Allocative Efficiency during a Sudden Stop*

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Abstract

We observe a massive decline in TFP and GDP during a sudden stop. Leveraging firm–product–destination-level data from Mexico, I offer the following new empirical evidence from the 1994 sudden stop: (i) 34% of the increase in aggregate export share during the sudden stop is explained by sales expansion in foreign markets at the plant–product level. (ii) The relative expansion of *maquiladoras*, specialized export plants enjoying various tax benefits, explains 40% of the increase in aggregate export share during the sudden stop. (iii) Prior to the sudden stop, unit values in foreign markets were 11% lower than those in domestic markets, but there was no clear difference in unit values during the sudden stop. To evaluate how these observations impact allocative efficiency and TFP, I provide a theoretical framework focusing on the second-order approximation at the inefficient equilibrium. Up to the second order, not only the ex ante but also the ex post sales shares and markups are relevant for the change in allocative efficiency. By utilizing the sufficient statistics formula, I demonstrate the quantitative importance of this second-order term. Last, I consider a multisector small open economy model to quantify the significance of the observed reallocation in explaining the decline in TFP and GDP.

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1. Introduction

We observe a substantial decline in total factor productivity (TFP) and gross domestic product (GDP) during a sudden stop. During the 1994 Mexican sudden stop, aggregate TFP declined by 5.7%, and aggregate real GDP declined by 6.1%. In the manufacturing sector, TFP declined by 4.5%, and real value-added decreased by 5.2%. In this paper, I do three things. First, I employ firm–product–destination-level data from Mexico to present novel empirical findings, with a primary focus on resource reallocation and differences in unit values across destinations. Second, driven by my empirical evidence, I develop a simple model of a sudden stop, with an emphasis on the second-order approximation at the inefficient equilibrium. Third, I conduct a quantitative analysis within a relatively standard open economy New Keynesian model incorporating features such as heterogeneous firms with different distortions, input–output linkages, and sticky prices to assess the significance of the observed reallocation in explaining the decline in TFP and GDP.

I establish the following empirical facts on the Mexican sudden stop. First, 34% of the increase in aggregate export share during the sudden stop is explained by the expansion of sales in foreign markets at the plant-product level. My decomposition analysis reveals that the extensive margin at the firm and product levels plays a relatively minor role in this context. Applying a difference-in-difference analysis, I show that the quantity of production for foreign markets relatively increased by 60% more than that for domestic markets during the sudden stop. This disparity in relative quantities of production triggered a reallocation of inputs toward foreign markets at the plant–product level.

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

It is important to highlight that the production structure of *maquiladoras* differs significantly from that of non-*maquiladoras*, the standard manufacturing plants. *Maquiladoras* allocate 77.2% of their expenditure to foreign intermediate inputs, in stark contrast to non-*maquiladoras*, where this allocation is a mere 20.4%. Conversely, non-*maquiladoras* allocate 58.8% of their spending toward domestic intermediate inputs, while *maquiladoras* allocate 8.3% to these inputs. The production of domestic intermediate inputs involves purchasing various inputs from the domestic economy such as labor, capital, and foreign and domestic intermediate inputs, often entailing distortions such as those arising from market power and tax in each transaction. These distortions accumulate throughout the production process, resulting in the supply chain for domestic intermediate inputs facing more distortions than that for the foreign intermediate inputs used by *maquiladoras*. This distinction plays a key role in our understanding of how the observed relative expansion of *maquiladoras* contributes to the decline in TFP and GDP.

Third, prior to the sudden stop, unit values in foreign markets were 11% lower than those in the domestic market, while there was no clear difference in unit values during the sudden stop. In most cases, observing unit values across different markets is difficult because the unit measurement for products varies between the markets. However, in the construction of my dataset, firms were asked to adjust their product units for equivalence across the two markets. This ensures that the unit values can be comparatively evaluated. Assuming uniform marginal costs across domestic and foreign markets, this implies that the markup in foreign markets was 11% lower than in the domestic market, and that there was no significant difference in markup levels during the sudden stop period[1].

Motivated by these empirical facts, I build a simple model of a sudden stop, with my primary focus being on the second-order approximation at the inefficient equilibrium. Existing literature such as Baqaee and Farhi [2020] and Baqaee et al. [2021] consider how resource reallocation contributes to economic growth and the effect of monetary policy on TFP. In contrast, this paper empirically and quantitatively evaluates how important resource reallocation is in the context of a large crisis. What sets my research apart from the existing literature is my consideration of the second-order approximation at the inefficient equilibrium. In the simple model, the change in allocative efficiency up to the second order

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

from time t to $t+1$ can be expressed as:

$$\underbrace{-Cov_{\lambda_{\theta,t}}\left[\frac{\overline{\mu}_t}{\mu_{\theta,t}}, \Delta \log l_{\theta,t}\right]}_{\text{First-Order Effect}} \underbrace{+\frac{1}{2}\left(-Cov_{\lambda_{\theta,t+1}}\left[\frac{\overline{\mu}_{t+1}}{\mu_{\theta,t+1}}, \Delta \log q_{\theta,t}\right] + Cov_{\lambda_{\theta,t}}\left[\frac{\overline{\mu}_t}{\mu_{\theta,t}}, \Delta \log l_{\theta,t}\right]\right)}_{\text{Second-Order Effect}}$$

where $\lambda_{\theta,t}$ is the sales share of producer θ at time t, $\overline{\mu}_t$ is the harmonic average markup at time t, $\mu_{\theta,t}$ is the markup of producer θ at time t, and $\Delta \log l_{\theta,t}$ is the logarithmic change in quantity of labor employed by producer θ from time t to time $t+1$. This second-order effect represents a novel aspect of my analysis. Up to the second order, not only the ex ante sales share ($\lambda_{\theta,t}$) and markup ($\mu_{\theta,t}$), but also the ex post sales share ($\lambda_{\theta,t+1}$) and markup ($\mu_{\theta,t+1}$) are relevant for the change in allocative efficiency. During the 1994 sudden stop in Mexico, the aggregate export sales share increased from 17.3% to 27.2%. Moreover, unit values of products for foreign markets increased by 11% over that for domestic markets. Assuming uniform marginal costs across domestic and foreign markets, this implies a relative increase in markup for foreign markets of 11% over that for domestic markets. These findings reveal the substantial disparities between the ex ante and the ex post sales share and markups during the sudden stop. In essence, this translates to $\lambda_{\theta,t} \neq \lambda_{\theta,t+1}$ and $\mu_{\theta,t} \neq \mu_{\theta,t+1}$. Consequently, we cannot ignore this second-order effect in the presence of large shocks, such as a sudden stop. To provide quantitative insights, I utilize data from 27 industries in Mexico from 1994 to 1995 to assess the significance of this second-order term.

Last, I conduct a quantitative analysis within a relatively standard open economy New Keynesian model incorporating features such as heterogeneous firms with different distortions, input–output linkages, and sticky prices to assess the significance of the observed reallocation in explaining the decline in TFP and GDP. My findings reveal that the resource reallocation observed in the data can account for approximately 40% of the decline in value added in the manufacturing sector in Mexico. Furthermore, when it comes to assessing the decline in TFP and value added in the manufacturing sector, considering changes in TFP and value added only up to the first order can result in overestimation. This also clarifies the significance of the second-order term.

Related Literature

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

Gopinath and Neiman [2014] consider the 2000 Argentina sudden stop, where the reduction in imported intermediate inputs of 70% provides a compelling rationale for the substantial decline in TFP. However, when we examine the 1994 Mexican sudden stop, the import of foreign intermediate inputs decreased by only a marginal 0.1% [2]. Consequently, attributing the decline in TFP in Mexico solely to the downturn in foreign intermediate inputs is an inadequate explanation. Sandleris and Wright [2014] focus on resource reallocation during the 2000 Argentina crisis using firm-level data. My research differs from theirs in several ways. First, I identify the specific types of firms and products that expanded or contracted relative to others during the sudden stop. Additionally, I pinpoint the wedge difference across firms and products. Moreover, I take into account the change in TFP up to the second order at the inefficient equilibrium, deepening the level of analysis relative to their paper's consideration of the change in TFP up to only the first order.

Castillo-Martınez [2018] explores the impact of a sudden stop on average TFPQ across various exchange rate regimes. When the exchange rate follows a floating regime, the domestic markets becomes less competitive because of the exit of foreign producers in response to a devaluation of the domestic currency. Consequently, firms with lower TFPQ enter domestic markets, resulting in an overall decline in average TFPQ during a sudden stop. However, the main focus of my paper is not average TFPQ but aggregate TFP in the context of growth

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

accounting, a metric directly relevant to changes in real GDP. Blaum [2019] considers how the 1994 Mexican sudden stop affected the aggregate share of foreign intermediate inputs, focusing on resource reallocation toward import-intensive firms. Empirically, it is observed that importers tend to be exporters, and that these firms relatively expanded during the sudden stop. My paper complements this paper by leveraging firm–product–destination-level data to provide new empirical insights[3]. In my paper, I highlight the significance of reallocation at the within-firm-product level toward foreign markets. Additionally, I shed light on the critical role of *maquiladoras*, a sector overlooked in this paper.

Baqaee and Farhi [2020] extend Hulten's theorem to distorted economies, offering a structurally interpretable decomposition of changes in aggregate TFP. This decomposition method dissects the impact of two crucial factors: the mechanical effect stemming from shifts in technology and the endogenous adjustments in allocative efficiency due to resource reallocation. Their findings reveal that approximately 50% of the cumulative growth in aggregate TFP in the United States during the period spanning 1997–2014 can be attributed to enhancements in resource allocation among firms. Baqaee and Farhi [2019] study real GDP and welfare in open economies characterized by disaggregated and interconnected production structures, accompanied by arbitrary distortions. They provide ex post sufficient statistics for measurement and ex ante sufficient statistics for the purpose of counterfactual analysis. Baqaee et al. [2021] demonstrate how changes in aggregate demand, such as those induced by monetary policy shocks, can naturally impact an economy's TFP. Their work highlights the interplay of heterogeneous firms and endogenous markups in this context. Building on this sequence of papers, my paper empirically and quantitatively evaluates how important resource reallocation is in the context of a large crisis. Furthermore, what sets my paper apart from these papers is its specialized focus on the second-order approximation at the inefficient equilibrium.

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

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

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

Outline

My paper is organized as follows. In Section 2, I present the empirical evidence. In Section 3, I develop the simplest model. In Section 4, I introduce the quantitative model and show quantitative results. Finally, Section 6 concludes.

2. Empirical Analysis

2.1 Data

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

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

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

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

In 1994, the sales share of *maquiladoras* was 28.8%, and *maquiladoras* contributed 43.1%

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

of the country's total exports and 52.7% of manufacturing exports.

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

2.2 Decomposition of Aggregate Export Growth

Aggregate manufacturing export as a fraction of aggregate manufacturing sales increased from 17.3% in 1994 to 27.2% in 1995. Using the data from both *maquiladoras* and non-*maquiladoras*, we decompose the change in the ratio of aggregate export to aggregate sales as follows:

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

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

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

I summarize our finding as follows:

Fact 1. *The compositional shift toward maquiladoras explains* 40.4% *of the increase in aggregate export shares. The increase in export share within non-maquiladoras explains the rest of the increase in aggregate export shares.*

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

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

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

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

I summarize my finding as follows:

Fact 2. *Within-firm expansion toward export markets explains* 67.7% *of the increase in export share among non-maquiladoras. Compositional change across firms with different export shares explains* 24.0% *of the increase in export share among non-maquiladoras.*

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

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

where p is the product index, $s_{i,p,t}$ is the ratio of sales of product p by firm i as a fraction of total sales by firm i at time t, and $e_{i,p,t}$ is the ratio of export of product p by firm

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

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

Fact 3. *The sales expansion in foreign market within firm–product level explains* 81.5% *of the increase in export at the firm level.*

2.3 Quantity Expansion at the Plant–Product–Destination Level

The preceding decomposition analysis reveals the importance of the sales expansion in foreign market within firm–product level. A crucial factor in my assessing changes in allocative efficiency and TFP is whether I observe shifts in relative input usage among products. When I detect a change in the relative quantity of sales among products, it implies a change in the relative utilization of inputs. To investigate whether there was a shift in the quantity of sales between domestic and foreign markets before and after the sudden stop, I employ a difference-in-differences strategy.

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

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

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

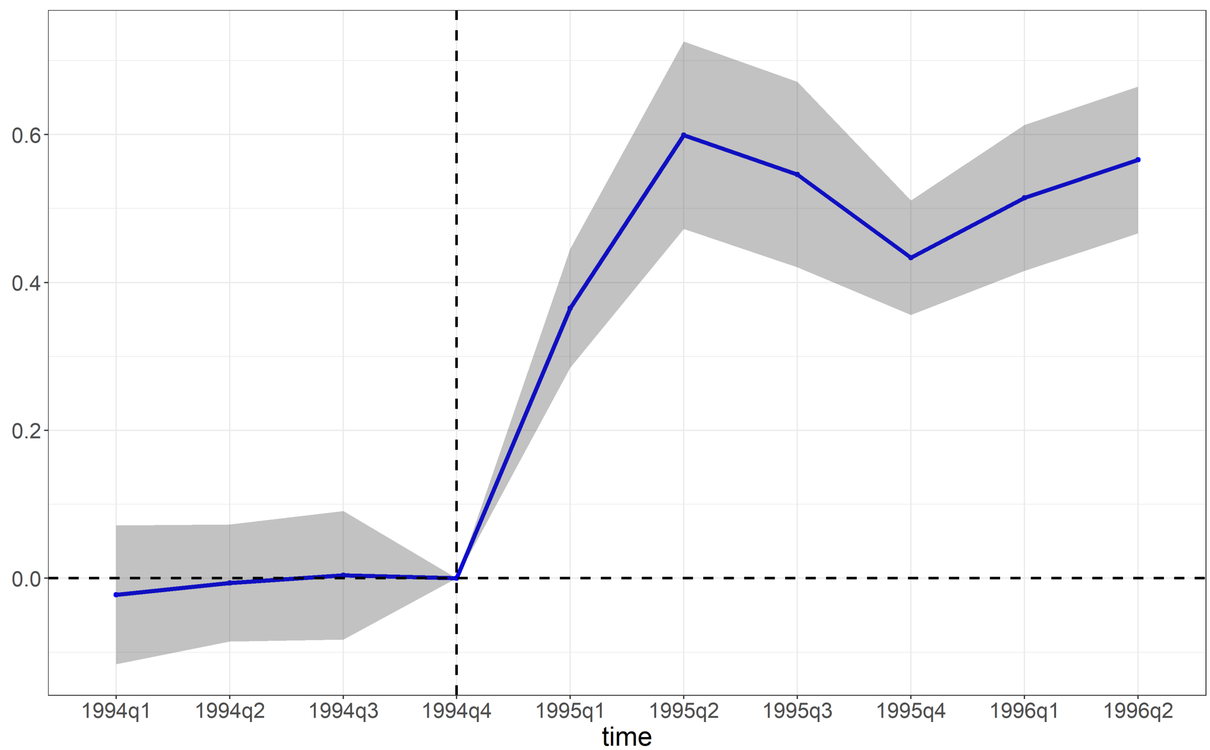

Figure 2.1: Changes in Quantity of Sales by Destination

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.

Figure 2.1 presents an event study graph illustrating the average effects of the sudden stop on sales quantity. It reports quarterly effects for products being exported to foreign markets before and after the sudden stop. In line with the absence of differential pretrends, I observe no effect in terms of products being exported to foreign markets before the sudden stop occurred. For the post–sudden stop period, I observe a substantially greater increase in the sales quantity in foreign markets than in the sales quantity in domestic markets. The average difference in sales quantity change reached approximately 60% by the second quarter of 1995.

Fact 4. *Following the sudden stop, the sales quantity in foreign markets increased by as much as* 60% *more than did that in domestic markets.*

2.4 Relative Expansion by *Maquiladoras*

More than 95% of the sales by *maquiladoras* come from export. During a sudden stop, domestic aggregate demand shrinks, and the domestic nominal exchange rate depreciates, while foreign aggregate demand is not affected. Therefore, relative to non-*maquiladoras, maquiladoras* were not negatively affected by the sudden stop. As the previous decomposition analysis shows, the relative expansion of *maquiladoras* explains 40.4% of the increase in aggregate export share during the sudden stop in 1994.

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

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

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

Figure 2.2 presents the event study graph of the average effects of the sudden stop on the number of workers. It reports quarterly effects in terms of the relative change in the number of workers across *maquiladoras* and non-*maquiladoras* before and after the sudden stop. In line with the absence of differential pretrends, I observe no differential effect for *maquiladoras* before the sudden stop occurred. For the post–sudden stop periods, I observe a substantially greater increase in number of workers in *maquiladoras* than in non-*maquiladoras*. The average difference in the change in number of workers reaches approximately 20% for the third quarter of 1995.

Fact 5. *Following the sudden stop, the number of workers increased by as much as 20% more in maquiladoras than in non-maquiladoras.*

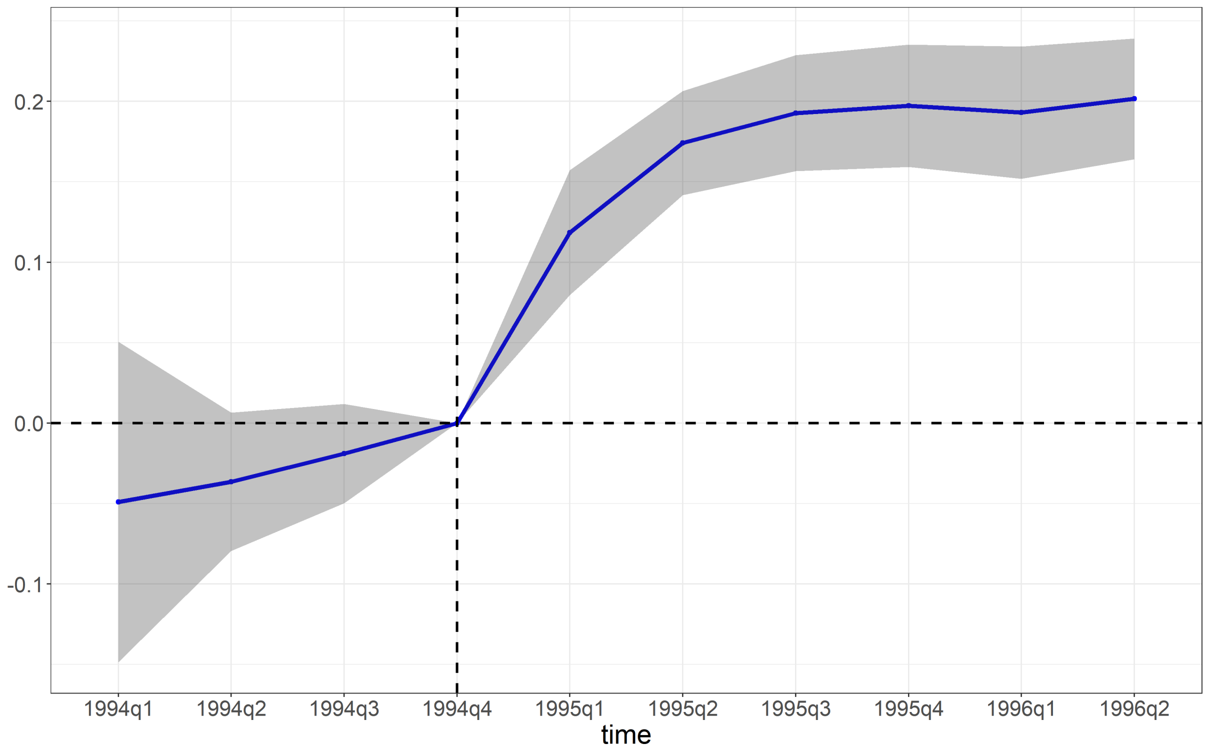

Figure 2.2: Changes in Number of Workers in *Maquiladoras* and Non-*Maquiladoras*

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 maquiladoras. The confidence interval is at the 95% level.

2.5 Unit Values across Domestic and Foreign Markets

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

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

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

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

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

My results are consistent with those of Blum et al. [2023] who use the Chilean manufacturing survey and customs data. They show that firms selling identical products both domestically and abroad charge a 15% lower markup in foreign markets.

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

3. Simple Model

I consider a simple small open economy model to understand how a sudden stop impacts allocative efficiency. In this economy, there are two types of producers: producers for domestic markets and exporters. I assume that producers face fully sticky prices in foreign currency in foreign markets while produces face flexible prices in domestic markets. Labor is the only factor of production in this economy. These assumptions are relaxed in the quantitative analysis.

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

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

where aggregate consumption (C_t) consists of domestically produced consumption goods ($C_{H,t}$) and foreign-produced consumption goods ($C_{F,t}$):

$$\frac{C_t}{\overline{C}} = \left[\gamma^{1/\eta}\left(\frac{C_{F,t}}{\overline{C}_F}\right)^{\frac{\eta-1}{\eta}} + (1-\gamma)^{1/\eta}\left(\frac{C_{H,t}}{\overline{C}_H}\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}$$

I allow for home bias in preferences and γ denotes the expenditure share of foreign-produced consumption goods. η captures the elasticity of substitution between domestically produced and foreign-produced consumption goods. $\overline{C}$ is the steady state of C_t, $\overline{C}_F$ is the steady state of $C_{F,t}$, and $\overline{C}_H$ is the steady state of $C_{H,t}$.

Domestically produced consumption goods ($C_{H,t}$) consist of different products produced for domestic markets, indexed by θ, and are aggregated through a CES aggregator with an elasticity parameter $\sigma > 1$:

$$\frac{C_{H,t}}{\overline{C}_H} = \left(\int_{\theta\in\mathcal{D}} \omega_\theta \left(\frac{c_{\theta,t}}{\overline{c}_\theta}\right)^{\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$$

where ω_θ is the expenditure weight on good θ, $\mathcal{D}$ denotes the set of producers for domestic markets, and $\overline{c}_\theta$ is the steady state of $c_{\theta,t}$.

The household inelastically supplies 1 unit of labor. The household budget constraint is expressed as:

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

where $p_{\theta,t}$ is the price for the domestic market of producer θ; $c_{\theta,t}$ is the domestic consumption produced by producer θ; ϵ_t is the nominal exchange rate, defined as the units of home currency for one unit of foreign currency[5]; and P_t^* is the price of foreign consumption goods in foreign currency. Θ_t captures exogenously determined net foreign repayment in foreign

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

currency. For the sake of simplicity, I abstract from the household's borrowing and saving behaviors. A sudden stop is characterized by an exogenous increase in Θ_t[6]. Furthermore, $W_t L_t$ is labor income, and Π_t is the sum of profits generated by all producers operating within the domestic economy.

The production function is linear in labor and denoted as:

$$y_{\theta,t} = A_{\theta,t} l_{\theta,t}$$

where $A_{\theta,t}$ is the technology level of producer θ and $l_{\theta,t}$ is the labor input of producer θ. The ideal markup for producer θ, $\mu_{\theta,t}$, is determined exogenously. This ideal markup, $\mu_{\theta,t}$, incorporates all distortions stemming from various sources such as tax distortions, financial frictions, market power, and other relevant factors. I define the aggregate markup charged in the domestic market as

$$\overline{\mu}_{\mathcal{D},t} \equiv \left(\int_{\theta \in \mathcal{D}} \frac{\lambda_{\theta,t}}{\int_{\theta \in \mathcal{D}} \lambda_{\theta,t} d\theta} \frac{1}{\mu_{\theta,t}} d\theta \right)^{-1}$$

where $\lambda_{\theta,t}$ represents the sales share of producer θ as a fraction of nominal GDP. I denote the aggregate domestic sales share as $\lambda_{\mathcal{D}} = \int_{\theta \in \mathcal{D}} \lambda_{\theta,t} d\theta$ and the aggregate export sales share as $\lambda_{\mathcal{F}} = \int_{\theta \in \mathcal{F}} \lambda_{\theta,t} d\theta$ where $\mathcal{F}$ is the set of exporters. $\overline{\mu}_{\mathcal{D},t}$ is the sales-weighted harmonic average of markups charged within domestic markets.

The demand for export is expressed as:

$$y^*_{\theta,t} = \left(\frac{p^*_{\theta,t}}{P^*_t} \right)^{-\sigma} D^*_t$$

where $y^*_{\theta,t}$ is the foreign demand for a product of exporter θ, $p^*_{\theta,t}$ is the price for foreign markets in foreign currency set by exporter θ, P^*_t is the price aggregator in foreign markets, and D^*_t is foreign aggregate demand. Note that P^*_t and D^*_t are exogenous because of the small open economy assumption. σ is the price elasticity of demand in foreign markets.

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

The empirical findings show that, prior to the sudden stop, the markup on foreign market was lower than that for the domestic market. However, this disparity in markup level disappeared during the sudden stop period. Furthermore, the export price index in US dollars remained stable during the sudden stop period[7]. Based on this empirical evidence, I assume that producers face sticky prices in foreign currency in foreign markets. When considering a menu-cost model, such as the one proposed by Golosov and Lucas Jr [2007], what matters for the frequency of price changes is the relative price compared to the aggregate price index. During the 1994 sudden stop, the domestic aggregate price index experienced a significant increase, whereas the foreign aggregate price index remained stable. Consequently, this resulted in a substantial relative price shift within domestic markets, while foreign markets saw only a marginal change in relative prices.

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

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

$$\begin{aligned} d\log\mu^*_{\theta,t} &= d\log\epsilon_t p^*_{\theta,t} - d\log\left(\frac{W_t}{A_t}\right) \\ &= d\log\epsilon_t \end{aligned}$$

I assume that technology level remains constant throughout the analysis.

The expression for domestic nominal GDP, which equals aggregate consumption plus net export, is given as follows:

$$\int_{\theta\in\mathcal{D}} p_{\theta,t}y_{\theta,t}d\theta + \epsilon_t P^*_t C_{F,t} + \int_{\theta\in\mathcal{F}} \epsilon_t p^*_{\theta,t}y^*_{\theta,t}d\theta - \epsilon_t P^*_t C_{F,t} = \mathrm{GDP}_t$$

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

[7] See Figure C.2.

pressed as:

$$\int_{\theta} p^*_{\theta,t} y^*_{\theta,t} d\theta - P^*_t C^*_t = \Theta_t$$

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

The definition of equilibrium is as follows: The endogenous variables are ($\{p_{\theta,t}\}$, $\{p^*_{\theta,t}\}$, $\{y_{\theta,t}\}$, $\{y^*_{\theta,t}\}$, $\{\mu_{\theta,t}\}$, $\{\mu^*_{\theta,t}\}$, $\{l_{\theta,t}\}$, $\{l^*_{\theta,t}\}$, C^*_t, ϵ_t) and the exogenous variables $\left(\Theta_t, D^*_t, \{A_{\theta,t}\}, \{A^*_{\theta,t}\}, P^*_t\right)$. The household and firms solve the maximization problem given a set of prices. The goods and labor markets clear.

In the following analysis, I consider the comparative statics to understand how the competitive equilibrium responds to a sudden stop shock. For any variable X_t, I denote its local deviation from its steady state as $d \log X_t$. The global change of variable X from time t to $t+1$ is defined by integrating local changes in X over the interval $[t, t+1]$, which can be expressed as

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

I denote the first-order approximation of this global change as $\Delta \log X_t$.

Now, I employ Divisia indices to define the local change in the aggregate price index as

$$d \log P_{Y,t} \equiv \int_{\theta \in \mathcal{D} \cup \mathcal{F}} \lambda_{\theta,t} d \log p_{\theta,t} d\theta$$

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

$$\begin{aligned} d \log Y_t &= d \log (\text{GDP}_t) - d \log P_{Y,t} \\ &= \int_{\theta \in \mathcal{D} \cup \mathcal{F}} \lambda_{\theta,t} d \log A_{\theta,t} d\theta + d \log L_t + d \log \overline{\mu_t} - \int_{\theta \in \mathcal{D} \cup \mathcal{F}} \lambda_{\theta,t} d \log \mu_{\theta,t} d\theta \end{aligned}$$

where $\overline{\mu}_t \equiv \left(\int_{\theta \in \mathcal{D} \cup \mathcal{F}} \frac{\lambda_{\theta,t}}{\int_{\theta \in \mathcal{D} \cup \mathcal{F}} \lambda_{\theta,t} d\theta} \mu^{-1}_{\theta,t} d\theta \right)^{-1}$ represents the average markup charged by all producers, including exporters.[8] The local change in aggregate TFP can be calculated as

$$d \log \text{TFP}_t = d \log Y_t - d \log L_t$$

[8]Note that $\overline{\mu}_{\mathcal{D}}$ is defined by excluding exporters.

$$= \underbrace{\int_{\theta \in \mathcal{D} \cup \mathcal{F}} \lambda_{\theta,t} d \log A_{\theta,t} d\theta}_{d(\text{Technology})} \underbrace{+ d \log \overline{\mu_t} - \int_{\theta \in \mathcal{D} \cup \mathcal{F}} \lambda_{\theta,t} d \log \mu_{\theta,t} d\theta}_{d(\text{Allocative Efficiency})}$$

Since I assume that labor supply is fixed, the local changes in real GDP and aggregate TFP coincide. As shows by Baqaee and Farhi [2020], the local change in aggregate TFP encompasses two components: the local change in technology and the local change in allocative efficiency. The latter captures the change in output resulting from the reallocation of labor across producers.

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

Proposition 1. *In response to a positive net capital outflow shock, the local changes in thenominal exchange rate and aggregate TFP are as follows:*

$$d \log \epsilon_t = \frac{\Theta_t}{P_t^* C_t^*} > 0$$

$$d \log TFP_t = \lambda_{\mathcal{D},t} \left(\frac{\overline{\mu}_t}{\overline{\mu}_{\mathcal{D},t}} - 1 \right) d \log \epsilon_t$$

If $\overline{\mu}_{\mathcal{D},t} > \overline{\mu}_t$ *holds,* $d \log TFP_t < 0$*, and vice versa.*

In response to a positive net capital outflow shock, net export needs to increase to balance the current account. This adjustment occurs through a reduction in foreign consumption goods since exports remain unchanged due to the fully sticky prices in foreign currency. To facilitate this adjustment, total income in foreign currency must decrease. As the domestic monetary authority perfectly controls nominal GDP, it effectively controls nominal total income. 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, decreased domestic consumption. Consequently, in relative term, exporters expand by more, while producers for the domestic market shrink. In essence, I observe a reallocation of labor toward exporters from producers for domestic markets.

The direction in which this resource reallocation impacts allocative efficiency at the local level depends on the relative markup charged in the domestic market, represented as $\left(\frac{\overline{\mu}_t}{\overline{\mu}_{\mathcal{D},t}}\right)$. From a social planner's perspective, producers with a higher markup underproduce. If $\overline{\mu}_{\mathcal{D},t} > \overline{\mu}_t$, this implies that producers for the domestic market underproduce. Consequently, this resource reallocation toward exporters and away from producers for the domestic market worsens allocative efficiency locally, leading to a local decline in aggregate TFP. Another observation is that if $\overline{\mu}_{\mathcal{D},t} = \overline{\mu}_t$ holds, the local change in TFP is equal to 0.

Now, I consider the global change in TFP up to the second order:

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

$$\underbrace{-Cov_{\lambda_{\theta,t}}\left[\frac{\overline{\mu}_t}{\mu_{\theta,t}}, \Delta\log l_{\theta,t}\right]}_{\textit{First-Order Effect}} \underbrace{+\frac{1}{2}\left(-Cov_{\lambda_{\theta,t+1}}\left[\frac{\overline{\mu}_{t+1}}{\mu_{\theta,t+1}}, \Delta\log l_{\theta,t}\right] + Cov_{\lambda_{\theta,t}}\left[\frac{\overline{\mu}_t}{\mu_{\theta,t}}, \Delta\log l_{\theta,t}\right]\right)}_{\textit{Second-Order Effect}}$$

Proposition 1 illustrates that when the ex ante markup is uniform across all producers ($\mu_{\theta,t} = \overline{\mu}_t \, \forall\theta \in \mathcal{D}\cup\mathcal{F}$), the first-order effect is 0. However, this does not necessarily imply that the change in TFP is 0 up to the second order. When producers with a higher ex post markup ($\mu_{\theta,t+1} > \overline{\mu}_{t+1}$) tend to expand more ($\Delta\log l_{\theta,t} > 0$), this improves allocative efficiency ($-\frac{1}{2}Cov_{\lambda_{\theta,t+1}}\left[\frac{\overline{\mu}_{t+1}}{\mu_{\theta,t+1}}, \Delta\log l_{\theta,t}\right] > 0$), resulting in an increase in TFP. From the perspective of a social planner, producers with ex post higher markup are considered too small, and the expansion of these producers leads to an improved allocation of resources. Another observation is that when the sales share and markup remain constant from time t to $t+1$ for all producers ($\mu_{\theta,t} = \mu_{\theta,t+1}$, $\lambda_{\theta,t} = \lambda_{\theta,t+1} \, \forall\theta$), the second-order effect is 0. This proposition has a broad applicability, as it continues to hold within each sector in a model with intermediate inputs and multiple sectors, it continues to hold with endogenous labor, and it continues to hold with partial sticky prices –under the condition that all producers within a given sector purchase inputs at a uniform price.

When the magnitude of the shock is substantial, as is the case with a sudden stop shock, we cannot ignore the second-order effect. As my empirical analysis has revealed, the sales share and markup of exporters experienced a remarkable increase during the Mexican sudden stop. In essence, this translates to $\lambda_{\theta,t} \neq \lambda_{\theta,t+1}$ and $\mu_{\theta,t} \neq \mu_{\theta,t+1}$.

In my simple model, the global change in TFP up to the second order can be further simplified, as shown in the following lemma:

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

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

If we assume $\frac{\overline{\mu}_t}{\overline{\mu}_{\mathcal{D},t}} < 1$, the first-order effect is always positive while the second-order effect is always positive.

My empirical analysis reveals that the markup for foreign markets was lower than the markup for domestic markets before the sudden stop, represented as $\frac{\overline{\mu}_t}{\overline{\mu}_{\mathcal{D},t}} < 1$. Under this assumption, the first-order effect is always negative, whereas the second-order effect is always positive. In response to a sudden stop shock, the markup by exporters increases ($\Delta\log\mu^*_{\theta,t} = \Delta\log\epsilon_t > 0$), and the ex post markup difference across destinations shrinks, leading to a more favorable situation in terms of resource allocation because the ex post distortions faced by all producers become more similar. Consequently, the second-order effect mitigates the deterioration of allocative efficiency.

To assess the significance of this second-order term during the sudden stop, I apply this formula across 27 industries and calculate the second-order effect for each industry. It's important to note that our exercise focuses on allocative efficiency within each industry, not across these 27 industries. The outcomes of this analysis are visually represented in Figure 3.1[9]. The second-order effect is positive for more than half of the industries. When I calculate the sales-weighted averages, the first-order effect is -1.03%, while the combined first-order and second-order effects is -0.36%. Taking into account up to the second-order, I observe that the increase in markup by exporters, particularly those with initially lower markups, plays a role in mitigating the decline in allocative efficiency. This exercise suggests that, quantitatively, the impact on allocative efficiency within industries is relatively modest

[9] I calculate markups as total sales relative to total variable costs. Total variable costs consist of total remuneration, raw materials of national origin, imported raw materials, containers and packaging used, electrical energy consumed, fuels and lubricants consumed, expenses for *maquila* services, and the cost of capital. The cost of capital is calculated by the product of the capital stock and user cost of capital. The capital stock is reported by plants in the EIA. The user cost of capital is the sum of the rental rate of capital and the capital-specific depreciation rates. See Appendix C-2 for these capital-specific depreciation rates. The rental rate of capital is set to 8.8% for 1994 and 17.3% for 1995, which is the annualized international interest rate faced by Mexico from Neumeyer and Perri [2005] computed as the 90-day U.S. T-bill rate plus the emerging market bond index (EMBI) for Mexico, adjusted by U.S. inflation.

up to the second order. As I will demonstrate in the following section, what is quantitatively important for the change in allocative efficiency is the relative expansion of *maquiladoras*.

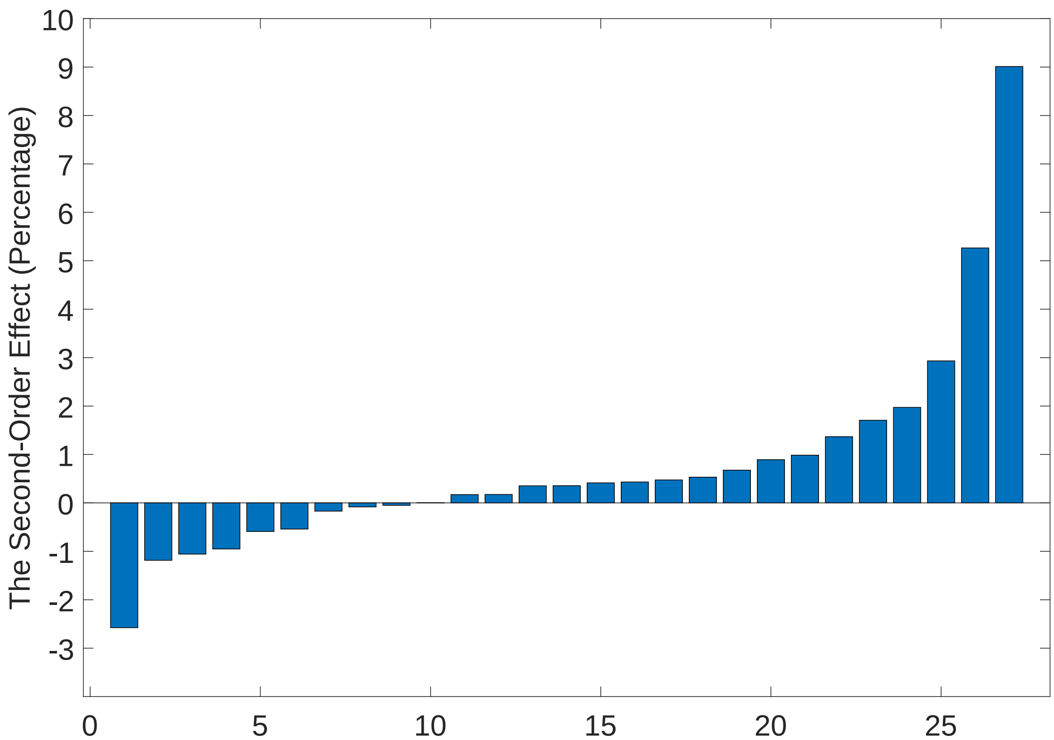

Figure 3.1: The Second-Order Effect of the Change in Allocative Efficiency

Notes: By using Proposition 1, this figure represents the second-order effect of the change in allocative efficiency, at the 3-digit industry level from 1994 to 1995. We have a total of 27 industries represented in this plot. At each industry level, we calculate the change in allocative efficiency at the plant-product-destination level. Markup at the firm level is calculated by using an accounting approach. Assuming a uniform marginal cost of production across destinations, we derive the markup ratio across destinations at the product level. In case where producers manufacture multiple products, we proceed with the assumption that they charge the identical markups across products in domestic markets. The change in quantity of production can be directly observable from our dataset.

4. Quantitative Model

4.1 Household

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

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

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

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

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

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

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

The household is subject to the following nominal budget constraint:

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

where $P_{M,H,t}$ is the ideal 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[10]; $P^*_{M,F,t}$ is the ideal price index of foreign-produced manufacturing products in foreign currency; and $P_{NM,H,t}$ is the ideal price index of nonmanufacturing products. Θ_t captures exogenously determined net foreign repayment in foreign currency. As is the case with the simple model, I abstract from the household's borrowing and saving behaviors. A sudden stop is characterized by an exogenous increase in Θ_t. Additionally, $W_t L_t$ is labor income, and Π_t is the sum of profits generated by all firms operating within the domestic

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

economy.

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

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

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

Consumption bundles consist of various varieties of goods indexed by $\theta \in [0,1]$. $c_{M,H,\theta,t}$ and $c_{NM,H,\theta,t}$ are the consumption of variety θ among domestically produced manufacturing and nonmanufacturing consumption goods, respectively. The functions $\Upsilon_{M,H}$ and $\Upsilon_{NM,H}$ are both increasing and concave functions. CES preferences are the special case when these functions, $\Upsilon_{M,H}$ and $\Upsilon_{NM,H}$, are power functions.

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

$$\frac{p_{M,H,\theta,t}}{\hat{P}_{M,H,t}} = \Upsilon'_{M,H,\theta}\left(\frac{c_{M,H,\theta,t}}{C_{M,H,t}}\right)$$

$$\frac{p_{NM,H,\theta,t}}{\hat{P}_{NM,H,t}} = \Upsilon'_{NM,H,\theta}\left(\frac{c_{NM,H,\theta,t}}{C_{NM,H,t}}\right)$$

where the price aggregator $\hat{P}_{M,H,t}$ and $\hat{P}_{NM,H,t}$ are defined as:

$$\hat{P}_{M,H,t} = \frac{P_{M,H,t}}{\int_0^1 \Upsilon'_{M,H}\left(\frac{c_{M,H,\theta,t}}{C_{M,H,t}}\right)\frac{c_{M,H,\theta,t}}{C_{M,H,t}} d\theta}$$

$$\hat{P}_{NM,H,t} = \frac{P_{NM,H,t}}{\int_0^1 \Upsilon'_{NM,H}\left(\frac{c_{NM,H,\theta,t}}{C_{NM,H,t}}\right)\frac{c_{NM,H,\theta,t}}{C_{NM,H,t}} d\theta}$$

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. The labor types $n_t(l)$ enter the production function of firms through the

CES basket:

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

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

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

where W_t denotes the nominal wage index and is defined as

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

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

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

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

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

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

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

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

4.2 Firms

There are three sectors in this economy: the manufacturing sector, the nonmanufacturing sector, and *maquiladoras*. I assume that the production technology is the same within manufacturing sector, non-manufacturing sector, and maquiladoras. The production function for sector i is expressed as:

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

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

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

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

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

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

As in the simple model, I assume that producers face sticky prices in foreign currency in foreign markets while producers face flexible prices in domestic markets.

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

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

subject to

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

$$\frac{p^*_{M,H,\theta,t}}{\hat{P}^*_{M,H,t}} = \Upsilon'_{M,H,\theta}\left(\frac{c^*_{M,H,\theta,t}}{C^*_{M,H,t}}\right)$$

The solution to this maximization problem can be found in Appendix D. The maximization problem for *maquiladoras* is identical to that for exporters in the manufacturing sector, following the same principles and equations.

4.3 Distortions

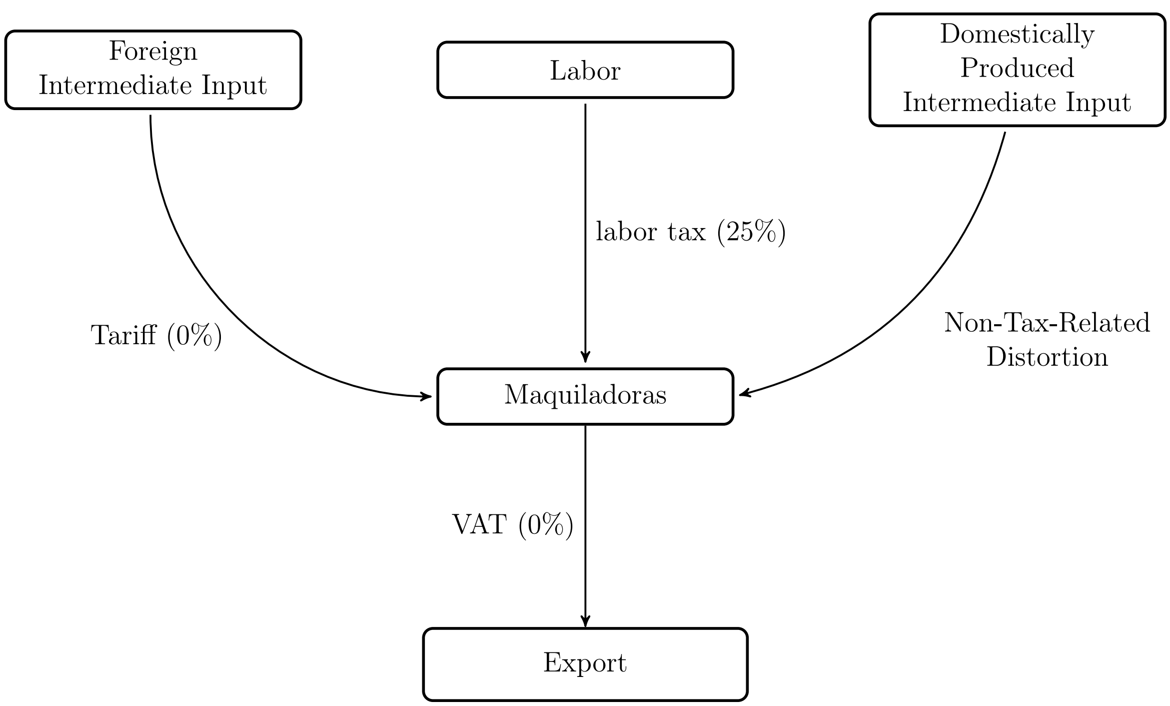

Figure 4.1: Distortions Faced by *Maquiladoras*

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

The specific distortions faced by *maquiladoras* are illustrated in Figure 4.1. *Maquiladoras* are exempt from paying tariffs on foreign intermediate inputs. They are subject to a 25% payroll tax on labor. When products produced by *maquiladoras* are exported, they are not subject to VAT charges. Additionally, if domestic intermediate good producers possess market power, *maquiladoras* face non–tax–related distortion when purchasing domestically produced intermediate inputs.

The expenditure share of *maquiladoras* for domestically produced intermediate inputs, represented as $(1 - \omega_{M,M})\,(\nu_{M,M}\,(1 - \varsigma_{M,M}) + (1 - \nu_{M,M}))$, amounts to 8.3%. In contrast, the expenditure share of *maquiladoras* for foreign intermediate inputs, represented as $(1 - \omega_{M,M})\,\nu_{M,M}\varsigma_{M,M}$, amounts to 77.2%. This highlights that *maquiladoras* rely less on domestically produced intermediate inputs and have a stronger dependence on foreign intermediate inputs.

On the other hand, the distortions faced by standard producers (non-*maquiladoras*) are depicted in Figure 4.2. Standard producers are subject to tariffs, which are, on average, from 5% to 10% on foreign intermediate inputs. They also face a 25% payroll tax and a 10% VAT charge when selling goods to domestic consumers. However, when their products are exported, VAT is not applied. Similarly to *maquiladoras*, standard producers face non–tax–related distortions such as market power among domestic intermediate goods suppliers –when purchasing domestically produced intermediate inputs.

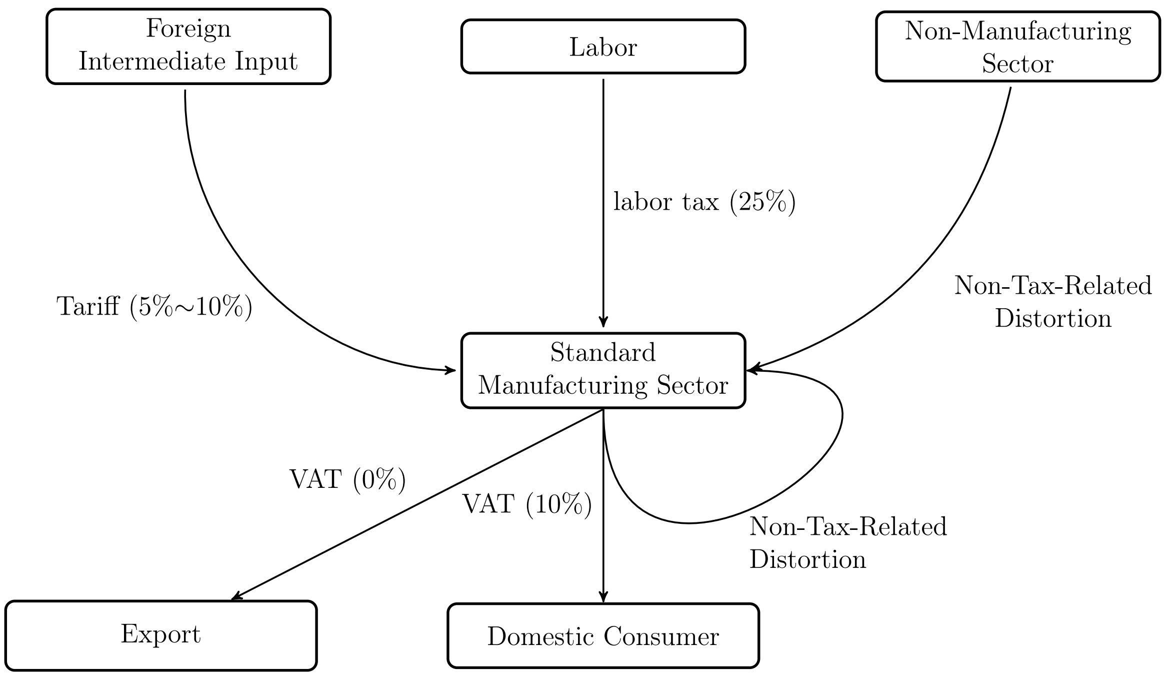

Figure 4.2: Distortions Faced by Standard Producers (Non-*Maquiladoras*)

The expenditure share of standard producers for domestically produced intermediate inputs, denoted as $(1-\omega_{M,H})\,(\nu_{M,H}\,(1-\varsigma_{M,H})+(1-\nu_{M,H}))$, is considerably higher at 58.8% than that of *maquiladoras*. In contrast, the expenditure share of standard producers for foreign intermediate inputs, represented as $(1-\omega_{M,H})\,\nu_{M,H}\varsigma_{M,H}$, amounts to 20.4%. This indicates that standard producers heavily rely on domestically produced intermediate inputs and have a weaker dependence on foreign intermediate inputs.

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

4.4 Nominal GDP, Current Account, and Monetary Regime

Domestic nominal GDP is given by the following equation:

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

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

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

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

As in the simple model in the previous section, for any variable X_t, I denote its local change from its steady state as $d\log X_t$. The global change of variable X from time t to $t+1$ is defined by integrating thelocal changes in X:

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

I denote the first-order approximation of this global change by $\Delta \log X_t$.

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

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

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

4.5 Input–Output Linkage and Factor Shares

The markup by producer j, whether it arises from tax or nontax distortions, is denoted by μ_j. I define Ω as a revenue-based input–output matrix with dimensions $(N+F+M) \times (N+F+M)$, where N represents the number of producers, F the number of factors, and M the number of foreign intermediate inputs. Each element (i,j) of Ω represents the share of i's expenditures on inputs from j relative to its total revenue:

$$\Omega_{ij,t} = \frac{p_{j,t}x_{ij,t}}{p_{i,t}y_{i,t}}$$

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

The revenue-based Leontief inverse matrix is given by

$$\Psi_t = (I - \Omega_t)^{-1}$$

The Leontief inverse matrix Ψ_t measures both direct and indirect exposure through the production network.

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

$$\begin{aligned}\tilde{\Omega}_t &= \mu_t \Omega_t \\ &= \frac{p_{j,t}x_{ij,t}}{\sum_{j=1}^{N+F+M} p_{j,t}x_{ij,t}}\end{aligned}$$

The cost-based Leontief inverse matrix is represented as

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

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

I define the forward and backward exposure of value added in the manufacturing sector as:

$$\lambda_{k,t} = \int_{i\in N_M} \Omega_{Y,i,t}\Psi_{i,k,t}di$$

$$\tilde{\lambda}_{k,t} = \int_{i\in N_M} \Omega_{Y,i,t}\tilde{\Psi}_{i,k,t}di$$

where $\Omega_{Y_M,i,t} = \frac{p_{i,t}q_{i,t}}{VA_{M,t}}$ is the share of a good i in the value added of the manufacturing sector, with $q_{i,t} = y_{i,t} - \sum_{j\in N_M} x_{ji,t}$ representing the final output of good i. N_M denotes the set of producers in the manufacturing sector. For the labor share, the share of the nonmanufacturing input share, and the share of the foreign intermediate inputs in the manufacturing sector, I write $\Lambda_{M,L,t}$, $\Lambda_{M,NM,t}$, $\Lambda^*_{M,t}$ and $\tilde{\Lambda}_{M,L,t}$, $\tilde{\Lambda}_{M,NM,t}$, $\tilde{\Lambda}^*_{M,t}$.

4.6 Real GDP and TFP

As in the simple model, the local change in value added in the manufacturing sector is obtained by deflating changes in nominal value added using the change in the value-added deflator:

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

where the change in the value-added deflator is defined as the weighted average of changes in final output prices:

$$d\log P_{M,t} = \int_{i\in N} \Omega_{Y_M,i,t} d\log p_{i,t}di$$

Throughout the paper, I define $d\log X = \frac{dX}{X}$ for any variable X, which allows me to write $d\log X$ even when X is a negative number.

Theorem 2. *Global changes in real value added in the manufacturing sector at an inefficient equilibrium from time t to $t+1$, represented by $\int_{s=t}^{t+1} d\log Y_{M,s}$, can be approximated up to the second order by the following equation:*

$$\begin{aligned}
&\underbrace{\int_{k\in N_M} \tilde{\lambda}_{k,t}\Delta\log A_{k,t}dk}_{\textit{Change in Technology (First-Order)}} + \underbrace{\frac{1}{2}\int_{k\in N_M} \tilde{\lambda}_{k,t}\Delta\log\tilde{\lambda}_{k,t}\Delta\log A_{k,t}dk}_{\textit{Change in Technology (Second-Order)}} \\
+ &\underbrace{\tilde{\Lambda}_{M,L,t}\Delta\log L_{M,t}}_{\textit{Change in Factor (First-Order)}} + \underbrace{\frac{1}{2}\tilde{\Lambda}_{M,L,t}\Delta\log\tilde{\Lambda}_{M,L,t}\Delta\log L_{M,t}}_{\textit{Change in Factor (Second-Order)}} \\
+ &\underbrace{\sum_{i\in OM}\left(\tilde{\Lambda}_{M,i,t} - \Lambda_{M,i,t}\right)\Delta\log Q_{i,t}}_{\textit{Change in External Inputs (First-Order)}} + \underbrace{\frac{1}{2}\sum_{i\in OM}\left(\tilde{\Lambda}_{M,i,t} - \Lambda_{M,i,t}\right)\Delta\log\left(\tilde{\Lambda}_{M,i,t} - \Lambda_{M,i,t}\right)\Delta\log Q_{i,t}}_{\textit{Change in External Inputs (Second-Order)}}
\end{aligned}$$

$$
\underbrace{-\int_{k\in N_M} \tilde{\lambda}_{k,t}\Delta\log\mu_{k,t}dk - \tilde{\Lambda}_{M,L,t}\Delta\log\Lambda_{M,L,t} - \sum_{i\in OM}\left(\tilde{\Lambda}_{M,i,t}-\Lambda_{M,i,t}\right)\Delta\log\Lambda_{M,i,t}}_{\textit{Allocative Efficiency (First-Order)}}
$$

$$
\underbrace{-\frac{1}{2}\left(\int_{k\in N_M} \tilde{\lambda}_{k,t}\Delta\log\tilde{\lambda}_k\Delta\log\mu_k dk + \tilde{\Lambda}_{M,L,t}\Delta\log\tilde{\Lambda}_{M,L}\Delta\log\Lambda_{M,L} + \sum_{i\in OM}\left(\tilde{\Lambda}_{M,i,t}-\Lambda_{M,i,t}\right)\Delta\log\left(\tilde{\Lambda}_{M,i,t}-\Lambda_{M,i,t}\right)\Delta\log\Lambda_{M,i,t}\right)}_{\textit{Allocative Efficiency (Second-Order)}}
$$

where OM is a set of intermediate inputs produced outside the manufacturing sector.

Theorem 2 generalizes Theorem 1 in Baqaee and Farhi [2019] up to the second order. As shown by Baqaee and Farhi [2019], the change in real GDP up to the first order consists of the change in pure technology, change in factor inputs, change in external inputs, and change in allocative efficiency. Up to the second order, I need to average the t and $t+1$ coefficients for each term. For example, up to the second order, I weigh $\Delta\log L_{M,t}$, the change in the quantity of labor from t to $t+1$, using the average of $\tilde{\Lambda}_{M,L,t}$ and $\tilde{\Lambda}_{M,L,t+1}$[11].

Theorem 1 in the simple model is a special version of Theorem 2 when the production structure is the same within the sector. In the quantitative analysis, we use Theorem 2 to calculate the change in allocative efficiency up to the first order and second order.

4.7 Calibration

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

All wedges except tax distortions, including market power and financial frictions, are captured by the markup. I assume that the initial markup for the foreign market is 11.3% lower than the markup for the domestic market. I assume that the markups charged by exporters and *maquiladoras* are the same. In addition, I assume that average markups

[11] Notice $\tilde{\Lambda}_{M,L,t} + \frac{1}{2}\tilde{\Lambda}_{M,L,t}\Delta\log\tilde{\Lambda}_{M,L,t} = \frac{1}{2}\left(\tilde{\Lambda}_{M,L,t} + \tilde{\Lambda}_{M,L,t+1}\right)$.

for the manufacturing and nonmanufacturing sectors are equivalent. The level of markup charged by domestic manufacturing producers is calibrated to achieve the net export to GDP ratio of -4.71 before the sudden stop. Markup influences this ratio as a higher markup widens the gap between export prices and input prices, resulting in a higher net export to GDP ratio. For exporters and maquiladoras operating in foreign markets, I assume an identical degree of price stickiness in foreign currency. Specifically, I set the degree of price stickiness to ensure that there is no markup difference between domestic and foreign markets during the sudden stop shock. In the benchmark calibration, I assume that the goods markets are perfectly competitive, and the aggregator for final demand takes a CES function with the elasticity of substitution 1.65[12]. This number is calibrated so that real exchange rate depreciates by 31.5% in response to the sudden stop shock.

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

We adjust the weighting by the monetary authority on stabilizing the CPI and labor. This adjustment is designed to match the 2.8% decline in employment numbers within the manufacturing sector, as seen in the data. Tax distortions are incorporated, with values set at $\tau_{VAT} = 0.1$, $\tau_{labor} = 0.25$, and $\tau_{tariff} = 0.08$. The size of the sudden stop shock is calibrated so that the increase in a net export to GDP ratio is 155.1%, in line with the observed data.

All the system of equations is described in Appendix D. The steady state of the model is detailed in Appendix E.

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

4.8 Impulse Response Functions

Figure 4.3 and 4.4 show the impulse response functions[13]. The change in allocative efficiency up to the first order is -3.53%, while the change in allocative efficiency up to the second order is -2.08%. This discrepancy arises from the difference between the ex ante sales shares and markup and the ex post sales shares and markup. Prior to the sudden stop, the markup for foreign markets is lower than the markup for domestic markets. However, the markup for foreign markets increases during the sudden stop because of sticky prices in foreign markets, closing the markup difference between the two markets. Considering up to the second order, the ex post markup difference of zero is better in terms of resource allocation because the distortions that producers face become closer to each other. Consequently, if I consider the change in allocatove efficiency up to the second order, the change is mitigated.

The change in allocative efficiency is primarily driven by the relative expansion of *maquiladoras*. Up to the second order, reallocation within non-*maquiladoras* contributes to 0.23% of the decline in TFP in the manufacturing sector, while the reallocation across *maquiladoras* and non-*maquiladoras* contributes to 1.85% of the decline in TFP in the manufacturing sector. As explained in section 4.3, *maquiladoras* face less distorted supply chain because they rely less on domestically produced intermediate inputs which accumulates distortions throughout the production process. This result shows the quantitative importance of *maquiladoras* and producers in special economic zones in general when analyzing TFP and GDP.

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

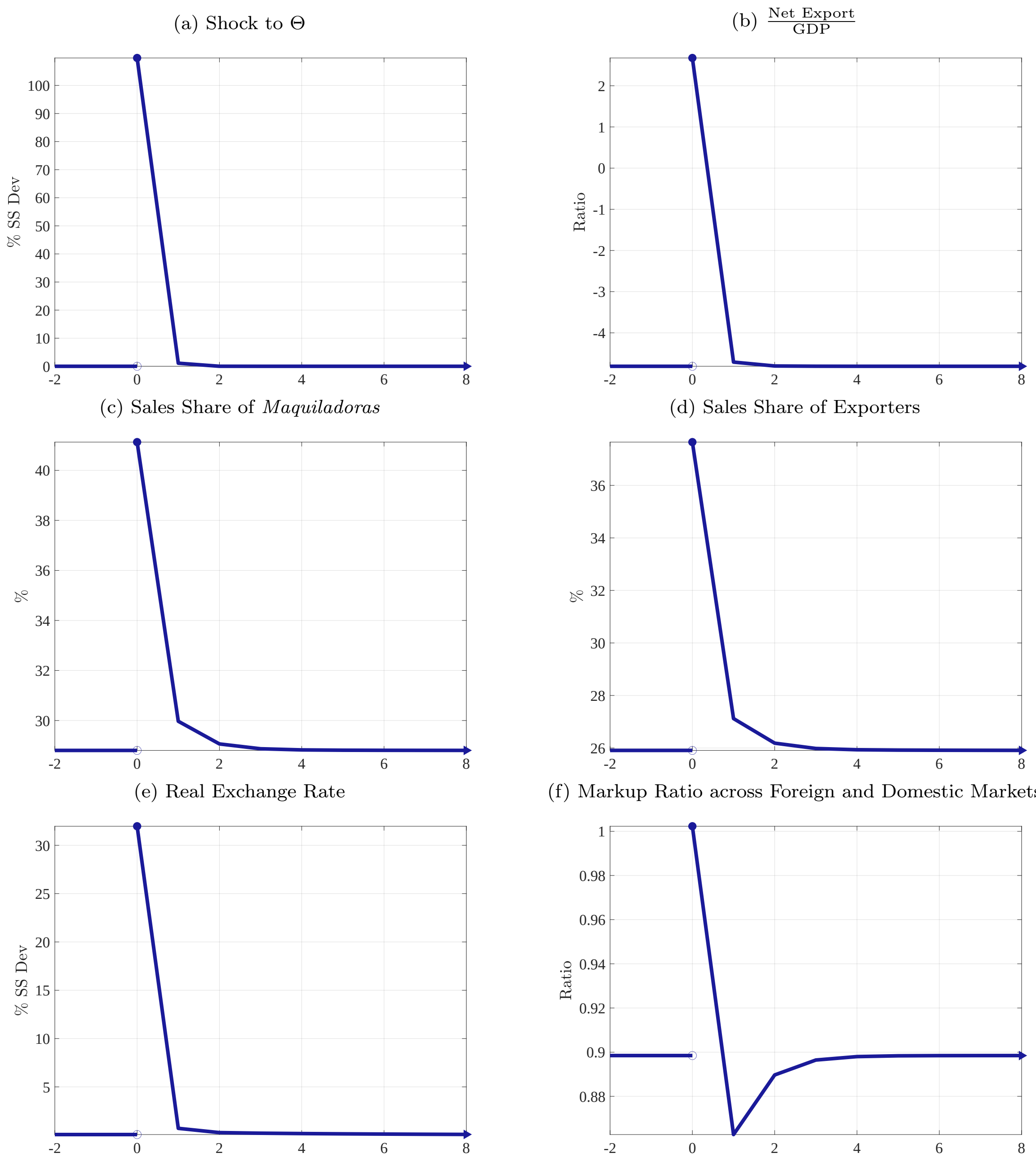

Figure 4.3: Transition Dynamics during a Sudden Stop.

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

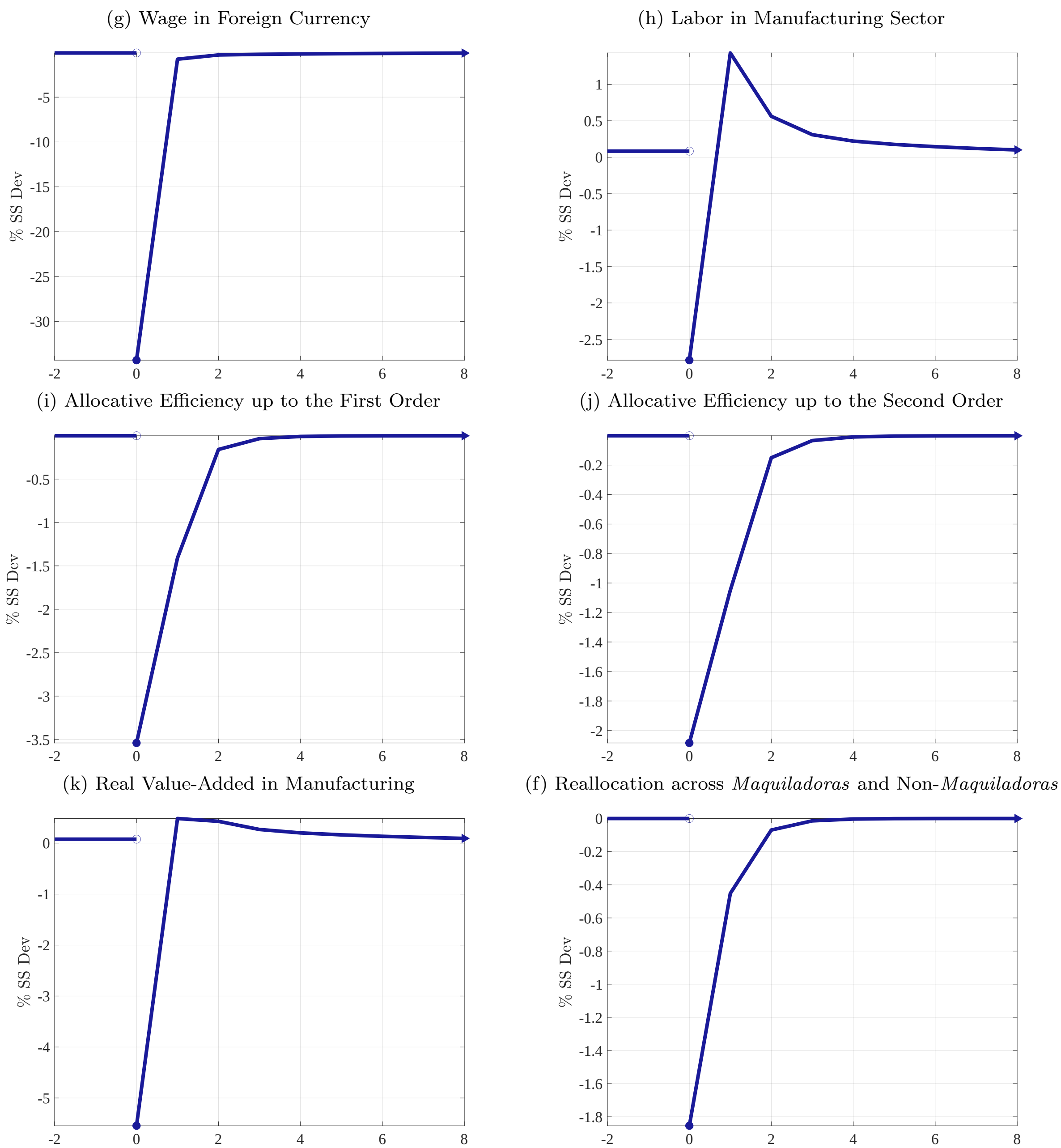

Figure 4.4: Transition Dynamics during a Sudden Stop.

Note: The figure reports the impulse response functions. Panel (g) reports the impulse response function of the domestic wage in foreign currency, 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.

5. Conclusion

I analyze the impact of a sudden stop on allocative efficiency, TFP, and real GDP. I provide a theoretical framework, with particular emphasis on the second-order approximation at the inefficient equilibrium. Up to the second order, not only the ex ante but also the ex post markup and sales share are relevant for the change in allocative efficiency. In the context of large shocks, such as a sudden stop shock, this second-order effect takes on significant quantitative importance. As my empirical analysis shows, this is because the sales share in foreign markets increases relative to that in domestic markets and the markup on foreign markets rises during the sudden stop.

From a quantitative perspective, my analysis demonstrates that the resource reallocation observed in the data leads to a 2.08% reduction in TFP. Furthermore, my findings reveal that if I were to restrict my analysis only up to the first order, I would tend to overestimate the decline in both TFP and GDP.

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A. Appendix A: Proofs

Proof of Theorem 1

The simple model is a simplified version of the quantitative model. According to Theorem 2, the global change in TFP up to the second-order ($\int_{s=t}^{t+1} d\log TFP_s$) in the simple model is expressed as:

$$\begin{aligned}\int_{s=t}^{t+1} d\log TFP_s &\approx -\int_{\theta\in\mathcal{D}\cup\mathcal{F}}\left(\tilde{\lambda}_{\theta,t}+\frac{1}{2}\left(\tilde{\lambda}_{\theta,t+1}-\tilde{\lambda}_{\theta,t}\right)\right)\Delta\log\mu_{\theta,t}d\theta-\left(\tilde{\Lambda}_{L,t}+\frac{1}{2}\Delta\tilde{\Lambda}_{L,t}\right)\Delta\log\Lambda_{L,t}\\ &=-\int_{\theta\in\mathcal{D}\cup\mathcal{F}}\left(\lambda_{\theta,t}+\frac{1}{2}\left(\lambda_{\theta,t+1}-\lambda_{\theta,t}\right)\right)\Delta\log\mu_{\theta,t}d\theta-\Delta\log\Lambda_{L,t}\end{aligned}$$

I know $d\log\Lambda_{L,t}=-d\log\overline{\mu}_t$ and $\Delta\log\Lambda_{L,t}=-\Delta\log\overline{\mu}_t$. Then,

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

Now I narrow our attention to $\Delta\log\overline{\mu}_t$, which represents the first-order approximation of the global change in $\overline{\mu}$ and can be denoted as $\int_{s=t}^{t+1} d\log\overline{\mu}(s)$.

$$\begin{aligned}\int_{s=t}^{t+1} d\log\overline{\mu}(s) &= \int_{s=t}^{t+1}-\overline{\mu}_s\int_{\theta\in\mathcal{D}\cup\mathcal{F}}\frac{\lambda_{\theta,s}}{\mu_{\theta,s}}\left(d\log\lambda_{\theta,s}-d\log\mu_{\theta,s}\right)d\theta\\ &=\int_{s=t}^{t+1}\int_{\theta\in\mathcal{D}\cup\mathcal{F}}\overline{\mu}_s\frac{\lambda_{\theta,s}}{\mu_{\theta,s}}\left(d\log\mu_{\theta,s}-d\log\lambda_{\theta,s}\right)d\theta\\ &=\int_{\theta\in\mathcal{D}\cup\mathcal{F}}\int_{s=t}^{t+1}\underbrace{\overline{\mu}_s\frac{\lambda_{\theta,s}}{\mu_{\theta,s}}}_{\equiv x_{\theta,s}}\left(d\log\mu_{\theta,s}-d\log\lambda_{\theta,s}\right)d\theta\end{aligned}$$

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

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

Therefore, I get

$$\begin{aligned}\Delta\log\overline{\mu}_t &= \int_{\theta\in\mathcal{D}\cup\mathcal{F}}\left(x_{\theta,t}\left(\Delta\log\mu_{\theta,t}-\Delta\log\lambda_{\theta,t}\right)+\frac{1}{2}\left(x_{\theta,t+1}-x_{\theta,t}\right)\left(\Delta\log\mu_{\theta,t}-\Delta\log\lambda_{\theta,t}\right)\right)d\theta\\ &= \int_{\theta\in\mathcal{D}\cup\mathcal{F}}\overline{\mu}_t\frac{\lambda_{\theta,t}}{\mu_{\theta,t}}\left(\Delta\log\mu_{\theta,t}-\Delta\log\lambda_{\theta,t}\right)+\frac{1}{2}\left(\overline{\mu}_{t+1}\frac{\lambda_{\theta,t+1}}{\mu_{\theta,t+1}}-\overline{\mu}_t\frac{\lambda_{\theta,t}}{\mu_{\theta,t}}\right)\left(\Delta\log\mu_{\theta,t}-\Delta\log\lambda_{\theta,t}\right)d\theta\end{aligned}$$

By substituting the approximated $\Delta\log\overline{\mu}$ into equation (A.1), I get

$$\begin{aligned}\int_{s=t}^{t+1}d\log TFP_s \approx &\int_{\theta\in\mathcal{D}\cup\mathcal{F}}\overline{\mu}_t\frac{\lambda_{\theta,t}}{\mu_{\theta,t}}\left(\Delta\log\mu_{\theta,t}-\Delta\log\lambda_{\theta,t}\right)d\theta\\ &+\frac{1}{2}\int_{\theta\in\mathcal{D}\cup\mathcal{F}}\left(\overline{\mu}_{t+1}\frac{\lambda_{\theta,t+1}}{\mu_{\theta,t+1}}-\overline{\mu}_t\frac{\lambda_{\theta,t}}{\mu_{\theta,t}}\right)\left(\Delta\log\mu_{\theta,t}-\Delta\log\lambda_{\theta,t}\right)d\theta\\ &-\int_{\theta\in\mathcal{D}\cup\mathcal{F}}\lambda_{\theta,t}\Delta\log\mu_{\theta,t}d\theta-\frac{1}{2}\int_{\theta=0}^{1}\left(\lambda_{\theta,t+1}-\lambda_{\theta,t}\right)\Delta\log\mu_{\theta,t}d\theta\end{aligned}$$

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

I focus on term A.

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

$$= -Cov_{\lambda_{\theta,t}} \left[\frac{\overline{\mu}_t}{\mu_{\theta,t}}, \Delta \log \left(\frac{\lambda_{\theta,t}}{\mu_{\theta,t}} \right) \right]$$

Next, I focus on term B.

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

I know that $\Delta \log \left(\frac{\lambda_{\theta,t}}{\mu_{\theta,t}} \right) = \Delta \log (W_t l_{\theta,t}) = \Delta \log l_{\theta,t}$ In the end, the global up to the second order is given by

$$\begin{aligned}
&-Cov_{\lambda_{\theta,t}} \left[\frac{\overline{\mu}_t}{\mu_{\theta,t}}, \Delta \log l_{\theta,t} \right] \\
&+\frac{1}{2} \left(-Cov_{\lambda_{\theta,t+1}} \left[\frac{\overline{\mu}_{t+1}}{\mu_{\theta,t+1}}, \Delta \log l_{\theta,t} \right] + Cov_{\lambda_{\theta,t}} \left[\frac{\overline{\mu}_t}{\mu_{\theta,t}}, \Delta \log l_{\theta,t} \right] \right)
\end{aligned}$$

which concludes the proof of Lemma 1.

Proof of Theorem 2

According to Baqaee and Farhi [2019], the local change in real value-added in manufacturing sector is expressed as:

$$\begin{aligned}
d \log Y_{M,t} = &\int_{k \in N_M} \tilde{\lambda}_{k,t} d \log A_{k,t} dk + \tilde{\Lambda}_{M,L,t} d \log L_{M,t} + \sum_{i \in OM} \left(\tilde{\Lambda}_{M,i,t} - \Lambda_{M,i,t} \right) d \log Q_{i,t} \\
&- \int_{k \in N_M} \tilde{\lambda}_{k,t} d \log \mu_{k,t} dk - \tilde{\Lambda}_{M,L,t} d \log \Lambda_{M,L,t} - \sum_{i \in OM} \left(\tilde{\Lambda}_{M,i,t} - \Lambda_{M,i,t} \right) d \log \Lambda_{M,i,t}
\end{aligned}$$

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

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

By integrating $d\log Y_{M,s}$ from $s = t$ to $s = t + 1$ and applying this formula to each term, I obtain the desired equation.

B. Appendix B: Parameters

Parameter	Description	Value	Note/Source
A. Parameters for Producers			
$\omega_{M,H}$	Labor Input Share of Non-*Maquiladoras*	0.21	INEGI
$\nu_{M,H}$	Manufacture Input Share of Non-*Maquiladoras*	0.59	INEGI
$\varsigma_{M,H}$	Foreign Manufacture Input Share of Non-*Maquiladoras*	0.44	INEGI
$\omega_{M,M}$	Labor Input Share of *Maquiladoras*	0.14	INEGI
$\nu_{M,M}$	Manufacturing Input Share of *Maquiladoras*	0.95	INEGI
$\varsigma_{M,M}$	Foreign Manufacturing Input Share of *Maquiladoras*	0.95	INEGI
$\omega_{NM,H}$	Labor Input Share of Nonmanufacturing	0.54	INEGI
$\nu_{NM,H}$	Manufacture Input Share of Nonmanufacturing	0.31	INEGI
$\varsigma_{NM,H}$	Foreign Manufacture Input Share of Nonmanufacturing	0.05	INEGI
$\mu_{M,H}$	Average Markup of Non-*Maquiladoras* for Domestic Markets	1.17	Read the Main Text
$\mu^*_{M,H}$	Average Markup of Exporters	1.05	Read the Main Text
$\mu^*_{M,M}$	Average Markup of *Maquiladoras*	1.05	Read the Main Text
$\mu_{NM,H}$	Average Markup of Nonmanufacturing	1.16	Read the Main Text
δ_p	Price Change Probability of Exporters and *Maquiladoras*	0.78	Read the Main Text
$\lambda^*_{M,H}$	Sales Share of Exporters in Value-Added	0.26	INEGI
$\lambda^*_{M,M}$	Sales Share of *Maquiladoras* in Value-Added	0.29	INEGI
$\xi^{\mathrm{f,d}}$	Elasticity (Foreign vs Domestic Manufacturing Intermediate Input)	0.76	Boehm et al. [2023]
$\xi^{\mathrm{m,nm}}$	Elasticity (Manufacturing vs Nonmanufacturing Intermediate Input)	0.2	Baqaee and Farhi [2022]
$\xi^{\mathrm{l,ii}}$	Elasticity (Value Added vs Intermediate Input)	0.6	Baqaee and Farhi [2022]
σ	Trade Elasticity for Exporters and *Maquiladoras*	1.65	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	0.17	Inegi
ζ	Elasticity (Manufacturing Good & Nonmanufacturing Good)	0.4	Burstein et al. [2007]
γ	Consumption Share of Foreign Good	0.11	Blaum [2019]
β	Discount Rate	0.91	Cugat [2022]
ι	Labor Supply Elasticity	1.84	Mendoza [2010]
δ_w	Probability of Changing Wage	0.08	Fukui et al. [2023]
C. Other Parameters			
Θ	Weight Placed on CPI by Monetary Authority	0.85	Read the Main Text
τ_{VAT}	Value-Added Tax	0.1	
τ_{labor}	Payroll Tax	0.25	
τ_{tariff}	Tariff on Foreign Intermediate Inputs	0.08	

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

C. Appendix C: Additional Figures and Tables

C.1 Import of Foreign Intermediate Inputs

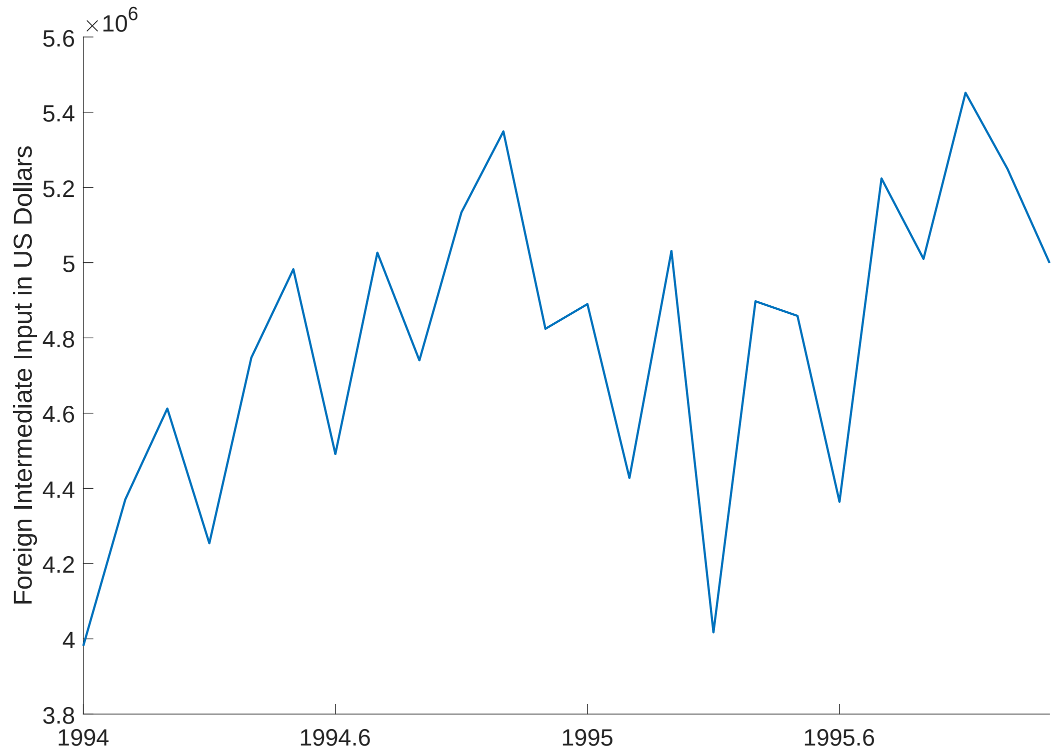

Figure C.1: Foreign Intermediate Inputs in US Dollars

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

C.2 Export Price Index

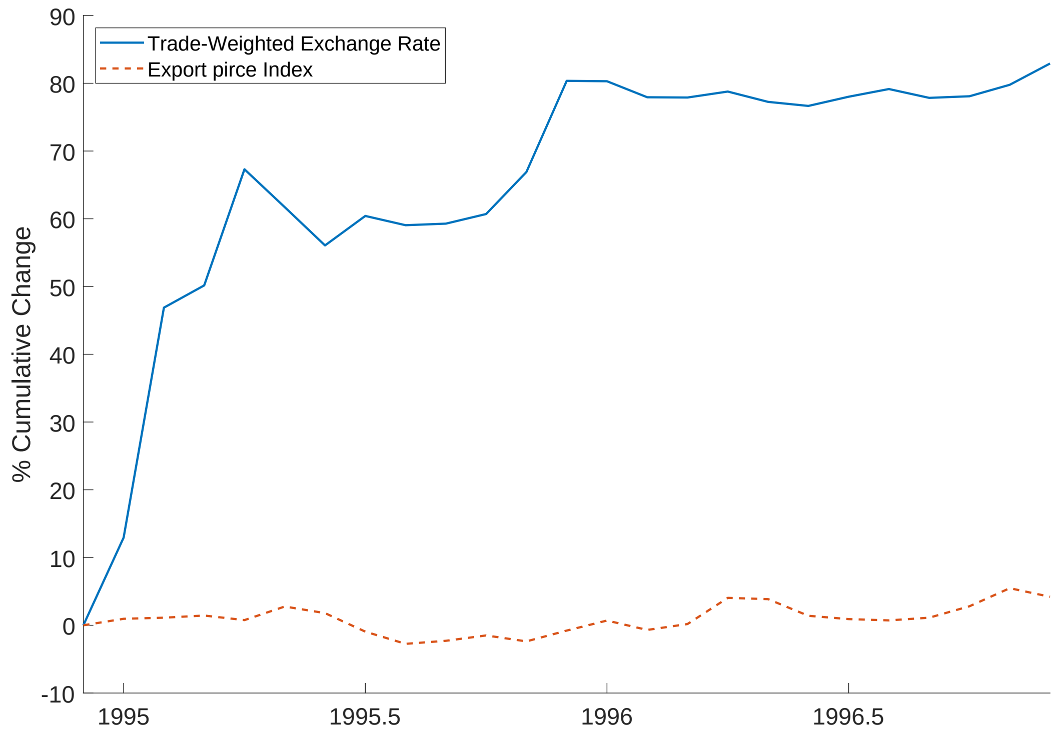

Figure C.2: Trade-Weighted Exchange Rate and Export Price Index

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

C.3 Depreciation Rate

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

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

Table C.1: Depreciation Rates of Capital

D. Appendix D: System of Equations

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

Household

(i) Consumption Expenditure Shares

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(ii) Aggregate Consumption and Consumer Price Index

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

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

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

By log-linearizing this equation, we get

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

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

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

(iii) New Keynesian Wage Phillips Curve

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

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

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 $\lambda_{t+s} = \frac{u_{1,t+s}}{P^C_{t+s}}$. 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:

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

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

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

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

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

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

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

Producers in Manufacturing Sector

(i) Sales Share

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

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

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

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:

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

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

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

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

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

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

(ii) Price and Markup

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

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

subject to

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

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

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

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

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

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

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

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

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

By combining these two equations, we get

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

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

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

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

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

which shows up in equation (D.14).

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

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

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

(iii) Input Shares

The change in foreign intermediate input share can be expressed by

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

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

The change in manufacturing input share can be expressed by

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

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

The changes in labor input share can be expressed by

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

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

Producers in Maquiladoras

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

(i) Sales Share

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

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

(ii) Price and Markup

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

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

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

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

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

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

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

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

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

(iii) Input Shares

The change in foreign intermediate input share can be expressed by

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

The change in manufacturing input share can be expressed by

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

The changes in labor input share can be expressed by

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

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

Producers in Non-Manufacturing Sector

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

(i) Input Shares

The change in foreign intermediate input share can be expressed by

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

The change in manufacturing input share can be expressed by

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

The changes in labor input share can be expressed by

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

Intermediaries Aggregating Domestically Produced Manufacturing Products

(i) Sales Share

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

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

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

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

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

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

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

Log-linearizing this equation, we get

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

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

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

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

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

By log-linearizing this equation, we derive

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

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

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

Subsequently, we get

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

By log-linearizing this equation, we get

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

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

Intermediaries Aggregating Domestically Produced Non-Manufacturing Products

(i) Sales Share

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

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

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

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

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

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

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

Factor Shares in Manufacturing Sector

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

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

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

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

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

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

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

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

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

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

By log-linearizing this equation, we get

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

Factor Shares in Non-Manufacturing Sector

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

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

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

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

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

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

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

Value Added and GDP

Value added in manufacturing sector is given by

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

By log-linearizing this equation, we get

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

Value added in non-manufacturing sector is given by

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

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

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

By log-linearizing this equation, we get

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

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

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

By log-linearizing this equation, we get

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

Nominal GDP can also be calculated using the expenditure approach:

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

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

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

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

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

and

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

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

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

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

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

By log-linearizing this equation, we get

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

Current Account Identity

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

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

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

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

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

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

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

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

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

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

By log-linearizing this equation, we get

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

Aggregate Labor

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

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

By log-linearizing this equation, we get

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

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

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

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

Monetary Policy

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

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

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:

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

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

Equilibrium

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

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

E. Appendix E: Steady State

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

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

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

The order of producers and inputs is structured as follows:

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

10. An intermediary imposing tariff on foreign intermediate inputs and providing them to non-maquiladoras.
11. An intermediary passing foreign intermediate inputs to maquiladoras.
12. Non-manufacturing intermediate inputs.
13. Foreign intermediate inputs.
14. Labor.

The cost-based input-output matrix is give by

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

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

The revenue-based input-output matrix is give by

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

Next, we can calculate:

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

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:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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