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Abstract

Aggregate production and total factor productivity (TFP) fall dramatically during sudden stop episodes. During these episodes, domestic demand contracts, while foreign demand remains largely stable, and exchange rate depreciation favors exporters. This shift leads to a relative expansion of export-oriented activities over domestic-oriented activities. Due to a combination of differences in market power and tax treatment, export-oriented activities exhibit lower revenue-based TFP (TFPR) than domestic-oriented activities. Consequently, the reallocation of resources toward export-oriented activities reduces aggregate TFP. 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 sudden stop. I then build a multisector small open economy new Keynesian model and show that reallocation effects explain about 50% of the observed decline in value added in the manufacturing sector.

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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) a significant decline in output; and (iii) falling asset prices. Growth accounting exercises show that a substantial portion of the output decline is explained by a drop in total factor productivity (TFP), as measured by the Solow residual. For instance, during Mexico's 1994 sudden stop, aggregate TFP fell by 5.7%, while real GDP declined by 6.1%. In the manufacturing sector, TFP declined by 4.5%, and real value added contracted by 5.2%.

This paper demonstrates that resource reallocation can account for a significant portion of the observed decline in TFP during sudden stop episodes. The central hypothesis is as follows: a sudden stop triggers an increase in net capital outflows, leading to a decline in domestic disposable income and a contraction in domestic aggregate demand. In contrast, foreign aggregate demand remains stable, and exchange rate depreciation enhances the competitiveness of exporters. As a result, export-oriented activities relatively expand by more than domestic-oriented activities. Due to differences in market power and tax treatment, export-oriented activities face smaller distortions—defined as gaps between prices and marginal costs—than domestic-oriented activities. In other words, export-oriented activities exhibit lower revenue-based TFP (TFPR). Therefore, by shifting resources from high-TFPR to low-TFPR activities, a sudden stop induces a decline in aggregate TFP through a reallocation effect.

To test this hypothesis, I use novel, detailed microdata to document four empirical facts about the Mexican sudden stop. First, prior to the sudden stop, unit values at the plant–product level in foreign markets were, on average, 11% lower than those in the domestic market. During the sudden stop, however, this difference disappeared. Assuming uniform marginal costs across markets at the plant–product level, this implies that pre-crisis distortions (i.e., markups) were 11% lower in foreign markets than in domestic ones, and that markup levels equalized during the crisis.[1] The latter finding is important for evaluating changes in TFP up to the second order, as will be discussed

[1] This estimate is consistent with the results in Blum et al. [2023] who find that, on average, markups by Chilean manufacturing plants 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.

later.

Second, I show that 34% of the increase in the aggregate export share during the sudden stop is accounted for by the expansion of sales in foreign markets at the plant–product level. Using a difference-in-differences approach, I further find that production quantities for foreign markets rose by 60% more than those for domestic markets at the plant–product level. This relative expansion triggered a reallocation of inputs within plants toward product lines serving foreign markets. Because these product lines are associated with lower distortions—reflected in lower TFPR—this input reallocation is expected to worsen allocative efficiency and contribute to a decline in aggregate TFP.

Third, I show that the relative expansion of maquiladoras—export-oriented plants that benefit from special tax incentives—accounts for 40% of the increase in aggregate export during the sudden stop. Using a difference-in-differences approach, I further find that the number of worker in maquiladoras relatively increased by 20% more than that in non-maquiladoras during the sudden stop. As specialized exporters, maquiladoras sell less than 5% of their output in the domestic market and were therefore largely insulated from the contraction in domestic aggregate demand.

Fourth, the supply chains of maquiladoras are subject to fewer domestic market distortions than those of non-maquiladoras, the standard manufacturing plants. This is largely due to differences in production structure. Maquiladoras allocate 77.2% of their expenditures to foreign intermediate inputs, compared to just 20.4% for non-maquiladoras. Thanks to preferential tax treatment, maquiladoras are exempt from tariffs on foreign inputs. In contrast, non-maquiladoras allocate 58.8% of their spending to domestic intermediate inputs, while maquiladoras allocate only 8.3%. The production of domestic intermediate goods typically requires the use of labor, capital, and both foreign and domestic inputs—each layer of which introduces distortions arising from market power or taxation. These distortions accumulate along the supply chain, making the domestic portion of the supply chain more distortionary for non-maquiladoras than for maquiladoras. Therefore, the relative expansion of maquiladoras—whose supply chains are less distorted—is expected to reduce allocative efficiency and contribute to a decline in aggregate TFP.

Motivated by these empirical facts and to clarify the underlying mechanism, I develop a pen-and-paper New Keynesian model of a sudden stop. Based on the empirical evidence, export-oriented activities face lower ex-ante distortions, reflected in lower TFPR, than domestic-oriented activities.

In the model, export-oriented firms face sticky prices in foreign currency and therefore raise their markups in response to exchange rate depreciation during a sudden stop. This mechanism reduces the ex-post TFPR gap between export- and domestic-oriented activities, consistent with the empirical findings. When considering changes in aggregate TFP up to the first order, only ex-ante TFPR levels matter—hence, the relative expansion of export-oriented activities with lower ex-ante TFPR reduces aggregate TFP. However, when accounting for changes up to the second order—consistent with how statistical agencies measure TFP using the Törnqvist index—ex-post TFPR dispersion also matters. In the context of a sudden stop, the narrowing of TFPR differences due to sticky prices in foreign currency helps mitigate the decline in aggregate TFP. Nevertheless, the first-order effect dominates the second-order effect, and aggregate TFP declines during a sudden stop.

Finally, to quantify how a sudden stop shock contributes to the decline in aggregate TFP through reallocation effects, I extend the pen-and-paper New Keynesian model into a quantitative framework with multiple sectors and sectoral input–output linkages. Simulations from the model show that resource reallocation accounts for approximately 50% of the decline in value added in Mexico's manufacturing sector. Moreover, I demonstrate that evaluating changes in aggregate TFP using the first-order approximation leads to an overestimation of the decline in both TFP and value added, highlighting the quantitative importance of the second-order term during sudden stop episodes. In addition to capturing the decline in aggregate TFP, the model successfully matches the dynamics of key macroeconomic variables, including the real exchange rate, the net export-to-GDP ratio, employment, and the use of foreign intermediate inputs.

Related Literature

Using aggregate macro-level data, Meza and Quintin [2007], Kehoe and Ruhl [2009] and Mendoza [2010] examine 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] emphasize the role of capacity utilization, while Kehoe and Ruhl [2009] and Mendoza [2010] conclude that identifying the mechanism behind the decline in TFP during the sudden stop remains an open question. This paper contributes to the literature by focusing on resource reallocation using firm–product–destination-level microdata. In addition, it highlights the role of maquiladoras—a key export-oriented sector in Mexico that is often overlooked in TFP analyses.

Gopinath and Neiman [2014] study the 2000 Argentina sudden stop, attributing the substantial decline in TFP to a 70% reduction in imported intermediate inputs. In contrast, during the 1994 Mexican sudden stop, imports of foreign intermediate inputs declined by only 0.1%[2], suggesting that this channel cannot fully explain Mexico's TFP decline. Sandleris and Wright [2014] examine resource reallocation during the Argentine crisis using firm-level data. This paper differs from theirs in several respects. First, I identify the specific types of firms and products that expanded or contracted relative to others during the sudden stop. Second, I document wedge differences across firms and products. Third, I account for changes in TFP up to the second order, in contrast to their focus on first-order TFP changes.

Castillo-Martınez [2018] examines the impact of sudden stops on average TFPQ across firms. In contrast, this paper focuses on aggregate TFP—measured by the Solow residual—which is linked to changes in real GDP. Blaum [2024] analyzes the effects of the 1994 Mexican sudden stop on the aggregate share of foreign intermediate inputs, emphasizing resource reallocation toward import-intensive firms. This paper complements Blaum [2024] by using firm–product–destination-level data to provide new empirical insights into reallocation dynamics. [3] Moreover, I highlight the critical role of maquiladoras, an important but often overlooked component of Mexico's export sector.

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 factors: the mechanical effect stemming from shifts in technology and the endogenous adjustments in allocative efficiency due to resource reallocation. Baqaee and Farhi [2024] extends Baqaee and Farhi [2020] in the context of open economies, while Baqaee et al. [2024] examine the first-order reallocation effects of monetary policy on aggregate TFP. Building on this sequence of papers, this paper

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

[3] To assess the impact of NAFTA on prices and competition, Kikkawa et al. [2019] use the same firm–product–destination dataset as this paper. Their primary focus is on the long-term effects of NAFTA, and they do not examine the 1994 sudden stop. Using unit value data across destinations, they also find that markups in foreign markets are lower than in domestic markets—consistent with the findings presented here. See also Pratap and Urrutia [2004], Verhoogen [2008], Teshima [2008], and Meza et al. [2019] , who employ firm-level microdata from Mexico.

empirically and quantitatively assesses the role of resource reallocation in the context of sudden stop episodes. While Baqaee et al. [2024] focus on the local change in TFP in response to a monetary policy shock—where ex-post distortions are irrelevant—this paper highlights that measured TFP, when computed using the Törnqvist index, is sensitive to ex-post distortions, particularly in sudden stop episodes.

This paper contributes to the literature on cross-sectional misallocation, including seminal work by Hsieh and Klenow [2009], Restuccia and Rogerson [2008], and Edmond et al. [2023]. In terms of quantitative analysis of sudden stop shocks, it is related to studies such as Bianchi [2011], Pratap and Urrutia [2012], Schmitt-Grohé and Uribe [2016], Ottonello [2021], Coulibaly [2023], Cugat [2022], and Benguria et al. [2022]. Additionally, while prior research has highlighted the role of maquiladoras in labor markets and international trade—see Feenstra and Hanson [1997], Hanson [2003], Burstein et al. [2008], Bergin et al. [2009], Utar and Ruiz [2013], and Estefan [2022]—these studies do not examine the impact of reallocation toward maquiladoras on aggregate TFP.

Outline

This paper is organized as follows. Section 2 presents empirical evidence on differences in distortions and resource reallocation at the plant–product–destination level. Section 3 develops a simple model of a sudden stop to characterize the underlying mechanism. Section 4 introduces the quantitative model to analyze the propagation effects of a sudden stop shock. Section 5 presents the quantitative results. Section 6 concludes.

2 Empirical Analysis

This section presents empirical evidence on differences in distortions and resource reallocation at the plant–product–destination level during the 1994 Mexican sudden stop. First, I show that export-oriented activities faced lower distortions than domestic-oriented ones prior to the crisis. In particular, product lines targeting foreign markets exhibited lower distortions than those aimed at the domestic market at the plant–product level. I also show that maquiladoras—specialized export-oriented plants—had less distorted supply chains than non-maquiladoras, the standard manufacturing plants. Second, I document that these lower-distortion, export-oriented activities expanded relatively more than domestic-oriented activities during the sudden stop. This resource reallocation has implications for aggregate productivity, explored in the following 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 the Statistics on the Maquila Export Industry (EMIME). Both the EIM and EIA classify plants according to a unique 6-digit system based on the 1994 Mexican Classification of Activities and Products (CMAP94), a precursor to the North American Industry Classification System (NAICS). These surveys cover 206 6-digit manufacturing classes. The samples for the EIM and EIA were constructed to ensure comprehensive coverage: they include all plants with more than 100 employees and are designed to capture at least 85% of value added within each class, resulting in broad coverage of the manufacturing sector.

The EIM provides monthly data on plant-level employment, the wage bill, and detailed information on product quantities and sales values. It distinguishes between products sold in the domestic market and those destined for export. Although the dataset does not report export destinations, more than 85% of Mexico's exports during the study period were shipped to the United States. Given this concentration, I assume that all exported products are destined for the U.S. The product data are reported at the 8-digit level, corresponding to individual product lines. This level of granularity allows calculation of unit values, which serve as a measure of prices. Importantly, the EIM instructs firms to standardize product units across domestic and foreign markets, ensuring that unit values are comparable across destinations.

The EIA provides annual, plant-level data covering a broad range of variables, including input use, total production, and operational characteristics. Except for product-level quantities and sales, most of the manufacturing plant data used in my analysis is drawn from this survey. Specifically, I rely on EIA data on domestic and foreign intermediate input expenditures, wage bills, total employment, capital, and export status.

The EMIME provides monthly, plant-level data on maquiladoras, including the number of workers, wage bills, usage of foreign and domestic intermediate inputs, and value added. Maquiladoras are manufacturing or assembly plants operated by foreign firms—primarily from the United States—that take advantage of Mexico's cost-effective labor force to produce goods for export. When the program began in 1965, maquiladoras were required to export 100% of their output. Although this requirement was gradually relaxed after 1989, maquiladoras continue to export nearly all of their production.[4] The program allows for tax-free temporary imports of raw materials from the U.S. and Canada for final assembly in Mexico, with the finished products subsequently exported to their countries of origin. It attracts foreign manufacturing operations by offering full VAT exemptions, zero trade duties on temporary input imports, simplified administrative procedures, and infrastructure to support new or existing industrial operations. In 1994, maquiladoras accounted for 28.8% of sales in the manufacturing sector, contributed 43.1% of Mexico's total exports, and made up 52.7% of manufacturing exports.

2.2 Distortions across Domestic and Foreign Markets at the Plant-Product Level

I conduct a comparative analysis of distortions in domestic and foreign markets at the plant–product level by comparing unit values across destinations. In most cases, the unit of measurement differs between markets. However, the EIM instructs firms to standardize product units to ensure equivalence across domestic and foreign markets, enabling meaningful comparisons of unit values. The foreign unit value is calculated by dividing the free-on-board export value (in Mexican pesos) by the corresponding export quantity. The domestic unit value is computed by dividing the sales value (excluding value-added tax) by the corresponding quantity sold in the domestic market. Unit values are constructed at the quarterly frequency. My empirical specification is as follows:

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

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. By including plant–

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

product–time fixed effects, the specification compares unit values between domestic and foreign markets within the same plant, product, and time period. The standard errors are clustered at the plant–product level.

Table 2.1 reports estimates of β across different time periods and weighting schemes. For 1994, the year preceding the sudden stop, the estimates of β consistently range from -0.11 to -0.13 with 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 1995—the year of 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. Finally, for 1996, following the sudden stop, the estimates of β settle around -0.07 with statistical significance. This implies that the unit values were approximately 7% lower in foreign markets than in domestic markets after the sudden stop.

Assuming that marginal costs are equal across domestic and foreign markets at the plant–product level, the observed disparities in unit values imply differences in markups across destinations.[5] It is important to note that these estimates likely represent a lower bound on the true markup gap between the two markets. Verhoogen [2008] documents that exporting plants tend to produce higher-quality goods for foreign markets compared to domestic ones. Producing higher-quality goods typically requires better inputs, which raises production costs. If exported products indeed have higher marginal costs, the actual difference in markups between foreign and domestic markets would be even greater than suggested by the unit value comparison.

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

[5] See Burstein et al. [2024], who also assume uniform marginal costs at the plant–product level to examine markup dispersion across different buyers.

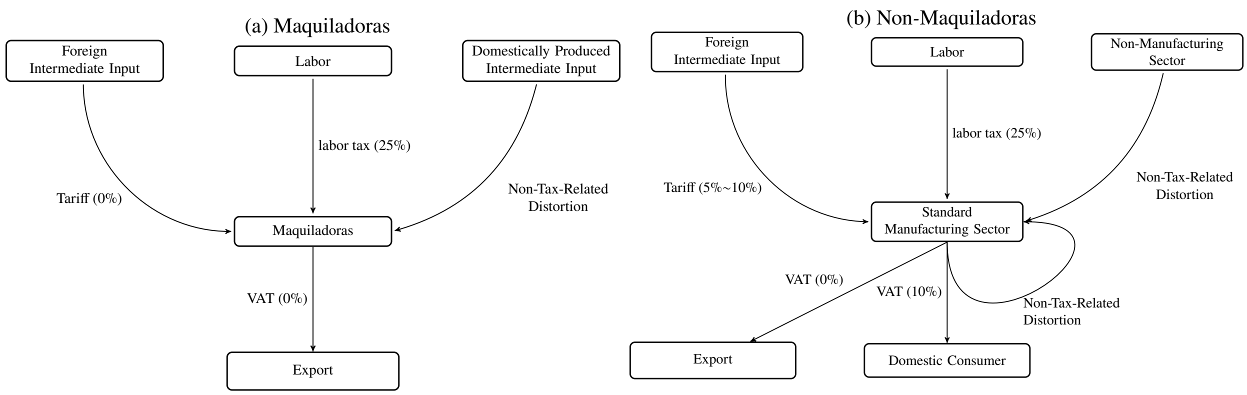

Figure 2.1: Distortions faced by Maquiladoras and Non-Maquiladoras

	(i)	(ii)	(iii)	(iv)	(v)	(vi)
β	−0.129 [0.014]	−0.113 [0.013]	−0.0152 [0.011]	−0.008 [0.011]	−0.072 [0.010]	−0.071 [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 in foreign markets were, on average,* 11% *to* 13% *lower than in domestic markets. During the sudden stop, this difference disappeared. After the sudden stop, unit values in foreign markets were, on average,* 7% *lower than those in domestic markets.*

2.3 Distortions across Maquiladoras and Non-Maquiladoras

I compare the distortions faced by maquiladoras and non-maquiladoras. The specific distortions affecting maquiladoras are illustrated on the left side of Figure 2.1. Maquiladoras are exempt from tariffs on foreign intermediate inputs and are subject to a 25% payroll tax on labor. When their products are exported, they are not subject to value-added tax (VAT). However, if domestic intermediate goods producers possess market power, maquiladoras may face non-tax distortions when purchasing domestically produced inputs. On average, maquiladoras allocate only 8.3% of their expenditures to domestically produced goods, compared to 77.2% for foreign intermediate inputs. This underscores their limited reliance on domestic suppliers and their heavy dependence on foreign inputs.

In contrast, the distortions faced by non-maquiladoras (standard producers) are illustrated on the right side of Figure 2.1. Non-maquiladoras are subject to tariffs on foreign intermediate inputs, which typically range from 5% to 10%. They also face a 25% payroll tax and a 10% value-added tax (VAT) when selling goods to domestic consumers, although exports are exempt from VAT. Like maquiladoras, non-maquiladoras may also encounter non-tax distortions, such as market power among domestic intermediate goods suppliers. Non-maquiladoras allocate a larger share of their expenditures—58.8%—to domestically produced inputs, compared to only 20.4% for foreign intermediate inputs. This indicates that non-maquiladoras are more dependent on domestic suppliers and rely less on foreign intermediate inputs than maquiladoras.

The production of domestic intermediate inputs relies on a range of inputs from the domestic economy, including labor, capital, and both foreign and domestic intermediate goods. Each stage of this process can be subject to distortions, such as those stemming from market power or taxation. As these distortions accumulate along the supply chain, non-maquiladoras are exposed to greater domestic market distortions than maquiladoras.[6] The quantitative impact of these accumulated distortions is analyzed in the subsequent section.

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 relatively more than domestic-oriented activities. This occurs because domestic aggregate demand contracts, while foreign demand

[6]Foreign producers that supply intermediate inputs to maquiladoras may exercise market power and incur tax obligations in their respective countries. However, the associated profits and tax payments are not included in the calculation of value added within Mexico. As a result, the maquiladora supply chain generates lower profit margins and pays less in taxes within the Mexican economy compared to the supply chain of non-maquiladoras.

remains stable, and the depreciation of the nominal exchange rate favors exporters. In the case of the 1994 Mexican sudden stop, the share of manufacturing exports in total manufacturing sales rose from 17.3% in 1994 to 27.2% in 1995. To understand whether this increase was driven by intensive or extensive margins, and to uncover the underlying resource reallocations, I conduct the following three decompositions.

First, to examine how the relative expansion of maquiladoras contributed to the increase in the aggregate manufacturing export share, I decompose the change in the ratio of aggregate exports 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 denotes the sector index, $S_{i,t}$ is the sales of sector i as a share of aggregate manufacturing sales at tim t, and $E_{i,t}$ is the export share (exports as a fraction of total sales) within sector i at time t. The first term is the within effect, which holds the sectoral sales shares fixed and captures changes in export intensity within maquiladoras and non-maquiladoras. The second term is the between effect, which holds export shares constant and reflects compositional shifts between maquiladoras and non-maquiladoras. The third term is a covariance term that captures the interaction between changes in sectoral size and export orientation—i.e., the extent to which sectors that expand also change their export intensity.

The decomposition results show that the within effect accounts for 62.6% and the between effect for 40.4% of the total increase in the export share. In this decomposition, I assume $E_{\text{Maquiladoras},1994} = E_{\text{Maquiladoras},1995} = 1$, as maquiladoras export nearly all of their output. Therefore, the within effect reflects an increase in the export share within non-maquiladoras. The positive between effect suggests a potential reallocation of resources from non-maquiladoras toward maquiladoras during the sudden stop.

I summarize the finding as follows:

Fact 3. *The compositional shift toward maquiladoras accounts for* 40.4% *of the increase in the aggregate export share. The increase in export intensity within non-maquiladoras explains* 62.6%.

Second, I decompose the increase in the export share within non-maquiladoras. In my data, the ratio of aggregate exports to aggregate sales among non-maquiladoras rose from 10.5% in 1994 to 20.1% in 1995. I assess the extent to which this increase can be attributed to various channels, including within-plant effects, between-plant effects, covariance effects, and plant entry into or exit from export status. I decompose the increase in the export share among non-maquiladoras as follows:

$$\underbrace{\Delta \frac{\text{Non-Maquiladoras Aggregate Export}}{\text{Non-Maquiladoras Aggregate Sales}}_{1994-1995}}_{9.6\%\ (=20.1\%-10.5\%)} = \underbrace{\sum_{i \in C} \frac{s_{i,1994}}{\sum_{i \in C} s_{i,1994}} \left(e_{i,1995} - e_{i,1994}\right)}_{\text{Within Effect } (6.5\%)}$$
$$+ \underbrace{\sum_{i \in C} e_{i,1994} \left(\frac{s_{i,1995}}{\sum_{i \in C} s_{i,1995}} - \frac{s_{i,1994}}{\sum_{i \in C} s_{i,1994}} \right)}_{\text{Between Effect } (2.3\%)}$$
$$+ \underbrace{\left(\sum_{i \in N} s_{i,1995} e_{i,1995} - \frac{1 - \sum_{i \in C} s_{i,1995}}{\sum_{i \in C} s_{i,1995}} \sum_{i \in C} s_{i,1995} e_{i,1995} \right)}_{\text{Entry Effect } (-0.6\%)}$$
$$+ \underbrace{\left(\frac{1 - \sum_{i \in C} s_{i,1994}}{\sum_{i \in C} s_{i,1994}} \sum_{i \in C} s_{i,1994} e_{i,1994} - \sum_{i \in E} s_{i,1994} e_{i,1994} \right)}_{\text{Exit Effect } (0.7\%)}$$
$$+ \underbrace{\sum_{i \in C} \left(\frac{s_{i,1995}}{\sum_{i \in C} s_{i,1995}} - \frac{s_{i,1994}}{\sum_{i \in C} s_{i,1994}} \right) \left(e_{i,1995} - e_{i,1994}\right)}_{\text{Residual } (0.7\%)}$$

Here, C is the set of plants whose export status did not change from 1994 to 1995; N is the set of plants who were non-exporters in 1994 but began exporting in 1995; and E is the set of plants that exported in 1994 but exited the export market 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, which fixes the sales shares across plants and captures changes in export intensity within plants. The second term is the between effect, which fixes the export shares and captures changes in the composition of sales across plants with different export intensities. The third and fourth terms capture the contributions from entry into and exit from the export market, respectively. The fifth term is a residual capturing the interaction between changes in sales shares and export shares among continuing exporters.

The decomposition results show that the within-plant increase in export share accounts for 67.7% of the overall rise in export share, while between-plant reallocation contributes 24.0%. The trade liberalization literature, such as Melitz [2003], emphasizes the reallocation of resources from smaller to larger exporters as a key mechanism. However, such adjustments typically occur over a longer horizon and are less pronounced in the short run. Plant entry into and exit from export markets explains only a small fraction of the total change. The quantitative model developed in the subsequent section is built on this empirical observation.

I summarize the findings as follows:

Fact 4. *Within-plant expansion into export markets accounts for* 67.7% *of the increase in the export share among non-maquiladoras. Compositional changes across plants with different export intensities explain an additional* 24.0%.

Finally, I further decompose the previously calculated within-plant effect by leveraging plant–product–destination-level information. The decomposition is as follows:

$$
\begin{aligned}
\underbrace{\sum_{i\in C} \frac{s_{i,1994}}{\sum_{i\in C} s_{i,1994}} \left(e_{i,1995} - e_{i,1994}\right)}_{\text{Within-Plant Effect (6.5\%)}} &= \underbrace{\sum_{i\in C} \frac{s_{i,1994}}{\sum_{i\in C} s_{i,1994}} \sum_{p\in C^{i,P}} s_{i,p,1994} \left(e_{i,p,1995} - e_{i,p,1994}\right)}_{\text{Within-Plant-Product Effect (5.3\%)}} \\
&+ \underbrace{\sum_{i\in C} \frac{s_{i,1994}}{\sum_{i\in C} s_{i,1994}} \sum_{p\in C^{i,P}} e_{i,p,1994} \left(s_{i,p,1995} - s_{i,p,1994}\right)}_{\text{Within-Plant Across-Product Effect (0.8\%)}} \\
&+ \underbrace{\sum_{i\in C} \frac{s_{i,1994}}{\sum_{i\in C} s_{i,1994}} \left(\sum_{p\in N^{i,p}} s_{i,p,1995} e_{i,p,1995} - \sum_{p\in E^{i,p}} s_{i,p,1994} e_{i,p,1994}\right)}_{\text{Within-Plant Extensive Margin (0.4\%)}} \\
&+ \underbrace{\sum_{i\in C} \frac{s_{i,1994}}{\sum_{i\in C} s_{i,1994}} \sum_{p\in C^{i,P}} \left(s_{i,p,1995} - s_{i,p,1994}\right) \left(e_{i,p,1995} - e_{i,p,1994}\right)}_{\text{Within-Plant Residual (0.03\%)}}
\end{aligned}
$$

Here, p denotes the product index, $s_{i,p,t}$ is the share of product p in total sales by plant i at time t, and $e_{i,p,t}$ is the export share of product p in plant i's sales at time t. $C^{i,p}$ is the set of products produced by plant i in both 1994 and 1995. $N^{i,p}$ is the set of new introduced in 1995, and$E^{i,p}$ is the set of products dropped after 1994. The Within–Plant–Product effect measures changes in export shares at the product level within plants. The Within–Plant Across-Product effect captures compositional shifts in sales among products with different export intensities within plants. The Within-Plant Extensive Margin measures the contribution of product entry into or exit from the export basket within plants. The Within-Plant Residual term captures the interaction between changes in product sales shares and changes in export intensity within plants.

This decomposition shows that within–plant–product reallocation toward export markets accounts for 81.5% of the within-plant increase in export share. Additions to or removals from the export product basket contribute only a small portion of the overall change.

I summarize the findings as follows:

Fact 5. *Sales expansion in foreign markets at the plant–product level accounts for* 81.5% *of the increase in export intensity at the plant level.*

2.5 Quantity Expansion at the Plant–Product–Destination Level

The analysis in Section 2.2 shows that product lines serving foreign markets face lower distortions than those serving domestic markets. Additionally, the decomposition in Section 2.4 highlights the importance of sales expansion in foreign markets at the plant–product level. A key factor in assessing changes in allocative efficiency and aggregate TFP is whether there are observable shifts in relative input usage across products destined for different markets. A change in the relative quantity of sales across destinations suggests a corresponding change in the allocation of inputs. To examine whether there was a shift in input usage between domestic and foreign markets before and after the sudden stop, I implement a difference-in-differences strategy. If production quantities for foreign markets increase more than those for domestic markets at the plant–product level, this implies a reallocation of inputs toward foreign-market products—those with lower distortions. Such reallocation is expected to worsen allocative efficiency and reduce aggregate TFP.

I define $q_{i,j,d,t}$ as the quantity of product j sold by plant i to destination d during period t. The sudden stop is identified with the fourth quarter of 1994 (1994 Q4). I restrict the sample to products sold in both domestic and foreign markets prior to the sudden stop and estimate the following panel regression:

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

for $t = 1994\,Q1, \cdots, 1996\,Q2$, where $\mathbf{1}_{s=t}$ is an indicator for period $s = t$, $\mathbf{1}_{\{d\in\text{Foreign}\}}$ equals 1 if the destination is a foreign market and 0 otherwise The specification includes plant–product–destination fixed effects ($\alpha_{i,j,d}$) and plant–product–time fixed effects ($\beta_{i,j,t}$). Because the regression is expressed in stacked log-differences relative to 1994 Q4, the fixed effects absorb not only the constant but also any plant–product–destination-level secular trends over the sample period. By including plant–product–time fixed effects, the specification compares sales quantities between domestic and foreign markets within the same plant, product, and time period. Standard errors are two-way clustered at the product and time levels to account for serial correlation and time-specific shocks.

Figure 2.2 presents an event study plot showing the average effect of the sudden stop on sales quantities to foreign markets relative to those in domestic markets. The graph indicates no significant differences in trends prior to the sudden stop, consistent with the absence of differential pre-trends. After the sudden stop, however, there is a markedly larger increase in sales to foreign markets relative to domestic ones. By the second quarter of 1995, the average relative increase in foreign sales quantities reached approximately 60%. This pattern suggests a reallocation of inputs toward foreign-market product lines at the plant–product level.

I summarize the findings as follows:

Fact 6. *Following the sudden stop, sales quantities in foreign markets increased by up to* 60% *more than those in domestic markets.*

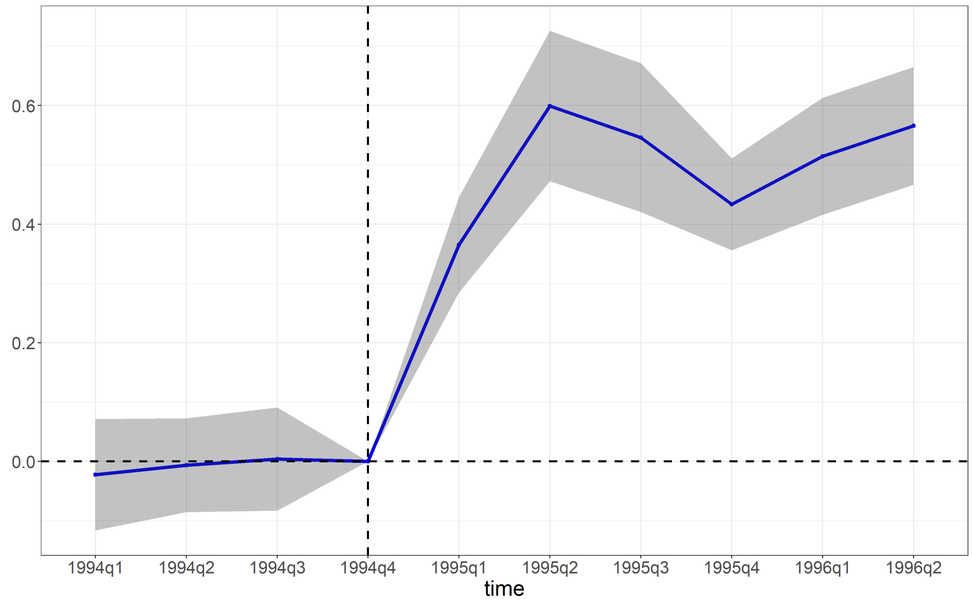

Figure 2.2: Changes in Quantity of Sales by Destination

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.

2.6 Relative Expansion by Maquiladoras

The analysis in Section 2.3 shows that maquiladoras operate with less distorted supply chains compared to non-maquiladoras. Furthermore, the decomposition in Section 2.4 reveals that the relative expansion of maquiladoras accounts for 40.4% of the increase in the aggregate export share during the 1994 sudden stop. As before, a key factor in evaluating changes in allocative efficiency and aggregate TFP is whether there are shifts in relative input usage across maquiladoras and non-maquiladoras. If input usage increases more among maquiladoras—which face fewer distortions—relative to non-maquiladoras, this reallocation is expected to reduce allocative efficiency and lower aggregate TFP.

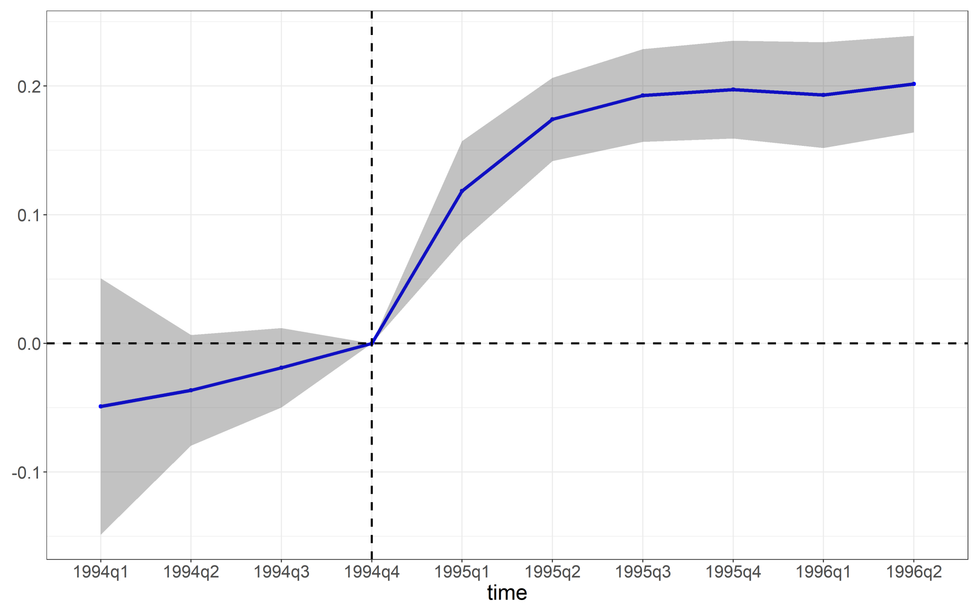

Figure 2.3: Changes in Number of Workers in Maquiladoras and Non-Maquiladoras
Notes: This figure reports the event study graph, depicting the average effect of the sudden stop on the number of workers. The dependent variable is expressed in logarithmic terms. The sudden stop occured in the fourth quarter 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.

To measure the effect of the sudden stop on the relative use of inputs across maquiladoras and non-maquiladoras, I employ a difference-in-differences strategy and 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 $t = 1994\,Q1, \cdots, 1996\,Q2$, where $L_{i,j,t}$ is the number of workers in plant j, industry i, at time t; α_j is a plant fixed effect; $\gamma_{i,t}$ is an industry-by-time-by-region fixed effect; $\mathbf{1}_{s=t}$ is a time indicator function; and $\text{Maquiladora Dummy}_{i,j}$ equals 1 if the plant is a maquiladora and 0 otherwise. Standard errors are two-way clustered at the industry and time levels to account for potential bias due to serial correlation.

Figure 2.3 presents an event study graph showing the average effect of the sudden stop on the number of workers. The graph reports quarterly differences in employment growth between maquiladoras and non-maquiladoras before and after the sudden stop. Consistent with the absence of differential pre-trends, there is no significant difference in employment growth prior to the shock. After the sudden stop, however, maquiladoras experienced a substantially larger increase in employment relative to non-maquiladoras. By the third quarter of 1995, the average relative increase in the number of workers in maquiladoras reached approximately 20%.

I summarize the findings as follows:

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

3 A Stylized Model

Empirical evidence shows that, prior to the sudden stop, export-oriented activities faced lower distortions than domestic-oriented ones. However, this distinction disappears at the plant–product level during the crisis. At the same time, resources shift from domestic- to export-oriented activities. To better understand how distortions, exchange rate dynamics, and resource reallocation jointly shape aggregate TFP, I construct a stylized model of a sudden stop in a small open economy.

The empirical analysis reveals little evidence of reallocation from small to large exporters or of significant entry or exit from export markets during the crisis. These margins may be relevant over the medium to long run, but they appear negligible in the short run. Accordingly, I abstract from them in the model.

The model features a representative household, two types of producers (domestic-oriented and exporters), sticky prices in foreign markets, and nominal wage rigidity. The structure is deliberately kept simple to allow for analytical tractability; richer features are incorporated in the quantitative model.

Household The representative household allocates income between domestic and foreign goods and repays external debt. Its nominal budget constraint, expressed in domestic currency, is given by:

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

where $P_{\mathcal{D}}C_{\mathcal{D}}$ represents expenditure on domestically produced goods, $\epsilon P_{\mathcal{F}}C_{\mathcal{F}}$ denotes spending on foreign goods converted into domestic currency, ϵ is the nominal exchange rate (units of domestic currency per unit of foreign currency)[7], W is the nominal wage, and Π denotes profits transferred from firms. Θ is exogenously determined net foreign repayment in foreign currency. For simplicity, I abstract from intertemporal saving and borrowing behavior. A sudden stop is modeled as an exogenous increase in Θ, reflecting a tightening of external financing conditions.[8]

The household's preferences are represented by a Cobb-Douglas utility function:

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

In the quantitative model, this specification is generalized to a CES utility function.

Producers There are two types of producers in the economy: domestic-oriented producers ($\mathcal{D}$) and exporters ($\mathcal{F}^*$). In this stylized model, I do not distinguish between maquiladoras and exporters among non-maquiladoras; this distinction is introduced in the quantitative analysis.

Exporters face fully sticky prices in foreign currency, consistent with pricing-to-market behavior, while domestic producers are assumed to set prices flexibly. This assumption is supported by empirical evidence from the 1994 Mexican crisis. During the crisis, domestic prices adjusted rapidly, whereas export prices—denominated in foreign currency—remained stable.[9] Using micro price data, Gagnon [2009] shows that in April 1995, 64.3% of domestic consumer goods underwent price changes, indicating high pricing flexibility. In contrast, relative prices in foreign markets showed minimal movement, suggesting strong nominal rigidity abroad. For analytical tractability, I model domestic prices as fully flexible and foreign prices as fully sticky.

Nominal wages are assumed to be perfectly rigid. While this simplifies the analysis and allows for closed-form solutions, this assumption is relaxed in the quantitative model.

Production uses labor as the sole input, with output linear in labor:

$$Y_i = A_i L_i,$$

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

[8] If the household's borrowing and saving behavior were explicitly modeled, Θ could be expressed as: $\Theta = b' - (1 + r^*)\, b$ where b' is new borrowing in foreign currency, b is outstanding foreign debt, and r^* is the foreign interest rate. In this formulation, a sudden stop corresponds to an increase in r^* or a tightening of borrowing constraints, which would reduce b'. In this paper, I abstract from modeling the source of the shock and treat the increase in Θ as exogenous. My focus is on tracing the equilibrium responses to this change in Θ.

[9] See Figure A.2.

where Y_i is the output of producer i, A_i isproductivity, and L_i is the labor input. In the quantitative model, this specification is generalized to allow for a CES production function with multiple inputs.

Given that prices in foreign markets are fixed in foreign currency, the markup charged by exporters evolves with the nominal exchange rate. The change in markup is given by:

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

under the assumption that productivity ($A_{\mathcal{F}^*}$) is not affected by a sudden stop shock. Thus, the change in exporters' markups is driven entirely by changes in the nominal exchange rate.

Monetary Policy and Current Account Monetary policy is assumed to perfectly stabilize nominal GDP, that is:

$$d \log GDP = 0.$$

Under this assumption, all fluctuations in real output are entirely driven by movements in the aggregate price level. In the quantitative model, this assumption is relaxed, and the monetary authority instead targets both inflation and employment.

The current account identity, expressed in domestic currency, is given by:

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

where the left-hand side represents net exports, and the right-hand side captures net capital outflows.

Aggregate TFP I define changes in the aggregate price index using Divisia weights:

$$d \log P_Y \equiv \lambda_{\mathcal{D}} d \log P_{\mathcal{D}} + \lambda_{\mathcal{F}^*} d \log P_{\mathcal{F}^*},$$

where $\lambda_{\mathcal{D}} = \frac{P_{\mathcal{D}} Y_{\mathcal{D}}}{GDP}$ the sales share of domestic-oriented producers, and $\lambda_{\mathcal{F}^*} = \frac{P_{\mathcal{F}^*} Y_{\mathcal{F}^*}}{GDP}$ is the sales share of exporters. The local change in real GDP is then:

$$d \log Y = d \log (\text{GDP}) - d \log P_Y,$$

and the local change in aggregate TFP is:

$$d \log \text{TFP} = d \log Y - d \log L,$$

where total labor is $L = L_{\mathcal{D}} + L_{\mathcal{F}^*}$.

Finally, the harmonic average markup across domestic producers and exporters is given by:

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

Summary This stylized model captures how a sudden stop—modeled as an exogenous increase in external repayment Θ—interacts with nominal rigidities, labor reallocation, and markup dynamics to influence aggregate TFP. I now use this framework to analyze how aggregate TFP responds to changes in the nominal exchange rate and resource allocation following 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, household's income in foreign currency must decrease. As the domestic monetary authority perfectly controls nominal GDP, it effectively controls nominal household's 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 in the labor market 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 due to a small open economy assumption. Consequently, in relative term, exporters expand by more, while producers for the domestic market shrink. In essence, I observe a reallocation of labor away from domestic producers toward exporters.

The effect of this reallocation on local TFP depends on the relative markup charged in the domestic market, captured by the ratio $\left(\frac{\overline{\mu}}{\mu_{\mathcal{D}}}\right)$. Empirical evidence shows that, prior to the sudden stop, domestic markets were more distorted than foreign markets: $\mu_{\mathcal{D}} > \overline{\mu} > \mu_{\mathcal{F}}$. This implies that exporters operate with a lower TFPR than domestic producers:

$$\text{TFPR}_{\mathcal{F}} = P_{\mathcal{F}} A_{\mathcal{F}} = W\mu_{\mathcal{F}} < W\mu_{\mathcal{D}} = P_{\mathcal{D}} A_{\mathcal{D}} = \text{TFPR}_{\mathcal{D}}.$$

Hence, the labor reallocation—away from high-TFPR domestic producers and toward low-TFPR exporters—worsens allocative efficiency. This leads to a local decline in aggregate TFP.

However, while this local change in aggregate TFP is reliable for small shocks, it does not capture the nonlinear effects that arise with large shocks. To remedy this, I compute the global TFP change over the interval $[t, t+1]$ using a second-order approximation. This is consistent with how statistical agencies compute TFP using the Törnqvist index.[10]

[10] Statistical agencies often measure the change in real GDP using the Törnqvist index, which aggregates the growth rates of individual outputs using their average nominal value shares as weights. Specifically, if Y_{it} is the output of sector or product i in period t, and P_{it} is its price, the growth rate of real GDP between periods t and $t+1$ is approximated by:

$$\Delta \log Y_t \approx \sum_i \overline{s}_{it} \Delta \log Y_{it},$$

where $\overline{s}_{it} = \frac{1}{2}\left(s_{it} + s_{it+1}\right)$ is the average sales share of product i in nominal GDP across two periods, and $s_{it} = \frac{P_{it} Y_{it}}{GDP}$ is the sales share in period t. Notice that the local change in real GDP is calculated by using the sales share at the beginning. TFP growth is then obtained as the residual from output growth, subtracting the contribution of factor growth—also measured using a Törnqvist index with factor cost shares as weights.

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.

When $\mu_{\mathcal{D},t} > \overline{\mu}_t$, the first-order component is negative, reflecting an efficiency loss. The second-order term, however, is positive and reflects a partial correction: the exchange rate depreciation raises exporters' markups (due to exporter's price stickiness in foreign currency), reducing the ex-post TFPR gap and easing the allocative distortion.

While Baqaee et al. [2024] analyze the local change in TFP in response to a monetary policy shock—where ex-post distortions are irrelevant—Theorem 1 highlights that measured TFP, consistent with the Törnqvist index approach, is sensitive to ex-post distortions, particularly in sudden stop episodes. This second-order effect is non-negligible as demonstrated in the quantitative exercise.

4 Quantitative Model

To quantify how a sudden stop contributes to the decline in TFP through reallocation effects—and how it affects key macroeconomic variables—I extend the stylized model developed in the previous section.[11] The quantitative version incorporates additional features, including a non-manufacturing sector, input–output linkages, richer production technologies, endogenous labor supply, and more realistic price rigidities. The simple model discussed earlier can be viewed as a special case of the quantitative framework presented here.

[11] Another way to assess the effect of allocative efficiency on TFP is through a sufficient statistics approach, following Baqaee and Farhi [2020]. The results of this analysis are presented in Appendix C and are broadly consistent with those from the quantitative model. While informative, the sufficient statistics approach captures the combined effects of multiple shocks—including the sudden stop, the financial crisis, and the introduction of NAFTA—making it difficult to isolate the impact of the sudden stop alone. For this reason, I rely on a quantitative structural model to more precisely evaluate the effect of allocative efficiency on TFP.

4.1 Household

A representative domestic household maximizes the discounted expected lifetime 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 non-manufacturing consumption goods ($C_{NM,t}$):

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

with ζ denoting the elasticity of substitution between manufacturing and non-manufacturing 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:

$$P_{M,H,t} C_{M,H,t} + \epsilon_t P_{M,F,t}^{*} C_{M,F,t} + P_{NM,H,t} C_{NM,H,t} + \epsilon_t \Theta_t = W_t L_t + \Pi_t,$$

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; $P_{M,F,t}^{*}$ is the price index of foreign-produced manufacturing products in foreign currency, which is exogenously determined due to the small open economy assumption; and $P_{NM,H,t}$ is the price index of nonmanufacturing products. Additionally, $W_t L_t$ is labor income, and Π_t is the sum of profits generated by all firms operating within the domestic economy. Θ_t captures exogenously determined net foreign repayment in foreign currency. As in the stylized model, I abstract from the household's borrowing and saving behavior. A sudden stop is modeled as an exogenous increase in Θ_t, capturing a tightening of external financing conditions.

Consumers have homothetic preferences over domestically produced manufacturing consumption goods and non-manufacturing 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 non-manufacturing consumption goods, respectively. The elasticity of substitution across varieties is given by $\sigma > 1$.

By solving the household's utility maximization problem, I obtain the demand curve for variety θ in the manufacturing and non-manufacturing sectors:

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

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

where $p_{M,H,\theta,t}$ and $p_{NM,H,\theta,t}$ denote the prices of variety θ in the respective sectors, and $P_{M,H,t}$ and $P_{NM,H,t}$ are the corresponding CES price indices.

The household supplies labor through a continuum of labor unions, represented by $l \in [0, 1]$. 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:

$$L_t = \int_0^1 n_t(l)\, dl.$$

Firms aggregate these differentiated labor inputs into an effective labor composite n_t via a CES aggregator:

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

where $\epsilon_w > 1$ is the elasticity of substitution between the labor types.

Cost minimization by firms implies that each labor union faces a downward-sloping demand curve for its specific labor type:

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

where $W_t\left(l\right)$ is the nominal wage set by union l, and W_t denotes the nominal wage index, defined as:

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

Following Erceg et al. [2000], each labor union l sets its wage $W_t\left(l\right)$ to maximize the expected utility of the representative household. Wage setting is subject to Calvo-style nominal rigidity: in each period, a union can reoptimize its wage with probability δ_w. Union l chooses $\{W_t\left(l\right), N_t\left(l\right)\}$ to maximize the objective function:

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

subject to:

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

$$L_{t+s} = \int_0^1 n_{t+s}\left(l\right) dl,$$

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

The solution to this optimization problem is presented in Supplement Appendix F.[12]

Finally, I assume symmetry in the foreign household's problem. All variables associated with the foreign economy are denoted with an asterisk (*).

[12] The Supplement Appendix F is available on the author's webpage.

4.2 Firms

There are two sectors in the economy: the manufacturing sector and the non-manufacturing sector. Within the manufacturing sector, I distinguish between maquiladoras and non-maquiladoras (standard manufacturing plants). Non-maquiladoras produce goods for both domestic and foreign markets, while maquiladoras produce exclusively for foreign markets. The non-manufacturing sector supplies goods solely to the domestic market.

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:

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

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 $\xi^{\text{l,ii}}$ is the elasticity of substitution among labor and the aggregated intermediate input. The aggregated intermediate input is given by:

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

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 non-manufacturing 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 non-manufacturing sector. The intermediate input from the manufacturing sector is given by

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

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.

I assume that exporters in the manufacturing sector (excluding maquiladoras) face sticky prices in foreign currency when selling in foreign markets. In contrast, both the manufacturing and non-manufacturing sectors are assumed to set prices flexibly when serving the domestic market. Maquiladoras, which produce exclusively for export, are also assumed to face flexible prices in foreign currency. This last assumption is motivated by empirical evidence indicating that maquiladoras' markups, measured using the accounting approach, remained stable between 1994 and 1995 [13].

Following Calvo [1983], I model price rigidity for non-maquiladora exporters by assuming that firms can reset their price in foreign currency with probability δ_p. Exporter θ sets its price in foreign currency, $p^*_{M,H,\theta,t}$, to maximize the expected discounted stream of profits:

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

subject to the demand in foreign market:

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

where $Q_{t,t+s}$ is the domestic household's stochastic discount factor, $P^*_{M,F,t}$ is the aggregate price index of foreign-produced manufacturing goods (in foreign currency), and $Y^*_{M,F,t}$ is total demand in the foreign market. $P^*_{M,F,t}$ and $Y^*_{M,F,t}$ are taken as exogenous due to the small open economy assumption. The solution to this maximization problem can be found in Supplement Appendix F.

4.3 Distortions from Taxation

To account for differences in tax rates across sectors—particularly between maquiladoras and non-maquiladoras—I introduce intermediaries who sit between suppliers and buyers of goods or labor. These intermediaries apply a markup of $1+\tau$, where τ is the tax rate. I consider three tax

[13] Markup is calculated as the ratio of total sales to total variable costs. For details on the measurement of total variable costs, see footnote 18 in Appendix C.1.

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:

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

where X_t denotes the total quantity of imported foreign intermediate inputs:

$$X_t = \int_0^1 x_{M,H,\theta,m,f,t} d\theta + \int_0^1 x^*_{M,H,\theta,m,f,t} d\theta + \int_0^1 x^*_{M,M,\theta,m,f,t} d\theta + \int_0^1 x_{NT,H,\theta,m,f,t} d\theta,$$

and $P^*_{X,t}$ is the price of foreign intermediate input in foreign currency.

The current account identity equates net exports to net capital outflows:

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

The monetary authority's policy rule targets a weighted average of changes in the consumer price index and labor market conditions:

$$\varXi \Delta \log P_{c,t} + (1 - \varXi)\, \Delta \log L_t = 0.$$

where $P_{c,t}$ is the domestic consumer index, and $\varXi \in [0, 1]$ 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 also allow for incomplete exchange rate pass-through to the price of foreign intermediate inputs. Specifically:

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

where $\varrho \in [0, 1]$ denotes the pass-through rate from changes in the nominal exchange rate to changes in the price of foreign intermediate inputs.

I define the equilibrium in Supplement Appendix F and the way to calculate the steady state of the model is explained in Supplement Appendix G.[14]

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, following Boehm et al. [2023]. For the elasticity of substitution between manufacturing and non-manufacturing intermediate inputs, I adopt a value of 0.2, consistent with Baqaee and Farhi [2022]. Likewise, the elasticity of substitution between labor and the entire bundle of intermediate input is set to 0.6, also based on Baqaee and Farhi [2022].

When measuring markups in the data, they reflect the combined effects of various distortions, including market power, financial frictions, and tax distortions. In this quantitative analysis, I explicitly separate tax distortions from other sources of inefficiency. Tax distortions are incorporated with the following parameter values: $\tau_{VAT} = 0.1$, $\tau_{labor} = 0.25$, and $\tau_{tariff} = 0.08$. All remaining distortions—such as market power and financial frictions—are captured by the markup.

Based on empirical evidence, I assume that the initial markup charged by non-maquiladoras in the foreign market is 11.3% lower than that in the domestic market prior to the sudden stop.

[14] The Supplement Appendix G is available on the author's webpage.

In the benchmark analysis, maquiladoras and exporters within non-maquiladoras are assumed to charge the same markup (1.05). As a robustness check, I allow for differential markups between these two groups. Similarly, in the baseline, I assume a common average markup of 1.16 across non-maquiladoras and the non-manufacturing sector. As a robustness check, I also explore cases with sector-specific differences in average markups.

While microdata provide information on markup differences and tax exposures across sectors, they do not reveal the absolute level of markups. To proceed with the numerical exercise, it is therefore necessary to pin down the level of markup in one sector. I calibrate the average markup charged by non-maquiladoras to match a net export-to-GDP ratio of −4.82% before the sudden stop. Markups influence this ratio because a higher markup increases the wedge between export prices and input costs, thereby raising the value of exports and, in turn, the net export-to-GDP ratio. Figure 5.1 illustrates the relationship between markups and the net export-to-GDP ratio. The resulting calibrated average markup for non-maquiladoras is 1.16.

As export prices become more rigid, markups in foreign markets rise during the sudden stop. Based on empirical evidence, the degree of price stickiness for exporters among non-maquiladoras is calibrated to ensure that markups are equal across destinations during the sudden stop. 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.[15] 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, based on Blaum [2024]. Labor elasticity is set to 1.84, as in Mendoza [2010]. Wage stickiness is set to 0.08, in line with estimates from Fukui et al. [2023]. The discount factor is set to 0.91, following Cugat [2022].

The monetary authority's weights on CPI and labor stabilization, along with the exchange rate pass-through to the price of foreign intermediate inputs (which is allowed to differ from one), are

[15] 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 analysis.

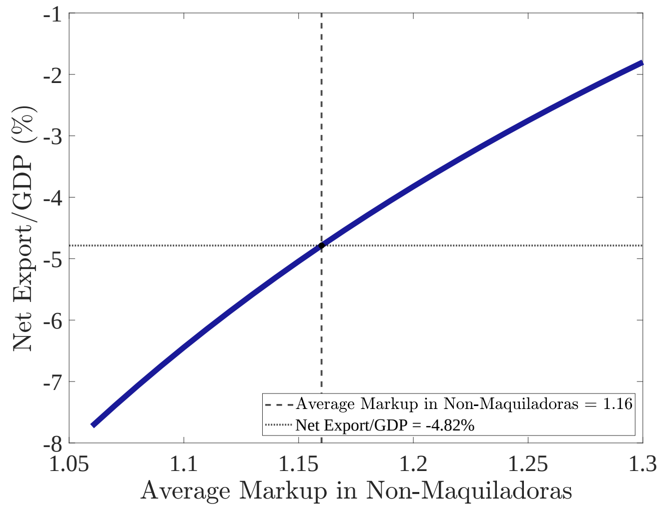

Figure 5.1: The Relationship Between Markup and Net Export

jointly calibrated to replicate a 2.8% decline in manufacturing employment observed in the data. The magnitude of the sudden stop shock is calibrated to generate a 156.3% increase in the net export-to-GDP ratio, consistent with empirical evidence.

5.2 Impulse Response Functions

Figure 5.2 and 5.3 show the impulse response functions.[16] 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 difference stems from the distinction between ex-ante and ex-post markups. Prior to the sudden stop, the markup in foreign markets is lower than that in domestic markets. However, during the sudden stop, the foreign markup rises due to price stickiness, narrowing the markup gap between the two markets.

When second-order effects are considered, the increase in the foreign markup reduces the ex-post TFPR gap, thereby alleviating allocative inefficiencies. As a result, the second-order change in allocative efficiency is smaller in magnitude, indicating a partial mitigation of the misallocation

[16] 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.

caused by the shock.

The change in allocative efficiency is primarily driven by the relative expansion of maquiladoras. When decomposed up to the second order, reallocation within non-maquiladoras accounts for 0.34% of the decline in TFP in the manufacturing sector, while reallocation between maquiladoras and non-maquiladoras contributes 3.36%. As discussed in Section 2.3, maquiladoras face fewer distortions in their supply chains because they rely less on domestically produced intermediate inputs, which tend to accumulate distortions throughout the production process.

This finding highlights the quantitative importance of maquiladoras—and more broadly, producers in special economic zones— when analyzing TFP and GDP dynamics. Overall, reallocation effects explain approximately 50% of the observed decline in value added in the manufacturing sector.

The model matches key features of the data well. In the data, the sales share of maquiladoras rises to 45.3% compared to 44.3% in the simulation. The sales share of exporters among non-maquiladoras increases to 46.0% in the data, versus 39.3% in the model. Part of this discrepancy may be attributed to the effects of NAFTA, which is not incorporated in the model. NAFTA likely benefited exporters among non-maquiladoras, while having limited impact on maquiladoras, which already benefited from tax exemptions prior to NAFTA.

Regarding input use, imports of foreign intermediate inputs declined by 0.1% in the data but increased by 0.22% in the simulation. In terms of output, real value added in the manufacturing sector declined by 5.2% in the data during the sudden stop. Given that the contribution of capital to real value added was 1.5%, this implies that TFP and labor jointly contributed to a 6.7% decline. The model, which abstracts from capital, predicts a 7.2% decline in real value added, suggesting a close match with the data.

5.3 Robustness

5.3.1 Markup by Maquiladoras

In the benchmark analysis, I assume that maquiladoras and exporters within non-maquiladoras charge the same markup, which is set to 1.05. As a robustness check, I vary the markup for maquiladoras to 1.00 and 1.15, while keeping the markup for exporters within non-maquiladoras

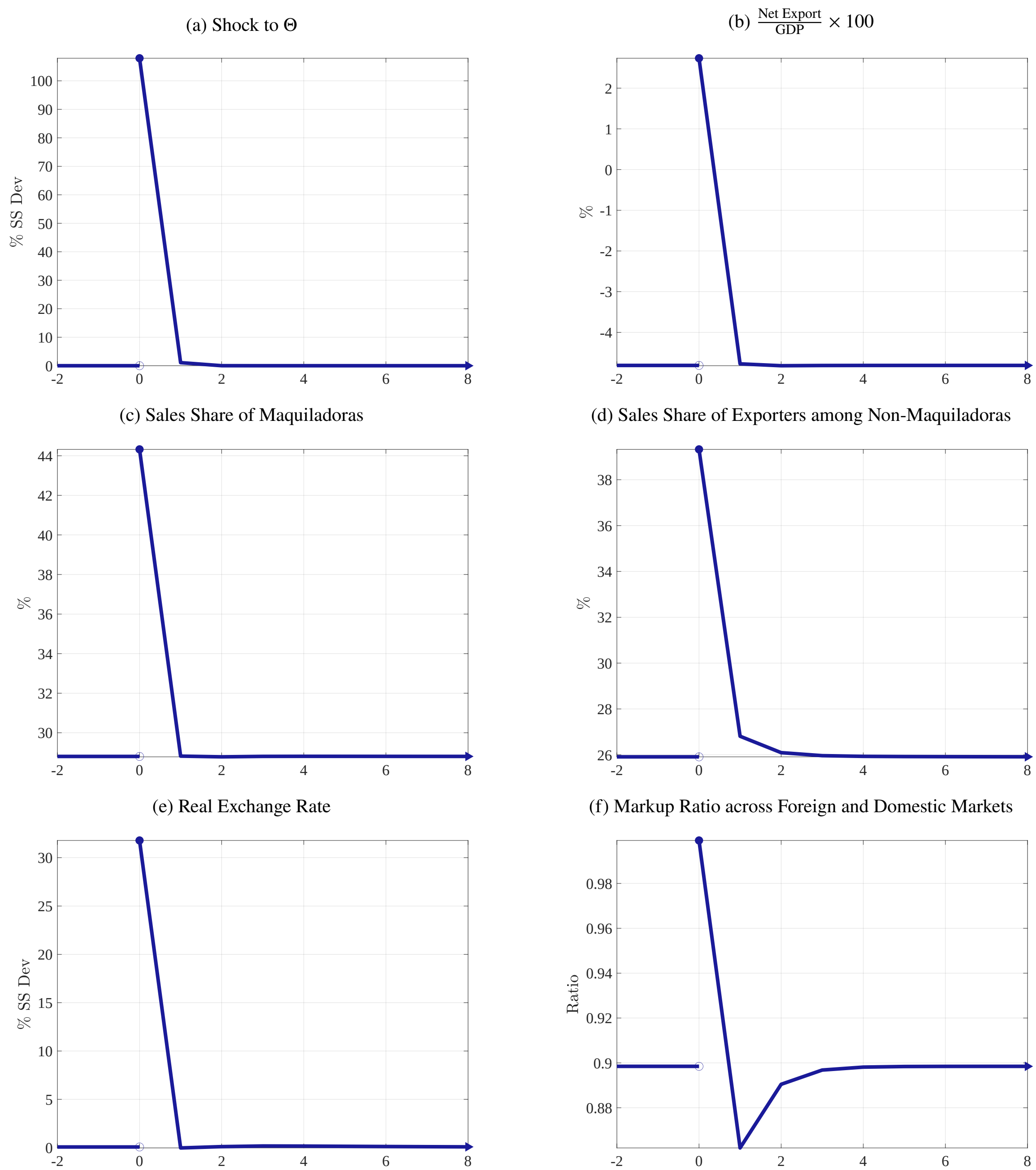

Figure 5.2: Transition Dynamics during a Sudden Stop

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 by non-maquiladoras for the foreign market to that for the domestic market.

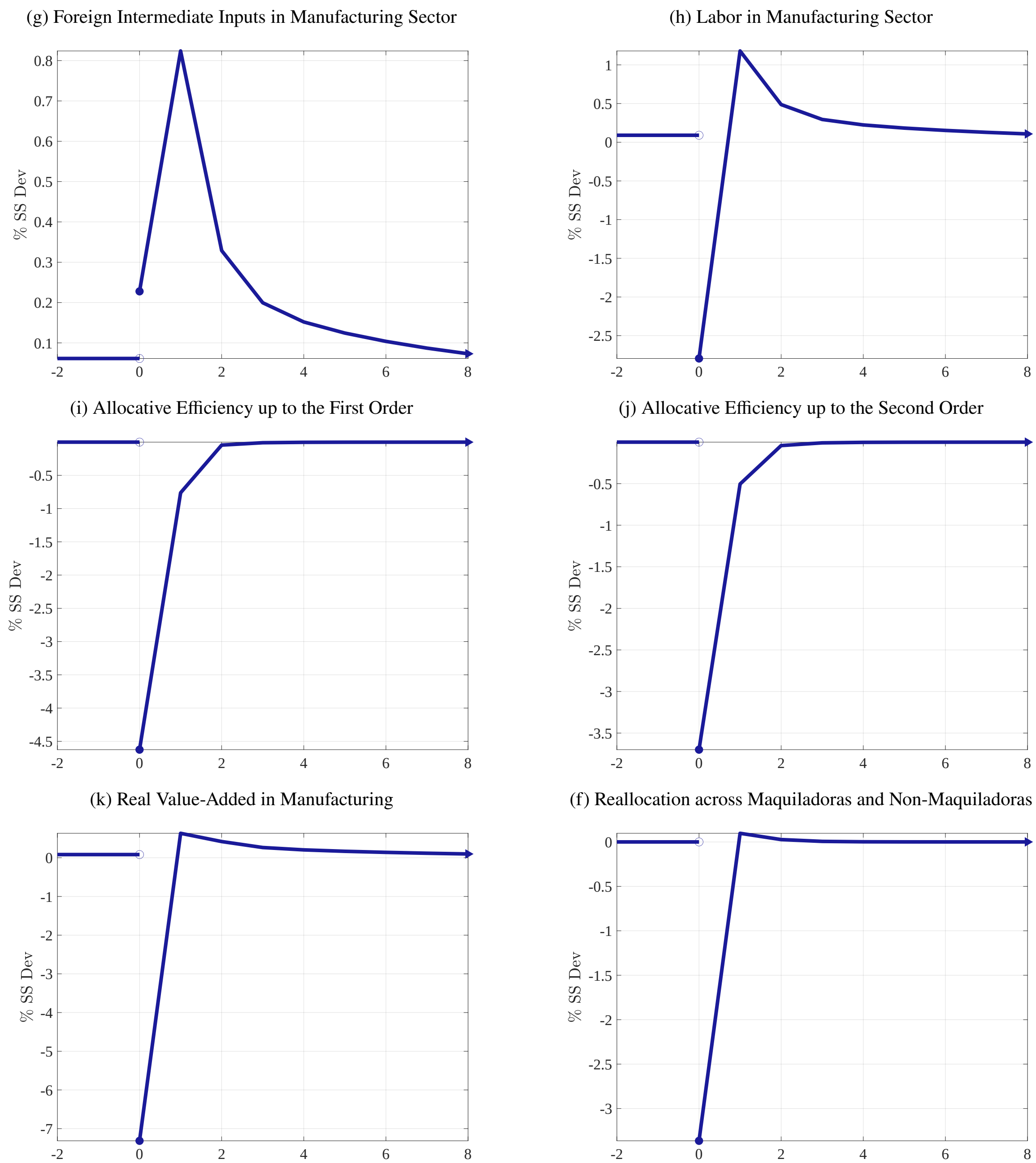

Figure 5.3: Transition Dynamics during a Sudden Stop

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.

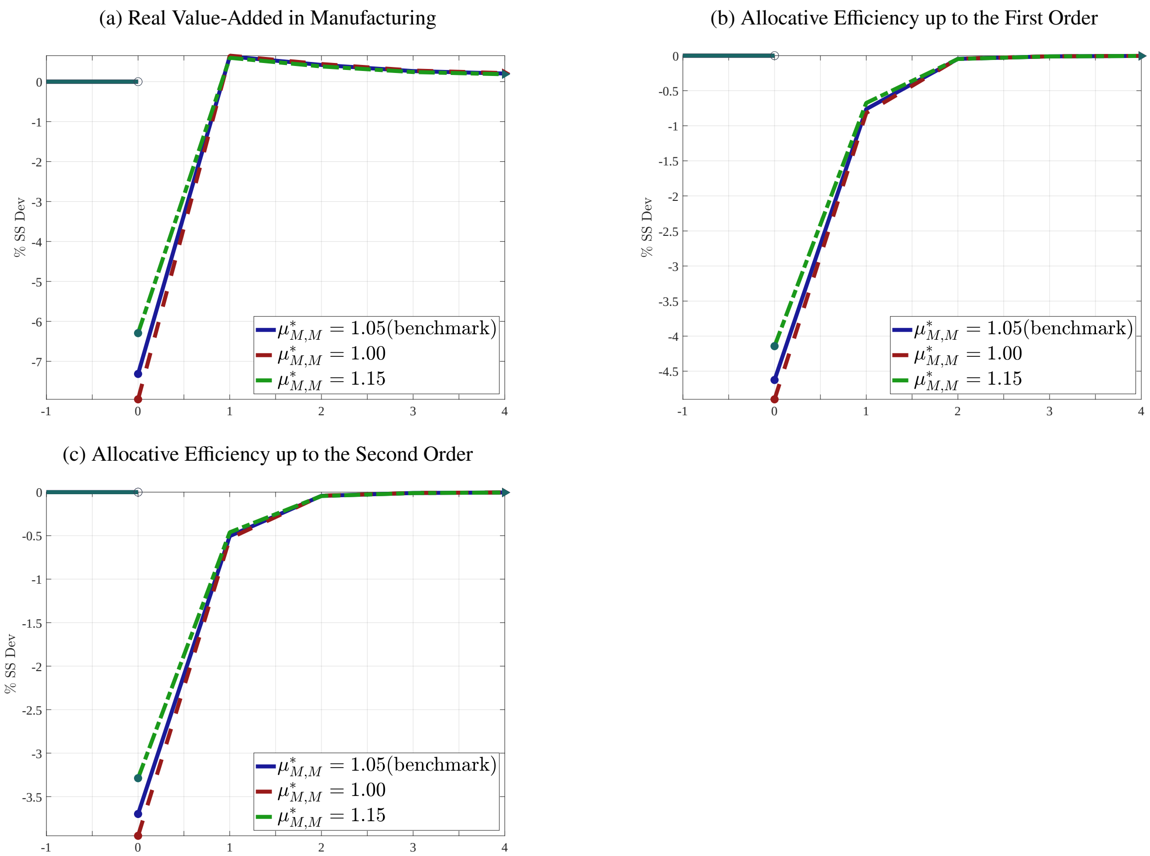

Figure 5.4: Impulse Responses under Alternative Maquiladora Markup Assumptions

Note: The figure reports the impulse response functions. Panel (a) reports the impulse response function of real value added in the manufacturing sector, expressed as a percentage deviation from the steady state. Panel (b) reports the percentage change in allocative efficiency up to the first order. Panel (c) reports the percentage change in allocative efficiency up to the second order.

and all other parameters fixed. The resulting impulse response functions are shown in Figure 5.4.

When the markup charged by maquiladoras decreases, the reallocation of resources toward maquiladoras amplifies the decline in allocative efficiency, since their supply chains are less distorted. This leads to a larger decline in real value added in the manufacturing sector. Conversely, when the markup by maquiladoras increases, it mitigates the decline in allocative efficiency and softens the contraction in real value added. In all cases, the second-order effect of allocative efficiency partially offsets the first-order effect. The main results remain robust to variations in maquiladora markups.

5.3.2 Markup by Non-Manufacturing Sector

In the benchmark analysis, I assume that non-maquiladoras and non-manufacturing sectors charge the same average markup, set at 1.16. As a robustness check, I vary the markup for the non-

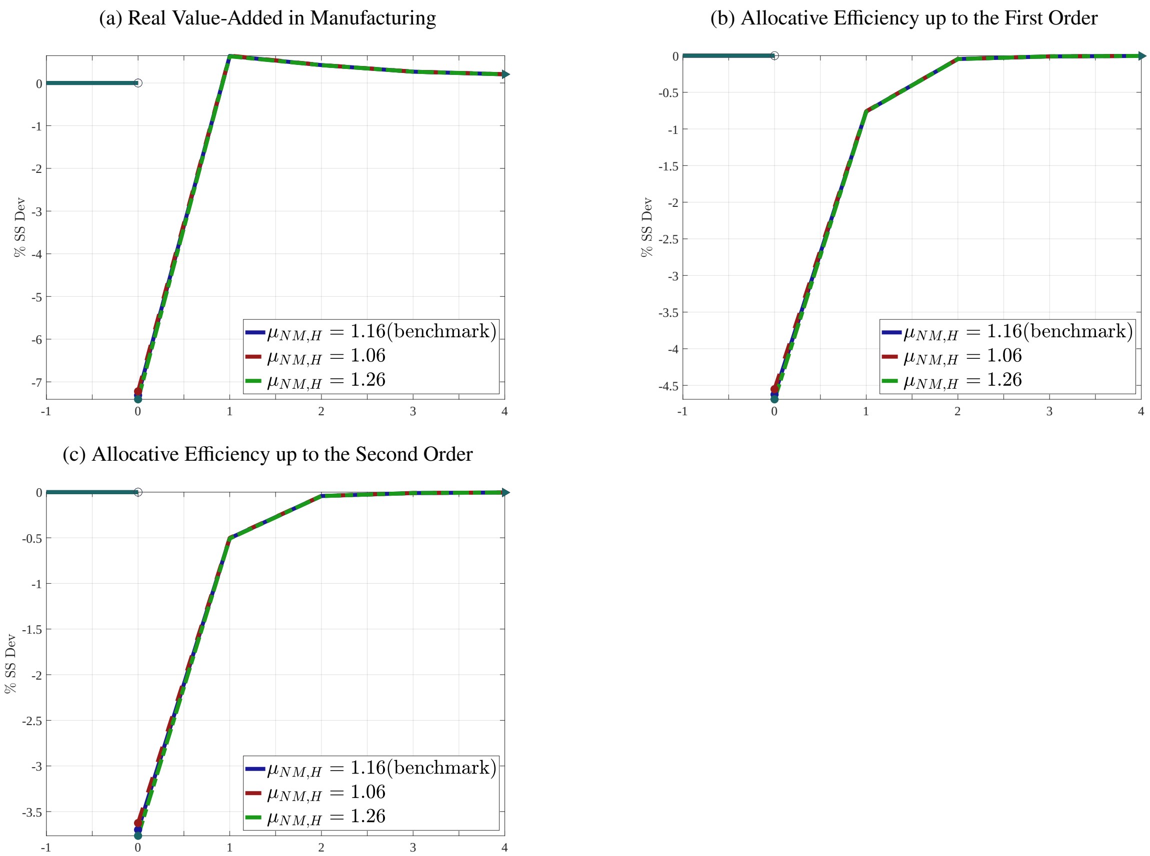

Figure 5.5: Impulse Responses under Alternative Non-Manufacturing Markup Assumptions

Note: *Note*: The figure reports the impulse response functions. Panel (a) reports the impulse response function of real value added in the manufacturing sector, expressed as a percentage deviation from the steady state. Panel (b) reports the percentage change in allocative efficiency up to the first order. Panel (c) reports the percentage change in allocative efficiency up to the second order.

manufacturing sector to 1.06 and 1.26, while keeping the average markup for non-maquiladoras and all other parameters fixed. The resulting impulse response functions are shown in Figure 5.5.

When the markup charged by the non-manufacturing sector increases, the reallocation of resources toward maquiladoras amplifies the decline in allocative efficiency, as supply chains for non-maquiladoras become more distorted. This effect reflects the fact that non-maquiladoras rely more heavily on non-manufacturing intermediate inputs, which are now more distorted. As a result, the decline in real value added in the manufacturing sector becomes larger. Conversely, when the markup in the non-manufacturing sector decreases, it reduces the degree of distortion in the supply chains of non-maquiladoras, thereby mitigating the decline in allocative efficiency and softening the contraction in real value added.

Overall, the main results remain robust to variations in the markup charged by the non-manufacturing sector.

6 Conclusion

This paper analyzes the impact of a sudden stop on allocative efficiency and TFP. I show that during a sudden stop, the reallocation of resources from non-exporting activities—typically more distorted—to export-oriented activities—typically less distorted—leads to a decline in TFP. I approach this question through a combination of empirical evidence, theoretical modeling, and quantitative analysis.

Using detailed plant–product–destination level microdata from Mexico, I provide new empirical evidence on how distortions and resource allocation patterns shift during a sudden stop. From a quantitative standpoint, the model successfully replicates key moments in the data and shows that resource reallocation accounts for approximately 50% of the observed decline in value added in the manufacturing sector during the 1994 Mexican sudden stop. These findings highlight the central role of misallocation dynamics in amplifying the real effects of sudden stops and highlight the importance of incorporating micro-level distortions into open-economy macroeconomic models.

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A Appendix A: Additional Figures and Tables

A.1 Import of Foreign Intermediate Inputs

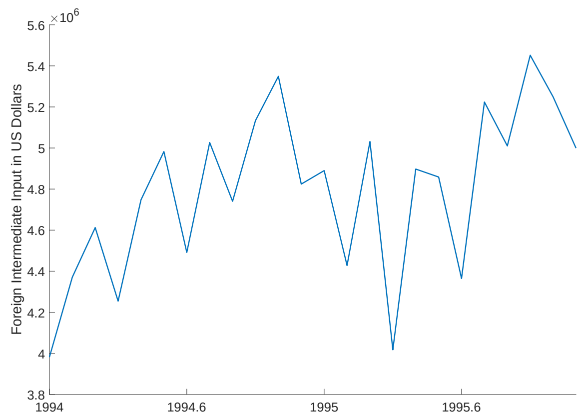

Figure A.1: Foreign Intermediate Inputs in US Dollars
Notes: This figure illustrates the import of foreign intermediate inputs in US dollars from 1994 to 1995. The data is sourced from the balance of payments records at the Bank of Mexico.

A.2 Export Price Index

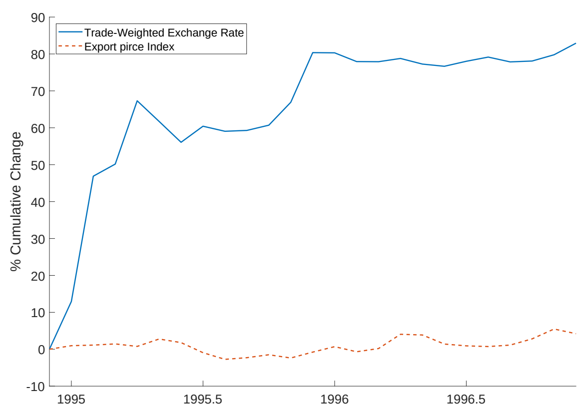

Figure A.2: Trade-Weighted Exchange Rate and Export Price Index
Notes: This figure illustrates cumulative logarithmic changes in trade-weighted nominal exchange rates and export price indices relative to the month preceding the sudden stop. To calculate the export price index, we subtract the the cumulative 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].

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 Non-manufacturing	0.54	INEGI
$\nu_{NM,H}$	Manufacture Input Share of Non-manufacturing	0.31	INEGI
$\varsigma_{NM,H}$	Foreign Manufacture Input Share of Non-manufacturing	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 Non-manufacturing	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 Non-manufacturing 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 & Non-manufacturing Good)	0.4	Burstein et al. [2007]
γ	Consumption Share of Foreign Good	0.11	Blaum [2024]
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)

Online Appendix

Not for Publication

C Sufficient Statistics Analysis

C.1 Sufficient Statistics Approach

I consider a small open economy framework, building on Baqaee and Farhi [2024], with the key distinction that I analyze changes in TFP up to the second order. Let $\mathcal{N}$ denote the set of plants in the economy. Each plant is assumed to produce a single type of product. Some plants serve both domestic and foreign markets, while others supply only one. Production at each plant requires labor, capital, and intermediate inputs, which may be sourced from either domestic or foreign producers.

Producers

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

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

where A_i is an exogenous Hicks-neutral productivity shifter of plant i, l_i is the labor input of plant i, k_i is the capital 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 given 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 cost and sets destination-specific prices:

$$p_{i,d} = \mu_{i,d} mc_i,$$

where mc_i is the marginal cost of production, assumed to be identical across destinations within each plant.

Nominal GDP, Input–Output Matrices and Sales Shares

Nominal GDP, equal to aggregate value added, is given by:

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

The first term represents gross output, the second captures expenditure on domestic intermediate inputs, and the third reflects foreign intermediate input spending.

Let Ω be the revenue-based input–output matrix of size $(\mathcal{N}+2+\mathcal{F})\times(\mathcal{N}+2+\mathcal{F})$. Each entry is:

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

denoting the share of producer i's revenue spent on inputs from j. The last $2+\mathcal{F}$ rows are zero because capital and labor require no inputs, and the expenditure shares of the foreign intermediate input on domestically produced products are zero due to the small open economy assumption.

The revenue-based Leontief inverse matrix is given by

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

Let μdenote the diagonal matrix of markups, then the cost-based input–output matrix is:

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

The corresponding cost-based Leontief inverse is:

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

While Ψ_{ij} captures how spending on good i affects the sales of good j through production network, $\tilde{\Psi}_{ij}$ captures how the price of j affects the marginal cost of good i.

Define the forward and backward exposure of GDP to good k 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 share of final output of good i in GDP, and $q_i = y_i - \sum_{j\in\mathcal{N}} x_{ji}$ is the final output of good i. Notice that $q_i < 0$ holds for the foreign intermediate inputs $i \in \mathcal{F}$. Let Λ_L, Λ_K, Λ_i^* denote the shares of labor, capital, and foreign intermediates in GDP, respectively, and $\tilde{\Lambda}_L$, $\tilde{\Lambda}_K$, $\tilde{\Lambda}_i^*$be their cost-based analogs.

The harmonic average markup of plant i across destinations is:

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

Real GDP

Using Divisia index weights, the local change in the aggregate price level at time t is:

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

Then, the local change in real GDP is:

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

The Change in Allocative Efficiency

For any variable X, the global change from time t to $t+1$ is defined by integrating local changes over the interval:

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

The second-order approximation of the global change in real GDP at an inefficient equilibrium 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:*

$$\Delta\log Y_t \approx \underbrace{\int_{k\in\mathcal{N}}\left(\frac{\tilde{\lambda}_{k,t}+\tilde{\lambda}_{k,t+1}}{2}\right)\Delta\log A_{k,t}dk}_{\text{Change in Technology}} + \underbrace{\left(\frac{\tilde{\Lambda}_{L,t}+\tilde{\Lambda}_{L,t+1}}{2}\right)\Delta\log L_t}_{\text{Change in Labor}} + \underbrace{\left(\frac{\tilde{\Lambda}_{K,t}+\tilde{\Lambda}_{K,t+1}}{2}\right)\Delta\log K_t}_{\text{Change in Capital}}$$

$$+\underbrace{\sum_{i\in\mathcal{F}}\left(\frac{\tilde{\Lambda}^*_{i,t}+\tilde{\Lambda}^*_{i,t+1}-\Lambda^*_{i,t}-\Lambda^*_{i,t+1}}{2}\right)\Delta\log X_{i,t}}_{\text{Change in External Inputs}}$$

$$\underbrace{-\int_{k\in\mathcal{N}}\left(\frac{\tilde{\lambda}_{k,t}+\tilde{\lambda}_{k,t+1}}{2}\right)\Delta\log\mu_{k,t}dk-\sum_{f\in\{K,L\}}\left(\frac{\tilde{\Lambda}_{f,t}+\tilde{\Lambda}_{f,t+1}}{2}\right)\Delta\log\Lambda_{f,t}-\sum_{i\in\mathcal{F}}\left(\frac{\tilde{\Lambda}^*_{i,t}+\tilde{\Lambda}^*_{i,t+1}-\Lambda^*_{i,t}-\Lambda^*_{i,t+1}}{2}\right)\Delta\log\Lambda^*_{i,t}}_{\text{Change in Allocative Efficiency}}.$$

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

Lemma 1 provides the second-order approximation of Theorem 1 in Baqaee and Farhi [2024]. As shown in their work, the change in real GDP can be decomposed into four components: the change in pure technology, the change in factor inputs, the change in external inputs, and the change in allocative efficiency. Correspondingly, the change in TFP reflects the combined effects of changes in technology, external inputs, and allocative efficiency. The change in allocative efficiency specifically captures how reallocation contributes to the overall change in TFP and thus to real GDP.

To account for second-order effects, I follow Baqaee and Farhi [2024]'s approach by averaging the coefficients at time t and $t+1$ for each term. For example, the change in labor input, $\Delta\log L_t$, is weighted by the average of $\tilde{\Lambda}_{L,t}$ and $\tilde{\Lambda}_{L,t+1}$ when computing the second-order contribution.

Reallocation from Non-Maquiladoras toward Maquiladoras

I use lemma 1 to see how reallocation across maquiladoras and non-maquiladoras contribute to the change in TFP.[17] 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 EIA

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

and the EMIME. I calculate markups as total sales relative to total variable costs.[18]

The resulting change in allocative efficiency due to reallocation between maquiladoras and non-maquiladoras is -3.50%, highlighting the quantitative importance of this margin. As shown in Section 2.3, maquiladoras operate with less distorted supply chains, so a shift of resources toward maquiladoras tends to worsen allocative efficiency.

While markup estimates from the data reflect all sources of distortion—such as market power, financial frictions, and tax distortions—the quantitative model explicitly separates tax distortions from other forms of inefficiency. Notably, the reallocation effects computed in the quantitative exercise are consistent with those obtained through the sufficient statistics approach, reinforcing the robustness of the findings.

Reallocation toward Product Lines for Foreign Markets: First-Oder Effect

I next examine how reallocation toward product lines for foreign markets contributes to changes in TFP. When the markup for foreign markets is lower at the plant–product level, reallocating output toward those markets is expected to reduce plant–product-level TFPQ.

To compute the change in TFPQ at the plant–product level, I begin by defining the price deflator for product j at time t:

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

where d indexes the destination (e.g., domestic or foreign), and $\lambda_{jd,t} = \frac{p_{jd,t} y_{jd,t}}{P_{j,t} Y_{j,t}}$ is the share of sales of product j at destination d, relative to the gross output of product j.

The change in real gross output at the plant–product level is then given by:

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

[18]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 Supplement Appendix E 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 the EMIME, as a proxy for the cost of capital.

I assume that the production technology is identical across destinations for each plant–product pair. 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*

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

$A_{jd,t}$ 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 lemma is a plant–product-level version of Lemma 2 in Baqaee et al. [2024]. The first term captures the direct contribution of technological change at each destination, while the second term reflects the reallocation effect—how shifts in sales across destinations, each with different markups, affect TFPQ. An immediate implication is that if a product is sold only in one market (e.g., the domestic market), the reallocation term is zero, since no destination-level substitution is possible.

Empirical evidence shows that, during the sudden stop, output expansion was greater for product lines sold in foreign markets, which tend to have lower markups. As a result,

$$Cov_{\lambda_{jd,t}}\left(\frac{\mu_{j,t}}{\mu_{jd,t}}, \Delta \log y_{jd,t}\right) > 0,$$

implying a negative reallocation effect on TFPQ. This is consistent with the prediction of the stylized model, which analytically shows that this covariance term is positive when markup is lower in the expanding destination (foreign market), thus reducing aggregate TFP.

I estimate this reallocation effect using plant–product–destination-level data. The sales shares $\lambda_{jd,t}$ and quantity changes $\Delta \log y_{jd,t}$ are directly observed. Markups are calculated using the accounting approach, as previously described. For multi-product plants, I assume a common markup across domestic products.

After computing the reallocation effect on TFPQ at the plant–product level, I aggregate its contribution to overall TFP as:

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

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

Reallocation toward Product Lines for Foreign Markets: Second-Oder Effect

Empirical evidence indicates that the markup difference across destinations disappeared during the sudden stop. This has important implications for analyzing 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 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 1994 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 3. The second-order reallocation effect on aggregate TFP is estimated to be −0.34%. Compared to −0.63% for the first-order effect, the second-order term partially offsets the allocative loss. This occurs because the increase in markups for previously underpriced foreign-market product lines leads to a more uniform distortion profile across destinations, improving efficiency.

However, the quantitative magnitude of the destination-level reallocation effect remains small relative to the larger reallocation from non-maquiladoras to maquiladoras, consistent with the findings from the quantitative model.

D Proofs

Proof of Lemma 1

According to Baqaee and Farhi [2024], the local change in real GDP is expressed as:

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

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:

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

By integrating equation (D.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:

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

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 (D.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.

$$
\begin{aligned}
A &= \int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}} \mu_{j,s}\frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}}\left(\Delta\log\mu_{j\theta,t}-\Delta\log\lambda_{j\theta,t}\right)d\theta-\int_{\theta\in\{\mathcal{D},\mathcal{F}^*\}}\lambda_{j\theta,t}\Delta\log\mu_{j\theta,t}d\theta\\
&= E_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}}\Delta\log\mu_{j\theta,t}\right]-E_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}}\Delta\log\lambda_{j\theta,t}\right]-E_{\lambda_{j\theta,t}}\left[\Delta\log\mu_{j\theta,t}\right]\\
&= Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}},\Delta\log\mu_{j\theta,t}\right]+\underbrace{E_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}}\right]}_{=1}E_{\lambda_{j\theta,t}}\left[\Delta\log\mu_{j\theta,t}\right]\\
&-\left(Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}},\Delta\log\lambda_{j\theta,t}\right]+E_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}}\right]\underbrace{E_{\lambda_{j\theta,t}}\left[\Delta\log\lambda_{j\theta,t}\right]}_{=0}\right)-E_{\lambda_{j\theta,t}}\left[\Delta\log\mu_{j\theta,t}\right]\\
&= Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}},\Delta\log\mu_{j\theta,t}\right]-Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}},\Delta\log\lambda_{j\theta,t}\right]\\
&= -Cov_{\lambda_{j\theta,t}}\left[\frac{\mu_{j,s}}{\mu_{j\theta,t}},\Delta\log\left(\frac{\lambda_{j\theta,t}}{\mu_{j\theta,t}}\right)\right].
\end{aligned}
$$

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 change in TFP 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.

E 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 E.1: Depreciation Rates of Capital

Supplement Appendix

F 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:

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

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

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

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

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

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

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

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

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

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

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

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

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

(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

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

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

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

(iii) New Keynesian Wage Phillips Curve

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

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

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:

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

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

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

Producers in Manufacturing Sector

(i) Sales Share

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

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

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

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:

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

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

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

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

$$\Delta \log \lambda^*_{M,H,t} = E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}} \left[E \left[\Delta \log \lambda^*_{M,H,\theta,t} \right] \right]$$

$$\Longleftrightarrow \Delta \log \lambda^*_{M,H,t} = \Delta \log \epsilon_t + E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}} \left[E \left[\left(1 - \sigma^*_{M,H,\theta} \right) \Delta \log p^*_{M,H,\theta,t} \right] \right] - \Delta \log VA_{M,t} \tag{F.14}$$

$E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}} \left[E \left[\left(1 - \sigma^*_{M,H,\theta} \right) \Delta \log p^*_{M,H,\theta,t} \right] \right]$ 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 $u_1 \left(C_{t+s}, L_{t+s} \right) = \frac{\partial u(C_{t+s}, L_{t+s})}{\partial C_{t+s}}$. 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

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

where $\hat{mc}^*_{M,H,\theta,t} = \frac{mc^*_{M,H,\theta,t+s}}{\epsilon_{t+s}}$. By log-linearizing equation (F.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

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

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

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

By combining these two equations, we get

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

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

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 (F.16), we get the difference equation for $E\left[\Delta \log \mu^*_{M,H,\theta,t}\right]$:

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

From equation (F.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 (F.14).

$$E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\left(1 - \sigma^*_{M,H,\theta}\right) \Delta \log p^*_{M,H,\theta,t} - \left(1 - \sigma^*_{M,H,\theta}\right) \Delta \log p^*_{M,H,\theta,t-1}\right]\right]$$

$$-\beta E_{\frac{\lambda^*_{M,H,\theta}}{\lambda^*_{M,H}}}\left[E\left[\left(1-\sigma^*_{M,H,\theta}\right)\Delta\log p^*_{M,H,\theta,t+1}-\left(1-\sigma^*_{M,H,\theta}\right)\Delta\log p^*_{M,H,\theta,t}\right]\right]$$

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

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

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

(iii) Input Shares

The change in foreign intermediate input share can be expressed by

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

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

The change in manufacturing input share can be expressed by

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

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

The changes in labor input share can be expressed by

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

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

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

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

(ii) Price and Markup

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

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

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

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

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

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

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

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

(iii) Input Shares

The change in foreign intermediate input share can be expressed by

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

The change in manufacturing input share can be expressed by

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

The changes in labor input share can be expressed by

$$\begin{aligned}
\Delta\log\omega^*_{M,M,t}=&\left(1-\xi^{\mathrm{l,ii}}\right)\left(1-\omega^*_{M,M}\right)\\
&\left(\Delta\log W_t-\left(\nu^*_{M,M}\left(\varsigma^*_{M,M}\Delta\log\epsilon_t+\left(1-\varsigma^*_{M,M}\right)\Delta\log p_{M,ii,t}\right)+\left(1-\nu^*_{M,M}\right)\Delta\log p_{NM,ii,t}\right)\right)
\end{aligned} \tag{F.33}$$

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

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

The change in manufacturing input share can be expressed by

$$\begin{aligned}\Delta \log \nu_{NM,H,t} = &\left(1 - \xi^{\text{m,nm}}\right)\left(1 - \nu_{NM,H}\right)\\ &\left(\varsigma_{NM,H}\Delta \log \epsilon_t + \left(1 - \varsigma_{NM,H}\right)\Delta \log p_{M,ii,t} - \Delta \log p_{NM,ii,t}\right)\end{aligned} \tag{F.35}$$

The changes in labor input share can be expressed by

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

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

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

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 (F.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

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

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

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

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

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

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:

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

Notice that measure θ' distinguishes between sticky and non-sticky firms, while measure θ does not make this distinction. We use equation (F.13) for the third transformation. Similarly to (F.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:

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

From equation (F.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 :

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

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

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

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

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

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:

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

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

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

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

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

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.

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

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

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

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

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

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

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

$$+\frac{\lambda^*_{M,M}}{1+\tau_{labor}} E_{\frac{\lambda^*_{M,M,\theta'}}{\lambda^*_{M,M}}}\left[\frac{\omega^*_{M,M}}{\mu^*_{M,M,\theta'}}\Delta\log\left(\frac{\lambda^*_{M,M,\theta',t}\omega^*_{M,M,t}}{\mu^*_{M,M,\theta',t}}\right)\right] \tag{F.54}$$

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

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

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

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

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

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

By log-linearizing this equation, we get

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

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

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

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

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

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

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

Value Added and GDP

Value added in manufacturing sector is given by

$$\begin{aligned}
VA_{M,t} &= \sum_{i\in\{\text{Manufacture,Maquiladoras}\}}\left(\text{Sales}_{i,t} - \text{Intermediate Input}_{i,t}\right)\\
\Longleftrightarrow VA_{M,t} &= \underbrace{\int_{\theta'}(1+\tau_{vat})\,p_{M,H,\theta',t}c_{M,H,\theta',t}d\theta'}_{\text{sales to domestic household}} + \underbrace{\Lambda_{NM,M,t}VA_{NM,t}}_{\text{sales to non-manufacturing sector}} + \underbrace{\int_{\theta'}p^*_{M,H,\theta',t}y^*_{M,H,\theta',t}d\theta'}_{\text{sales by exporter}}\\
&\quad + \underbrace{\int_{\theta'}p^*_{M,M,\theta',t}y^*_{M,M,\theta',t}d\theta'}_{\text{sales by maquiladoras}} - \underbrace{\Lambda^*_{M,t}VA_{M,t}}_{\text{expenditure on foreign input}} - \underbrace{\Lambda_{M,NM,t}VA_{M,t}}_{\text{expenditure on non-manufacturing input}}\\
\Longleftrightarrow 1 &= b_{M,H,t} + \Lambda_{NM,M,t}\frac{VA_{NM,t}}{VA_{M,t}} + \lambda^*_{M,H,t} + \lambda^*_{M,M,t} - \Lambda^*_{M,t} - \Lambda_{M,NM,t}
\end{aligned}$$

By log-linearizing this equation, we get

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

Value added in non-manufacturing sector is given by

$$\begin{aligned}
VA_{NM,t} &= \left(\text{Sales}_{NM,t} - \text{Intermediate Input}_{NM,t}\right)\\
\Longleftrightarrow VA_{NM,t} &= \underbrace{\int_{\theta'} p_{NM,H,\theta',t}c_{NM,H,\theta',t}d\theta'}_{\text{sales to domestic consumer}} + \underbrace{\lambda_{M,H,A_{NM},t}VA_{NM,t}}_{\text{sales to manufacturing producer for domestic market}}\\
&+ \underbrace{\lambda^*_{M,H,A_{NM},t}VA_{NM,t}}_{\text{sales to manufacturing exporter}} + \underbrace{\lambda^*_{M,M,A_{NM},t}VA_{NM,t}}_{\text{sales to maquiladoras}}\\
&- \underbrace{\Lambda^*_{NM,t}VA_{NM,t}}_{\text{expenditure on foreign input}} - \underbrace{\Lambda_{NM,M,t}VA_{NM,t}}_{\text{expenditure on manufacturing input}}\\
\Longleftrightarrow 1 &= b_{NM,H,t} + \lambda_{M,H,A_{NM},t} + \lambda^*_{M,H,A_{NM},t} + \lambda^*_{M,M,A_{NM},t} - \Lambda^*_{NM,t} - \Lambda_{NM,M,t}
\end{aligned}$$

By log-linearizing this equation, we get

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

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

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

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., $\text{Net Export}_t = \epsilon_t \Theta_t$. Therefore, we have

$$P_{M,H,t}C_{M,H,t} + \epsilon_t P^*_{M,F,t}C_{M,F,t} + P_{NM,H,t}C_{NM,H,t} + \epsilon_t\Theta_t = GDP_t \tag{F.63}$$

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 (F.63) as follows:

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

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

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

By log-linearizing this equation, we get

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

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

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

$$- \Lambda^*_{NM} \frac{VA_{NM}}{VA_M} \left(\Delta \log \Lambda^*_{NM,t} + \Delta \log VA_{NM,t} - \Delta \log VA_{M,t} \right) \tag{F.65}$$

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

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

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

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

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

Monetary Policy

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

$$\varXi \Delta \log P^C_t + (1 - \varXi) \Delta \log L_t = 0 \tag{F.68}$$

where P^C is the domestic consumer index, and $\varXi$ 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:

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

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

G 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:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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.