expenditure on Labor}^*_{M,H,\theta',t}} d\theta' \\
&+ \int_0^1 \frac{\epsilon_t p^*_{T,M,\theta',t} y^*_{T,M,\theta',t}}{VA_{T,t}} \frac{\text{Expenditure on Labor}^*_{T,M,\theta',t}}{\epsilon_t p^*_{T,M,\theta',t} y^*_{T,M,\theta',t}} \frac{W_t n^*_{M,M,\theta',t}}{\text{Expenditure on Labor}^*_{M,M,\theta',t}} d\theta' \\
&= \int_0^1 \frac{p_{M,H,\theta',t} y_{M,H,\theta',t}}{VA_{M,t}} \frac{\text{Expenditure on Labor}_{M,H,\theta',t}}{\mu_{M,H,\theta',t} \times \text{Total Cost}_{M,H,\theta',t}} \frac{1}{1+\tau_{labor}} d\theta' \\
&+ \int_0^1 \frac{\epsilon_t p^*_{M,H,\theta',t} y^*_{M,H,\theta',t}}{VA_{M,t}} \frac{\text{Expenditure on Labor}^*_{M,H,\theta',t}}{\mu^*_{M,H,\theta',t} \times \text{Total Cost}^*_{M,H,\theta',t}} \frac{1}{1+\tau_{labor}} d\theta' \\
&+ \int_0^1 \frac{\epsilon_t p^*_{M,M,\theta',t} y^*_{M,M,\theta',t}}{VA_{M,t}} \frac{\text{Expenditure on Labor}^*_{M,H,\theta',t}}{\mu^*_{M,M,\theta,t} \times \text{Total Cost}^*_{M,M,\theta',t}} \frac{1}{1+\tau_{labor}} d\theta' \\
&= \int_0^1 \lambda_{M,H,\theta',t} \frac{\omega_{M,H,t}}{\mu_{M,H,\theta',t}} \frac{1}{1+\tau_{labor}} d\theta' + \int_0^1 \lambda^*_{M,H,\theta',t} \frac{\omega^*_{M,H,t}}{\mu^*_{M,H,\theta',t}} \frac{1}{1+\tau_{labor}} d\theta' \\
&+ \int_0^1 \lambda^*_{M,M,\theta',t} \frac{\omega^*_{M,M,t}}{\mu^*_{M,M,\theta',t}} \frac{1}{1+\tau_{labor}} d\theta'
\end{aligned}
$$

where "Expenditure on Labor" represents the total expenditure on labor by producers, including payroll taxes, which introduces a wedge between worker income and producer labor expenditure, denoted as $1+\tau_{labor}$. By log-linearizing this equation, we get

$$
\begin{aligned}
\Lambda_{M,L} \Delta \log \Lambda_{M,L,t} = & \frac{\lambda_{M,H}}{1+\tau_{labor}} E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}} \left[\frac{\omega_{M,H}}{\mu_{M,H,\theta'}} \Delta \log \left(\frac{\lambda_{M,H,\theta',t} \omega_{M,H,t}}{\mu_{M,H,\theta',t}} \right) \right] \\
& + \frac{\lambda^*_{M,H}}{1+\tau_{labor}} E_{\frac{\lambda^*_{M,H,\theta'}}{\lambda^*_{M,H}}} \left[\frac{\omega^*_{M,H}}{\mu^*_{M,H,\theta'}} \Delta \log \left(\frac{\lambda^*_{M,H,\theta',t} \omega^*_{M,H,t}}{\mu^*_{M,H,\theta',t}} \right) \right] \\
& + \frac{\lambda^*_{M,M}}{1+\tau_{labor}} E_{\frac{\lambda^*_{M,M,\theta'}}{\lambda^*_{M,M}}} \left[\frac{\omega^*_{M,M}}{\mu^*_{M,M,\theta'}} \Delta \log \left(\frac{\lambda^*_{M,M,\theta',t} \omega^*_{M,M,t}}{\mu^*_{M,M,\theta',t}} \right) \right] \qquad \text{(D.54)}
\end{aligned}
$$

Similarly, the revenue-based foreign intermediate inputs share in the manufacturing sector can be expressed as:

$$
\begin{aligned}
\Lambda^*_{M,t} = & \int_0^1 \lambda_{M,H,\theta',t} \frac{(1-\omega_{M,H,t})\,\nu_{M,H,t}\varsigma_{M,H,t}}{\mu_{M,H,\theta',t}} \frac{1}{1+\tau_{im,NM}} d\theta' \\
& + \int_0^1 \lambda^*_{M,H,\theta',t} \frac{\left(1-\omega^*_{M,H,t}\right)\nu^*_{M,H,t}\varsigma^*_{M,H,t}}{\mu^*_{M,H,\theta',t}} \frac{1}{1+\tau_{im,NM}} d\theta' \\
& + \int_0^1 \lambda^*_{M,M,\theta',t} \frac{\left(1-\omega^*_{M,M,t}\right)\nu^*_{M,M,t}\varsigma^*_{M,M,t}}{\mu^*_{M,M,\theta',t}} \frac{1}{1+\tau_{im,M}} d\theta'
\end{aligned}
$$

where $\tau_{im,NM}$ and $\tau_{im,M}$ are import tariff faced by non-maquiladoras and maquiladoras. By log-linearizing this equation, we get

$$
\begin{aligned}
\Lambda^*_M \Delta \log \Lambda^*_{M,t} = & \frac{\lambda_{M,H}}{1+\tau_{im,NM}} E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}} \Bigg[\frac{(1-\omega_{M,H})\,\nu_{M,H}\varsigma_{M,H}}{\mu_{M,H,\theta'}} \\
& \left(\Delta \log \left(\frac{\lambda_{M,H,\theta',t}\nu_{M,H,t}\varsigma_{T,H,t}}{\mu_{T,H,t}} \right) - \frac{\omega_{M,H}}{1-\omega_{M,H}} \Delta \log \omega_{M,H,t} \right) \Bigg] \\
& + \frac{\lambda^*_{M,H}}{1+\tau_{im,NM}} E_{\frac{\lambda^*_{M,H,\theta'}}{\lambda^*_{M,H}}} \Bigg[\frac{\left(1-\omega^*_{M,H}\right)\nu^*_{M,H}\varsigma^*_{M,H}}{\mu^*_{M,H,\theta'}} \\
& \left(\Delta \log \left(\frac{\lambda^*_{M,H,\theta',t}\nu^*_{M,H,t}\varsigma^*_{M,H,t}}{\mu^*_{M,H,\theta',t}} \right) - \frac{\omega^*_{M,H}}{1-\omega^*_{M,H}} \Delta \log \omega^*_{M,H,t} \right) \Bigg] \\
& + \frac{\lambda^*_{M,M}}{1+\tau_{im,M}} E_{\frac{\lambda^*_{M,M,\theta'}}{\lambda^*_{M,M}}} \Bigg[\frac{\left(1-\omega^*_{M,M}\right)\nu^*_{M,M}\varsigma^*_{M,M}}{\mu^*_{M,M,\theta'}} \\
& \left(\Delta \log \left(\frac{\lambda^*_{M,M,\theta',t}\nu^*_{M,M,t}\varsigma^*_{M,M,t}}{\mu^*_{M,M,\theta',t}} \right) - \frac{\omega^*_{M,M}}{1-\omega^*_{M,M}} \Delta \log \omega^*_{M,M,t} \right) \Bigg] \qquad \text{(D.55)}
\end{aligned}
$$

The revenue-based non-manufacturing intermediate input share in the manufacturing sector is given by

$$
\begin{aligned}
\Lambda_{M,NM,t} = & \int_0^1 \lambda_{M,H,\theta',t} \frac{(1-\omega_{M,H,t})\,(1-\nu_{M,H,t})}{\mu_{M,H,\theta,t}} d\theta' \\
& + \int_0^1 \lambda^*_{M,H,\theta,t} \frac{\left(1-\omega^*_{M,H,t}\right)\left(1-\nu^*_{M,H,t}\right)}{\mu^*_{T,H,\theta,t}} d\theta' \\
& + \int_0^1 \lambda^*_{M,M,\theta',t} \frac{\left(1-\omega^*_{M,M,t}\right)\left(1-\nu^*_{M,M,t}\right)}{\mu^*_{M,M,\theta,t}} d\theta'
\end{aligned}
$$

By log-linearizing this equation, we get

$$\Lambda_{M,NM}\Delta\log\Lambda_{M,NM,t} = \lambda_{M,H} E_{\frac{\lambda_{M,H,\theta'}}{\lambda_{M,H}}}\left[\frac{\left(1-\omega_{M,H}\right)\left(1-\nu_{M,H}\right)}{\mu_{M,H,\theta'}}\right.$$
$$\left.\left(\Delta\log\left(\frac{\lambda_{M,H,\theta',t}}{\mu_{M,H,\theta',t}}\right) - \frac{\omega_{M,H}}{1-\omega_{M,H}}\Delta\log\omega_{M,H,t} - \frac{\nu_{M,H}}{1-\nu_{M,H}}\Delta\log\nu_{M,H,t}\right)\right]$$
$$+ \lambda^*_{M,H} E_{\frac{\lambda^*_{T,H,\theta'}}{\lambda^*_{T,H}}}\left[\frac{\left(1-\omega^*_{M,H}\right)\left(1-\nu^*_{M,H}\right)}{\mu^*_{M,H,\theta}}\right.$$
$$\left.\left(\Delta\log\left(\frac{\lambda^*_{M,H,\theta',t}}{\mu^*_{M,H,\theta',t}}\right) - \frac{\omega^*_{M,H}}{1-\omega^*_{M,H}}\Delta\log\omega^*_{M,H,t} - \frac{\nu^*_{M,H}}{1-\nu^*_{M,H}}\Delta\log\nu^*_{M,H,t}\right)\right]$$
$$+ \lambda^*_{M,M} E_{\frac{\lambda^*_{M,M,\theta'}}{\lambda^*_{M,M}}}\left[\frac{\left(1-\omega^*_{M,M}\right)\left(1-\nu^*_{M,M}\right)}{\mu^*_{M,M,\theta}}\right.$$
$$\left.\left(\Delta\log\left(\frac{\lambda^*_{M,M,\theta',t}}{\mu^*_{M,M,\theta',t}}\right) - \frac{\omega^*_{M,M}}{1-\omega^*_{M,M}}\Delta\log\omega^*_{M,M,t} - \frac{\nu^*_{M,M}}{1-\nu^*_{M,M}}\Delta\log\nu^*_{M,M,t}\right)\right] \tag{D.56}$$

Factor Shares in Non-Manufacturing Sector

The change in factor shares in non-manufacturing sector can be obtained using the same method as employed for deriving factor shares in manufacturing sector.

The change in the revenue-based labor share in non-manufacturing sector is given by

$$\Lambda_{NM,L}\Delta\log\Lambda_{NM,L,t} = \frac{\lambda_{NM,H}}{1+\tau_{labor}} E_{\frac{\lambda_{NM,H,\theta'}}{\lambda_{NM,H}}}\left[\frac{\omega_{NM,H}}{\mu_{NM,H,\theta'}}\Delta\log\left(\frac{\lambda_{NM,H,\theta',t}\omega_{NM,H,t}}{\mu_{NM,H,\theta',t}}\right)\right] \tag{D.57}$$

The change in the revenue-based foreign intermediate input share in non-manufacturing sector is given by

$$\Lambda^*_{NM}\Delta\log\Lambda^*_{NM,t} = \frac{\lambda_{NM,H}}{1+\tau_{im,NM}} E_{\frac{\lambda_{NM,H,\theta'}}{\lambda_{NM,H}}}\left[\frac{\left(1-\omega_{NM,H}\right)\nu_{NM,H}\varsigma_{NM,H}}{\mu_{NM,H,\theta}}\right.$$
$$\left.\left(\Delta\log\left(\frac{\lambda_{NM,H,\theta',t}\nu_{NM,H,t}\varsigma_{NM,H,t}}{\mu_{NM,H,\theta',t}}\right) - \frac{\omega_{NM,H}}{1-\omega_{NM,H}}\Delta\log\omega_{NM,H,t}\right)\right] \tag{D.58}$$

The change in the revenue-based domestically produced manufacturing intermediate input share in non-manufacturing sector is given by

$$\Lambda_{NM,M}\Delta\log\Lambda_{NM,M,t} = \lambda_{NM,H}E_{\frac{\lambda_{NM,H,\theta'}}{\lambda_{NM,H}}}\left[\frac{(1-\omega_{NM,H})\,\nu_{NM,H}\,(1-\varsigma_{NM,H})}{\mu_{NM,H}}\left(\Delta\log\left(\frac{\lambda_{NM,H,\theta',t}\nu_{NM,H,t}}{\mu_{NM,H,\theta',t}}\right)-\frac{\omega_{NM,H}}{1-\omega_{NM,H}}\Delta\log\omega_{NM,H,t}-\frac{\varsigma_{NM,H}}{1-\varsigma_{NM,H}}\Delta\log\varsigma_{NM,H,t}\right)\right] \tag{D.59}$$

Value Added and GDP

Value added in manufacturing sector is given by

$$VA_{M,t} = \sum_{i\in\{\text{Manufacture,Maquiladoras}\}}\left(\text{Sales}_{i,t} - \text{Intermediate Input}_{i,t}\right)$$

$$\Longleftrightarrow VA_{M,t} = \underbrace{\int_{\theta'}(1+\tau_{vat})\,p_{M,H,\theta',t}c_{M,H,\theta',t}d\theta'}_{\text{sales to domestic household}} + \underbrace{\Lambda_{NM,M,t}VA_{NM,t}}_{\text{sales to non-manufacturing sector}} + \underbrace{\int_{\theta'}p^*_{M,H,\theta',t}y^*_{M,H,\theta',t}d\theta'}_{\text{sales by exporter}}$$

$$+\underbrace{\int_{\theta'}p^*_{M,M,\theta',t}y^*_{M,M,\theta',t}d\theta'}_{\text{sales by maquiladoras}} - \underbrace{\Lambda^*_{M,t}VA_{M,t}}_{\text{expenditure on foreign input}} - \underbrace{\Lambda_{M,NM,t}VA_{M,t}}_{\text{expenditure on non-manufacturing input}}$$

$$\Longleftrightarrow 1 = b_{M,H,t} + \Lambda_{NM,M,t}\frac{VA_{NM,t}}{VA_{M,t}} + \lambda^*_{M,H,t} + \lambda^*_{M,M,t} - \Lambda^*_{M,t} - \Lambda_{M,NM,t}$$

By log-linearizing this equation, we get

$$b_{M,H}\Delta\log b_{M,H,t} + \Lambda_{NM,M}\frac{VA_{NM}}{VA_{NM}}\Delta\log\left(\Lambda_{NM,M,t}\frac{VA_{NM,t}}{VA_{M,t}}\right)$$
$$+\lambda^*_{M,H}\Delta\log\lambda^*_{M,H,t} + \lambda^*_{M,M}\Delta\log\lambda^*_{M,M,t} - \Lambda^*_{M}\Delta\log\Lambda^*_{M,t} - \Lambda_{M,NM}\Delta\log\Lambda_{M,NM} = 0 \tag{D.60}$$

Value added in non-manufacturing sector is given by

$$VA_{NM,t} = \left(\text{Sales}_{NM,t} - \text{Intermediate Input}_{NM,t}\right)$$

$$\Longleftrightarrow VA_{NM,t} = \underbrace{\int_{\theta'}p_{NM,H,\theta',t}c_{NM,H,\theta',t}d\theta'}_{\text{sales to domestic consumer}} + \underbrace{\lambda_{M,H,A_{NM},t}VA_{NM,t}}_{\text{sales to manufacturing producer for domestic market}}$$

$$+\underbrace{\lambda^*_{M,H,A_{NM},t}VA_{NM,t}}_{\text{sales to manufacturing exporter}} + \underbrace{\lambda^*_{M,M,A_{NM},t}VA_{NM,t}}_{\text{sales to maquiladoras}}$$

$$- \underbrace{\Lambda^*_{NM,t} VA_{NM,t}}_{\text{expenditure on foreign input}} - \underbrace{\Lambda_{NM,M,t} VA_{NM,t}}_{\text{expenditure on manufacturing input}}$$

$$\iff 1 = b_{NM,H,t} + \lambda_{M,H,A_{NM},t} + \lambda^*_{M,H,A_{NM},t} + \lambda^*_{M,M,A_{NM},t} - \Lambda^*_{NM,t} - \Lambda_{NM,M,t}$$

By log-linearizing this equation, we get

$$b_{NM,H} \Delta \log b_{NM,H,t} + \lambda_{M,H,A_{NM}} \Delta \log \lambda_{M,H,A_{NM},t} + \lambda^*_{M,H,A_{NM}} \Delta \log \lambda^*_{M,H,A_{NM},t}$$
$$+ \lambda^*_{M,M,A_{NM}} \Delta \log \lambda^*_{M,M,A_{NM},t} - \Lambda^*_{NM} \Delta \log \Lambda^*_{NM,t} - \Lambda_{NM,M} \Delta \log \Lambda_{NM,M,t} = 0 \quad \text{(D.61)}$$

The sum of value added by manufacturing sector and non-manufacturing sector equals nominal GDP.

$$VA_{M,t} + VA_{NM,t} = GDP_t$$

By log-linearizing this equation, we get

$$VA_M \Delta \log VA_{M,t} + VA_{NM} \Delta \log VA_{NM,t} = GDP \Delta \log GDP_t \quad \text{(D.62)}$$

Nominal GDP can also be calculated using the expenditure approach:

$$\underbrace{P_{M,H,t} C_{M,H,t} + \epsilon_t P^*_{M,F,t} C_{M,F,t} + P_{NM,H,t} C_{NM,H,t}}_{\text{Domestic Consumption}}$$
$$+ \text{Net Export}_t = GDP_t$$

We know net export is equal to net capital outflow, i.e., Net $\text{Export}_t = \epsilon_t \Theta_t$. Therefore, we have

$$P_{M,H,t} C_{M,H,t} + \epsilon_t P^*_{M,F,t} C_{M,F,t} + P_{NM,H,t} C_{NM,H,t} + \epsilon_t \Theta_t = GDP_t \quad \text{(D.63)}$$

We know $\frac{P_{M,H,t} C_{M,H,t}}{GDP_t} = \frac{P_{M,H,t} C_{M,H,t}}{VA_{T,t}} \frac{VA_{T,t}}{GDP_t} = b_{T,H,t} \frac{VA_{T,t}}{GDP_t}$. From consumer's preferences, we get

$$\frac{P_{NM,H,t} C_{NM,H,t}}{P_{M,H,t} C_{M,H,t} + \epsilon_t P^*_{M,F,t} C_{M,F,t}} = \frac{1 - \phi}{\phi}$$

and

$$\frac{\epsilon_t P^*_{M,F,t} C_{M,F,t}}{P_{M,H,t} C_{M,H,t}} = \frac{\gamma}{1 - \gamma}$$

By using these equations, we can transform equation (D.63) as follows:

$$P_{M,H,t}C_{M,H,t} + \epsilon_t P^*_{M,F,t}C_{M,F,t} + P_{NM,H,t}C_{NM,H,t} + \epsilon_t \Theta_t = GDP_t$$

$$\iff b_{M,H,t}\frac{VA_{M,t}}{GDP_t} + \frac{\gamma}{1-\gamma}b_{M,H,t}\frac{VA_{M,t}}{GDP_t} + \frac{1-\phi}{\phi}\frac{1}{1-\gamma}b_{M,H,t}\frac{VA_{M,t}}{GDP_t} + \frac{\epsilon_t\Theta_t}{GDP_t} = 1$$

$$\iff \frac{1}{1-\gamma}\frac{1}{\phi}b_{M,H,t}\frac{VA_{M,t}}{GDP_t} = 1 - \frac{\epsilon_t\Theta_t}{GDP_t}$$

By log-linearizing this equation, we get

$$\Delta \log b_{M,H,t} + \Delta \log VA_{M,t} - \Delta \log GDP_t + \frac{\gamma}{1-\gamma}\Delta \log \gamma_t - \Delta \log \phi_t$$
$$= \frac{1}{(1-\frac{\epsilon\Theta}{GDP})}\left(\frac{\epsilon\Theta}{GDP}\right)(\Delta \log GDP_t - \Delta \log \Theta_t - \Delta \log \epsilon_t) \tag{D.64}$$

Current Account Identity

According to the current account identity, net export is equal to net capital outflow:

$$\underbrace{\int_0^1 \epsilon_t p^*_{M,H,\theta,t}y^*_{M,H,\theta,t}d\theta + \int_0^1 \epsilon_t p^*_{M,M,\theta,t}y^*_{M,M,\theta,t}d\theta - P^*_{M,F,t}C_{M,F,t} - \epsilon_t X_t P^*_{X,t}}_{\text{Net Export}}$$
$$= \underbrace{\epsilon_t\Theta_t}_{\text{Net Capital Outflow}}$$

where $X_t = \int_0^1 x_{M,H,\theta,m,f,t}d\theta + \int_0^1 x^*_{M,H,\theta,m,f,t}d\theta + \int_0^1 x^*_{M,M,\theta,m,f,t}d\theta + \int_0^1 x_{NT,H,\theta,m,f,t}d\theta$ is total quantity of foreign intermediate input. From consumer's preference, we get

$$\frac{\epsilon_t P^*_{M,F,t}C_{M,F,t}}{P_{M,H,t}C_{M,H,t}} = \frac{\gamma}{1-\gamma}$$

$$\iff \frac{\epsilon_t P^*_{M,F,t}C_{M,F,t}}{VA_{M,t}} = \frac{\gamma}{1-\gamma}\underbrace{\frac{P_{M,H,t}C_{M,H,t}}{VA_{M,t}}}_{=b_{M,H,t}}$$

Also from the definition of revenue based foreign intermediate input share, we know

$$\Lambda^*_{M,t} = \frac{\int_0^1 \epsilon_t P^*_{X,t}x_{M,H,\theta,m,f,t}d\theta + \int_0^1 \epsilon_t P^*_{X,t}x^*_{M,H,\theta,m,f,t}d\theta + \int_0^1 \epsilon_t P^*_{X,t}x^*_{M,M,\theta,m,f,t}d\theta}{VA_{M,t}}$$

$$\Lambda^*_{NM,t} = \frac{\int_0^1 \epsilon_t P^*_{X,t} x^*_{NM,H,\theta,m,f,t} d\theta}{VA_{NM,t}}$$

By using these equations, we can transform the current account identity as follows:

$$\lambda^*_{M,H,t} + \lambda^*_{M,M,t} - \frac{\gamma}{1-\gamma} b_{M,H,t} - \Lambda^*_{M,t} - \Lambda^*_{NM,t} \frac{VA_{NM,t}}{VA_{M,t}} = \frac{\epsilon_t \Theta_t}{VA_{M,t}}$$

By log-linearizing this equation, we get

$$\begin{aligned} \frac{\epsilon\Theta}{VA_M} \left(\Delta \log \epsilon_t + \Delta \log \Theta_t - \Delta \log VA_{M,t}\right) = \lambda^*_{M,H} \Delta \log \lambda^*_{M,H,t} + \lambda^*_{M,M} \Delta \log \lambda^*_{M,M,t} - \frac{\gamma}{1-\gamma} b_{M,H} \Delta \log b_{M,H,t} \\ - \frac{\gamma}{1-\gamma} \frac{1}{1-\gamma} b_{M,H} \Delta \log \gamma_t - \Lambda^*_M \Delta \log \Lambda^*_{M,t} \\ - \Lambda^*_{NM} \frac{VA_{NM}}{VA_M} \left(\Delta \log \Lambda^*_{NM,t} + \Delta \log VA_{NM,t} - \Delta \log VA_{M,t}\right) \end{aligned} \tag{D.65}$$

Aggregate Labor

We need an equation which pins down the change in aggregate labor supply, as this is needed for calculating marginal disutility from labor, a factor that plays a role in the New Keynesian Wage Phillips Curve. The revenue-based aggregate labor share is given by

$$\begin{aligned} \Lambda_{L,t} &= \frac{W_t L_t}{GDP_t} \\ &= \left(\Lambda_{M,L,t} VA_{M,t} + \Lambda_{NM,L,t} VA_{NM,t}\right) \frac{1}{GDP_t} \end{aligned}$$

By log-linearizing this equation, we get

$$\begin{aligned} \Delta \log \Lambda_{L,t} = &\frac{\Lambda_{M,L} VA_M}{(\Lambda_{M,L} VA_M + \Lambda_{NM,L} VA_{NM})} \left(\Delta \log \Lambda_{M,L,t} + \Delta \log VA_{M,t}\right) \\ &+ \frac{\Lambda_{NM,L} VA_{NM}}{(\Lambda_{M,L} VA_M + \Lambda_{NM,L} VA_{NM})} \left(\Delta \log \Lambda_{NM,L,t} + \Delta \log VA_{NM,t}\right) - \Delta \log GDP_t \end{aligned} \tag{D.66}$$

Once the change in the revenue-based aggregate labor share is pinned down, we can determine the change in aggregate labor supply, which can be expressed as

$$\Delta \log \Lambda_{L,t} = \Delta \log W_t + \Delta \log L_t - \Delta \log GDP_t$$

$$\iff \Delta \log L_t = \Delta \log \Lambda_{L,t} - \Delta \log W_t + \Delta \log GDP_t \tag{D.67}$$

Monetary Policy

The primary objectives of the monetary authority are to achieve stabilization in the labor market and price levels:

$$\Xi \Delta \log P_t^C + (1 - \Xi) \Delta \log L_t = 0 \tag{D.68}$$

where P^C is the domestic consumer index, and Ξ determines the extent to which the monetary authority prioritizes the stabilization of the domestic consumer price index.

Shock

Sudden stop is described by an exogenous increase in Θ_t which follows the following AR(1) process:

$$\Delta \log \Theta_t = \rho_\Theta \Delta \log \Theta_{t-1} + \epsilon_{\Theta,t} \tag{D.69}$$

We refer to the shock to this equation $\{\epsilon_{\Theta,t}\}$ as the sudden stop shock.

Equilibrium

Given a sequence of sudden stop shock, the equilibrium consists of the paths of allocations, $\{\Delta \log \gamma_t,\ \Delta \log \phi_t,\ \Delta \log C_t,\ \Delta \log GDP_t,\ \Delta \log \left(\frac{MD_t}{MU_t}\right),\ \Delta \log \lambda^*_{M,H,t},\ \Delta \log \varsigma_{M,H,t},$ $\Delta \log \varsigma^*_{M,H,t},\ \Delta \log \nu_{M,H,t},\ \Delta \log \nu^*_{M,H,t},\ \Delta \log \omega_{M,H,t},\ \Delta \log \omega^*_{M,H,t},\ \Delta \log \lambda^*_{M,M,t},\ \Delta \log \varsigma^*_{M,M,t},$ $\Delta \log \nu^*_{M,M,t}, \Delta \log \omega^*_{M,M,t}, \Delta \log \varsigma_{NM,H,t}, \Delta \log \nu_{NM,H,t}, \Delta \log \omega_{NM,H,t}, \Delta \log \lambda_{M,H,t}, \Delta \log b_{M,H,t},$ $\Delta \log \lambda_{M,H,A_M,t},\ \Delta \log \lambda^*_{M,H,A_M,t},\ \Delta \log \lambda^*_{M,M,A_M,t},\ \Delta \log \lambda_{NM,H,A_M,t},\ E_{\frac{\lambda^*_{M,H,\theta'}}{\lambda^*_{M,H}}}\left[\frac{\Delta \log \lambda^*_{M,H,\theta',t}}{\mu^*_{M,H,\theta'}}\right],$ $E_{\frac{\lambda^*_{M,H,\theta'}}{\lambda^*_{M,H}}}\left[\frac{\Delta \log \mu^*_{M,H,\theta,t}}{\mu^*_{M,H,\theta}}\right], E_{\frac{\lambda^*_{M,M,\theta'}}{\lambda^*_{M,M}}}\left[\frac{\Delta \log \lambda^*_{M,M,\theta',t}}{\mu^*_{M,M,\theta'}}\right], E_{\frac{\lambda^*_{M,M,\theta'}}{\lambda^*_{M,M}}}\left[\frac{\Delta \log \lambda^*_{M,M,\theta',t}}{\mu^*_{M,M,\theta'}}\right], \Delta \log \lambda_{NM,H,t}, \Delta \log \lambda_{NM,H,t},$ $\Delta \log \lambda_{M,H,A_{NM},t}, \Delta \log \lambda^*_{M,H,A_{NM},t}, \Delta \log \lambda^*_{M,M,A_{NM},t}, \Delta \log \lambda_{NM,H,A_{NM},t}, \Delta \log \Lambda_{M,L,t}, \Delta \log \Lambda^*_{M,t},$ $\Delta \log \Lambda_{M,NM,t}, \Delta \log \Lambda_{NM,L,t}, \Delta \log \Lambda^*_{NM,t}, \Delta \log \Lambda_{NM,M,t}, \Delta \log VA_{M,t}, \Delta \log VA_{NM,t}, \Delta \log \Lambda_{L,t},$ $\Delta \log L_t\}$, the path of shock processes, $\{\Delta \log \Theta_t\}$, the path of prices, $\{\Delta \log \epsilon_t, \Delta \log P_{M,H,t},$ $\Delta \log W_t,\ \Delta \log p_{NM,ii,t},\ \Delta \log p_{M,ii,t},\ \Delta \log P_{M,t},\ \Delta \log P_{NM,H,t},\ \Delta \log P_t^C,\ \Delta \log \hat{mc}^*_{M,H,\theta,t},$ $\Delta \log \hat{mc}^*_{M,M,\theta,t},\ E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\left(1 - \sigma^*_{M,H,\theta}\right) \Delta \log p^*_{M,H,\theta,t}\right]\right],$

$E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\left(1-\sigma^*_{M,M,\theta}\right)\Delta\log p^*_{M,M,\theta,t}\right]\right]$, $E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\frac{\left(1-\sigma^*_{M,H,\theta}\right)}{\mu^*_{M,H,\theta}}\Delta\log p^*_{M,H,\theta,t}\right]\right]$, $E_{\frac{\lambda^*_{M,M,\theta}}{\lambda^*_{M,M}}}\left[E\left[\frac{\left(1-\sigma^*_{M,M,\theta}\right)}{\mu^*_{M,M,\theta}}\Delta\log p^*_{M,M,\theta,t}\right]\right]\}$ such that equations (D.1), (D.2), (D.3), (D.4), (D.5), (D.6), (D.7), (D.8), (D.9), (D.10), (D.11), (D.14), (D.18), (D.19), (D.20), (D.21), (D.22), (D.23), (D.24), (D.25) (D.26), (D.29), (D.30), (D.31), (D.32), (D.33), (D.34), (D.35), (D.36), (D.38) (D.39), (D.40), (D.41), (D.42), (D.43), (D.44), (D.45), (D.46), (D.47), (D.48) (D.49), (D.50), (D.51), (D.52), (D.53), (D.54), (D.55), (D.56), (D.57), (D.58) (D.59), (D.60), (D.61), (D.62), (D.64), (D.65), (D.66), (D.67), (D.68), and (D.69) hold.

E. Appendix E: Steady State

We outline the procedure for calculating the steady state. Once we calculate the steady state values of the following four variables, we can pin down the steady states of all other variables: the sales share of manufacturing producer for domestic markets as a fraction of value-added in the manufacturing sector ($\lambda_{M,H}$), the sales share of non-manufacturing producers as a fraction of value-added in the non-manufacturing sector ($\lambda_{NM,H}$), domestic household's consumption share of manufacturing good as a fraction of value-added in the manufacturing sector ($b_{M,H}$), and the sales share of an intermediary aggregating manufacturing products for the non-manufacturing sector (λ_{NM,H,A_M}).

The vector representing the final output sales as a fraction of value-added in the manufacturing sector is as follows:

$$\Omega_{Y_m} = \left(0, \lambda^*_{M,H}, \lambda^*_{M,M}, b_{M,H}, \lambda_{NM,H,A_M}, 0, 0, 0, 0, 0, 0, 0, 0, 0\right)$$

The order of producers and inputs is structured as follows:

1. Manufacturing producers for domestic markets.
2. Manufacturing exporters in non-maquiladoras.
3. Maquiadoras.
4. An intermediary aggregating manufacturing products for the domestic consumer.
5. An intermediary aggregating manufacturing products for the non-manufacturing sector.
6. An intermediary aggregating manufacturing products for the manufacturing producer for domestic markets.
7. An intermediary aggregating manufacturing products for the exporters in non-maquiladoras.
8. An intermediary aggregating manufacturing products for maquiladoras.
9. An intermediary imposing payroll tax on labor and providing labor service to producers.

10. An intermediary imposing tariff on foreign intermediate inputs and providing them to non-maquiladoras.

11. An intermediary passing foreign intermediate inputs to maquiladoras.

12. Non-manufacturing intermediate inputs.

13. Foreign intermediate inputs.

14. Labor.

The cost-based input-output matrix is give by

$$\tilde{\Omega} = \begin{bmatrix}
0 & \mathbf{0} & \tilde{\Omega}_{M,H,M,D} & 0 & 0 & \tilde{\Omega}_{M,H,L} & \tilde{\Omega}_{M,H,M,F} & 0 & \tilde{\Omega}_{M,H,NM} & 0 & 0 \\
0 & \mathbf{0} & 0 & \tilde{\Omega}^{*}_{M,H,M,D} & 0 & \tilde{\Omega}^{*}_{M,H,L} & \tilde{\Omega}^{*}_{M,H,M,F} & 0 & \tilde{\Omega}^{*}_{M,H,NM} & 0 & 0 \\
0 & \mathbf{0} & 0 & 0 & \tilde{\Omega}^{*}_{M,M,M,D} & \tilde{\Omega}^{*}_{M,M,L} & 0 & \tilde{\Omega}^{*}_{M,M,M,F} & \tilde{\Omega}^{*}_{M,M,NM} & 0 & 0 \\
1 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}$$

where $\mathbf{0}$ represents a 1×4 zero vector, $\tilde{\Omega}_{i,L} = \omega_i$ denotes the expenditure share on labor by sector i, $\tilde{\Omega}_{i,NM} = (1-\omega_i)(1-\nu_i)$ represents the expenditure share on non-manufacturing intermediate input by sector i, $\tilde{\Omega}_{i,M,D} = (1-\omega_i)\nu_i(1-\varsigma_i)$ denotes the expenditure share on domestically-produced manufacturing intermediate input by sector i, and $\tilde{\Omega}_{i,M,F} = (1-\omega_i)\nu_i\varsigma_i$ indicates the expenditure share on foreign-produced manufacturing intermediate input by sector i.

The revenue-based input-output matrix is give by

$$
\Omega = \begin{bmatrix}
0 & \mathbf{0} & \frac{\tilde{\Omega}_{M,H,M,D}}{\mu_{M,H}} & 0 & 0 & \frac{\tilde{\Omega}_{M,H,L}}{\mu_{M,H}} & \frac{\tilde{\Omega}_{M,H,M,F}}{\mu_{M,H}} & 0 & \frac{\tilde{\Omega}_{M,H,NM}}{\mu_{M,H}} & 0 & 0 \\
0 & \mathbf{0} & 0 & \frac{\tilde{\Omega}^*_{M,H,M,D}}{\mu^*_{M,H}} & 0 & \frac{\tilde{\Omega}^*_{M,H,L}}{\mu^*_{M,H}} & \frac{\tilde{\Omega}^*_{M,H,M,F}}{\mu^*_{M,H}} & 0 & \frac{\tilde{\Omega}^*_{M,H,NM}}{\mu^*_{M,H}} & 0 & 0 \\
0 & \mathbf{0} & 0 & 0 & \frac{\tilde{\Omega}^*_{M,M,M,D}}{\mu^*_{M,M}} & \frac{\tilde{\Omega}^*_{M,M,L}}{\mu^*_{M,M}} & 0 & \frac{\tilde{\Omega}^*_{M,M,M,F}}{\mu^*_{M,M}} & \frac{\tilde{\Omega}^*_{M,M,NM}}{\mu^*_{M,M}} & 0 & 0 \\
\frac{1}{1+\tau_{VAT}} & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
1 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{1}{1+\tau_{labor}} \\
0 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{1}{1+\tau_{tariff}} & 0 \\
0 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & \mathbf{0} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0
\end{bmatrix}
$$

Next, we can calculate:

$$\hat{\lambda} = \Omega_{Y_m} \left(I - \Omega\right)^{-1}$$

Notice that the revenue-based input-output matrix can be observed directly from the data. Once we have an initial guess for λ_{NM,H,A_M} and $b_{M,H}$, we can then derive Ω_{Y_m} and compute $\hat{\lambda}$ using the above equation.

Now we consider the non-manufacturing sector. Given λ_{NM,H,A_M} and $\lambda_{NM,H}$, we can calculate $\frac{\hat{VA}_{NM}}{\hat{VA}_M}$ using the following equation:

$$\lambda_{NM,H,A_M} \hat{VA}_M = \lambda_{NM,H} \frac{\left(1 - \omega_{NM,H}\right) \nu_{NM,H} \left(1 - \varsigma_{NM,H}\right)}{\mu_{NM,H}} \hat{VA}_{NM}$$

The left-hand side represents the total sales by an intermediary aggregating manufacturing products for the non-manufacturing sector, while the right-hand side represents the total expenditure by the non-manufacturing sector on domestically-produced manufacturing intermediate inputs. Rearranging this equation, we obtain

$$\frac{\hat{VA}_{NM}}{\hat{VA}_{M}} = \frac{\lambda_{NM,H,A_M}}{\lambda_{NM,H}} \frac{\mu_{NM,H}}{(1-\omega_{NM,H})\,\nu_{NM,H}\,(1-\varsigma_{NM,H})}$$

Using this relationship, we can calculate the sales share by intermediaries aggregating non-manufacturing products:

$$\hat{\lambda}_{M,H,A_{NM}} = \frac{\hat{VA}_{M}}{\hat{VA}_{NM}} \lambda_{M,H} \frac{(1-\omega_{M,H})\,(1-\nu_{M,H})}{\mu_{M,H}}$$

$$\hat{\lambda}^{*}_{M,H,A_{NM}} = \frac{\hat{VA}_{M}}{\hat{VA}_{NM}} \lambda^{*}_{M,H} \frac{\left(1-\omega^{*}_{M,H}\right)\left(1-\nu^{*}_{M,H}\right)}{\mu^{*}_{M,H}}$$

$$\hat{\lambda}^{*}_{M,M,A_{NM}} = \frac{\hat{VA}_{M}}{\hat{VA}_{NM}} \lambda^{*}_{M,M} \frac{\left(1-\omega^{*}_{M,M}\right)\left(1-\nu^{*}_{M,M}\right)}{\mu^{*}_{M,M}}$$

$$\hat{\lambda}_{NM,H,A_{NM}} = \lambda_{NM,H} \frac{(1-\omega_{NM,H})\,(1-\nu_{NM,H})}{\mu_{NM,H}}$$

From the goods market clearing condition for non-manufacturing goods, we obtain:

$$\lambda_{NM,H} = \frac{\hat{b}_{NM,H}}{1+\tau_{VAT}} + \hat{\lambda}_{M,H,A_{NM}} + \hat{\lambda}^{*}_{M,H,A_{NM}} + \hat{\lambda}^{*}_{M,M,A_{NM}} + \hat{\lambda}_{NM,H,A_{NM}}$$

$$\Longleftrightarrow \hat{b}_{NM,H} = \left(\lambda_{NM,H} - \hat{\lambda}_{M,H,A_{NM}} - \hat{\lambda}^{*}_{M,H,A_{NM}} - \hat{\lambda}^{*}_{M,M,A_{NM}} - \hat{\lambda}_{NM,H,A_{NM}}\right)(1+\tau_{VAT})$$

Revenue-based factor shares in the non-manufacturing sector are expressed as:

$$\hat{\Lambda}_{NM,L} = \lambda_{NM,H} \frac{\omega_{NM}}{\mu_{NM,H}} \frac{1}{1+\tau_{labor}}$$

$$\hat{\Lambda}_{NM,M} = \lambda_{NM,H} \frac{(1-\omega_{NM})\,\nu_{NM,H}\,(1-\varsigma_{NM,H})}{\mu_{NM,H}}$$

$$\hat{\Lambda}_{NM,NM} = \lambda_{NM,H} \frac{(1-\omega_{NM})\,(1-\nu_{NM,H})}{\mu_{NM,H}}$$

$$\hat{\Lambda}^{*}_{NM} = \lambda_{NM,H} \frac{(1-\omega_{NM})\,\nu_{NM,H}\varsigma_{NM,H}}{\mu_{NM,H}} \frac{1}{1+\tau_{tariff}}$$

Lastly, from the household's maximization problem, we obtain:

$$\check{b}_{NM,H} = \frac{1-\phi}{\phi}\frac{1}{1-\gamma}b_{T,H}\frac{\hat{VA}_M}{\hat{VA}_{NM}}$$

The steady state $(\lambda_{M,H}, \lambda_{NM,H}, b_{M,H}, \lambda_{NM,H,A_M})$ is the solution to the following system of equations:

$$\begin{aligned}
\hat{\lambda}_{NM,H,A_M} - \lambda_{NM,H,A_M} &= 0 \\
b_{M,H} + \lambda^*_{M,H} + \lambda^*_{M,M} + \lambda_{NM,H,A_M} - \hat{\Lambda}^*_M - \hat{\Lambda}_{M,NM} &= 1 \\
\hat{b}_{NM,H} + \hat{\lambda}_{M,H,A_{NM}} + \hat{\lambda}^*_{M,H,A_{NM}} + \hat{\lambda}^*_{M,M,A_{NM}} - \hat{\Lambda}^*_{NM} - \hat{\Lambda}_{NM,M} &= 1 \\
\hat{b}_{NM,H} &= \check{b}_{NM,H}
\end{aligned}$$

where λ_{NM,H,A_M} and $b_{M,H}$ are initial guesses for the steady state values, $\lambda^*_{M,H}$ and $\lambda^*_{M,M}$ are directly observable from data. the variables $\hat{\lambda}_{NM,H,A_M}$, $\hat{\Lambda}^*_M$, $\hat{\Lambda}_{M,NM}$, $\hat{b}_{NM,H}$, $\hat{\lambda}_{M,H,A_{NM}}$, $\hat{\lambda}^*_{M,H,A_{NM}}$, $\hat{\lambda}^*_{M,M,A_{NM}}$, $\hat{\Lambda}^*_{NM}$, $\hat{\Lambda}_{NM,M}$, $\hat{b}_{NM,H}$, and $\check{b}_{NM,H}$ can be calculated by using the equations derived in this section, given the initial guesses for the steady state values of $(\lambda_{M,H}, \lambda_{NM,H}, b_{M,H}, \lambda_{NM,H,A_M})$. Once these equations are solved, we can calculate the steady state values for the rest of the variables.