Global Firms in Large Devaluations*

Joaquin Blaum†

May 2018

Abstract

I investigate the consequences of firms' joint import and export behavior in the context of large devaluations. I provide evidence that the aggregate imported input share increases after large depreciations, contrary to what standard quantitative trade models of importing predict. Using Mexican micro data, I show that the increase in the overall import intensity is explained by the expansion of exporters, which are intense importers. I develop a model where firms globally decide their import and export strategies and discipline it to match salient features of the Mexican micro data. I study a counterfactual devaluation and show that the calibrated model can generate an increase in the aggregate import share and compositional effects in line with the data. Models of importing-only, or with uncorrelated importing-exporting, cannot generate either and predict increases in consumer prices that are 15-30% larger. JEL Codes: F11, F12, F14, F62, D21, D22

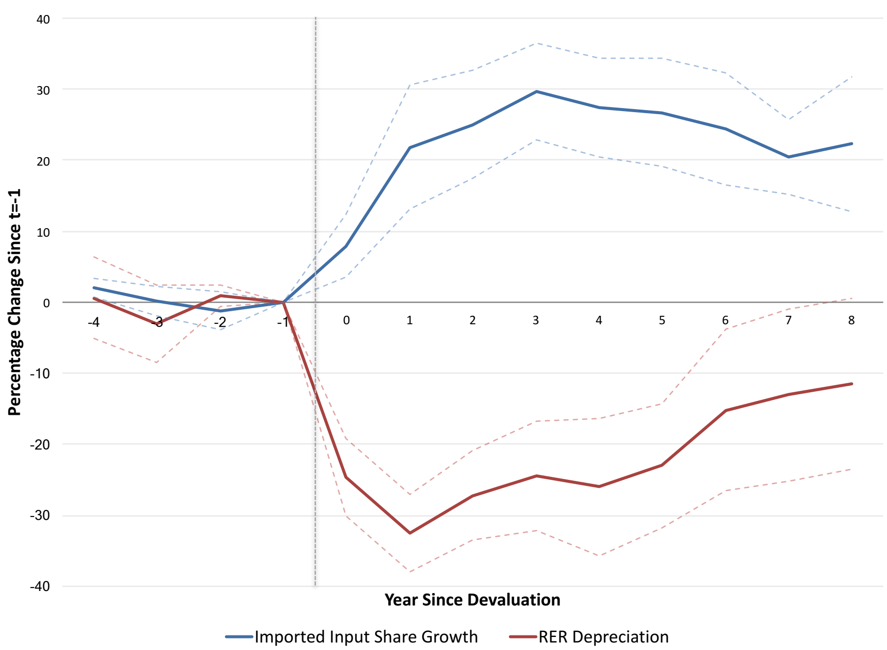
*I thank Ariel Burstein, Lorenzo Caliendo, Ben Faber, Pablo Fajgelbaum, Javier Cravino, Andrei Levchenko, Michael Peters, Jesse Schreger and seminar participants at Atlanta Fed, Brown, LACEA-TIGN in Montevideo, Di Tella University, Harvard, Nottingham GEP, NBER IFM SI Meeting, Michigan, SED in Edinburgh, SAET in Faro, Tufts, UT Austin, RIDGE in Buenos Aires, and Yale. I am grateful to Rob Johnson and Sebastian Claro for excellent discussions. I also thank the International Economics Section of Princeton University for its hospitality and funding during part of this research. I thank Marcel Peruffo for excellent research assistance. This paper circulated previously under the title "Importing, Exporting and Aggregate Productivity in Large Devaluations".

†Brown University. Email: jblaum@gmail.com

1 Introduction

Until recently, the majority of the research in international trade studied the behavior of exporters and importers separately. The canonical model of firm-level trade decisions, pioneered by Melitz (2003), deals exclusively with exporting. Recently, a number of contributions have brought firms' importing decisions to the forefront and studied how input trade affects firm and aggregate productivity - see Gopinath and Neiman (2014) or Halpern et al. (2015). With a few exceptions, notably Amiti et al. (2014), most studies abstract from the fact that intense importers tend to be intense exporters and that these firms, which I refer to as global firms, account for a large fraction of total trade. In this paper, I investigate the implications of firms' joint import and export behavior for the aggregate effects of large devaluations.

The starting point of the analysis is the empirical finding that large devaluations are associated with an increase in the overall import intensity of the economy. Figure 1 depicts the aggregate imported input share, defined as the ratio of spending in imported inputs to total input spending, in a window of 12 years around a large devaluation for a sample of 9 episodes including Argentina 2002, Brazil 1999 and the East Asian crises of 1997-98. The imported input share increases on impact and remains elevated relative to its pre-devaluation level for 8 years. At the same time, the real exchange rate remains depreciated in the entire post-devaluation period.



Notes: The blue line is the rate of growth in the aggregate imported input share between a given year and the year before the devaluation (labeled -1). The year of the devaluation is labeled 0. The red line depicts the rate of growth in the real exchange rate. The lines in the Figure are averages of the experiences of Argentina in 2002, Brazil 1999, Colombia 1999, Indonesia 1998, Korea 1997, Malaysia 1997, Russia 1998, Thailand 1997 and Turkey 2001. The dashed lines give standard errors of the corresponding average (i.e. the standard deviation divided by the square root of the sample size). The data for Brazil, Indonesia, Korea, Russia and Turkey is taken from WIOD, while data for Argentina, Malaysia, Colombia and Thailand is from OECD Sources: OECD, WIOD, IFS.

Figure 1: Aggregate Imported Input Share After a Large Devaluation

This finding is at odds with existing quantitative models of importing that study the gains from input trade - see Halpern et al. (2015), Gopinath and Neiman (2014), Blaum et al. (2016) or Ramanarayanan (2017). These frameworks predict a decrease in the aggregate import share when foreign inputs become more expensive. Two features are crucial in generating this prediction. First, these frameworks feature an elasticity of substitution between domestic and foreign inputs in firms' technology that exceeds unity. Thus, as foreign inputs become more expensive, firms strongly substitute away from imported inputs leading to a fall in import shares for all firms.[1] Second, an increase in the price of foreign inputs disproportionally affects the more intense importers, which tend to lose market share, further reducing the aggregate import share. Both of these features are intimately linked to the aggregate effects of the depreciation. The degree of substitution governs the magnitude of firms' cost increases, while the pattern of reallocation determines how these are mapped into an aggregate effect.

Exploiting Mexican and Indonesian micro data around the 1994 and 1998 devaluations, I provide evidence that the increase in the aggregate import share is driven by the expansion of exporters. In a decomposition exercise, I start by showing that the growth in the aggregate import share is entirely accounted by compositional effects. Following the devaluation, initially import intensive firms expand their size and the firms that increase their import intensity tend to expand. These "between" and "covariance" effects are inconsistent with the type of reallocation predicted by standard models of importing. In contrast, holding their size constant, firms tend to lower their import shares following the devaluation, consistent with relatively high substitution between domestic and foreign varieties.

In turn, the expansion of intense importers can be linked to their export behavior. Firm with high import shares before the devaluation, which tend to be intense exporters, grow their total sales and export intensity following the devaluation. Across firms, changes in export intensity are highly correlated with changes in import intensity. These patterns suggest that the increase in the aggregate import share of Figure 1 arises from the combination of (i) increased incentives to export after the currency depreciation and (ii) a correlation between exporting and importing. Indeed, I show that the aggregate export share tends to increase after the depreciation in the sample of countries of Figure 1.[2] The fact that large exporters tend to be large importers has been verified in a variety of settings - see Bernard et al. (2007) for the US, Lapham and Kasahara (2013) for Chile, Amiti et al. (2014) for Belgium, and Albornoz and Lembergman (2015) for Argentina, among others[3].

To rationalize these findings, I propose a model where firms globally decide their import and export strategies that can be taken to the data to study the effects of devaluations. I consider a static small open economy where a mass of local firms can import their material inputs and export their output. As is standard in the literature, importing materials from abroad is a means to lower the unit cost of production, but is subject to frictions in the form of fixed costs. This gives rise to a non-homothetic extensive margin of importing, by which larger firms import more intensively, as in the theories of Gopinath and Neiman (2014) and Halpern et al. (2015). At the same time, firms can sell their products to a continuum of foreign markets which differ in their total demand. Exporting is a means to increase demand but is also subject to fixed costs, generating an association between firm size and export intensity. Importantly, there is a complementarity between importing and exporting that stems from the fact that the profit function is log supermodular in demand and the unit cost. That is, the profits from exporting to a particular destination are increasing in the firm's import intensity.

[1] Indeed, relying on different methods, the quantitative models of importing of the literature find values of the elasticity of substution between domestic and imported inputs that exceeds unity. For example, Blaum et al. (2016) estimate this parameter from the sensitivity of firm revenue to (plausibly exogenous) changes in the imported input share holding material spending constant. Applying this approach to firm-level data from the French manufacturing sector results in an elasticity of 2.4. Halpern et al. (2015) estimate a structural model of importing with Hungarian firm-level data and recover a value for this parameter of 4. Antras et al. (2017) estimate this parameter, which in their framework corresponds to the Frechet parameter governing the dispersion of firm efficiency, from a cross-country regression of sourcing potentials and wages. They obtain a value of 2.8. Gopinath and Neiman (2014) use a value of 4 based on estimates from Broda and Weinstein (2006), Eaton and Kortum (2002) and Bernard et al. (2003).

[2] Additionally, Alessandria et al. (2015) provide evidence that export levels tend to increase, albeit slowly, in the sample of countries of Figure 1. The fact in Figure 1 is consistent with the sluggish behavior of exports reported in Alessandria et al. (2015). Initially, the within component is positive, meaning that firms tend to increase their import intensity, due to the J-curve effect. Over time, the within component decreases (to become eventually negative) and the compositional effect becomes stronger.

[3] Albornoz and Lembergman (2015) argue that exporting to a new destination leads to subsequent importing from that destination, suggesting that export entry tends to reduced the fixed costs of importing.

This interaction generates an association between the intensities of importing and exporting, which is widely supported by the data.

I discipline the model to match salient features of the Mexican data in 1994. In particular, I target moments from the joint distribution of firm size, import and export intensity. These include the aggregate import and export shares, the dispersion in import and export shares and their correlation, as well as the fraction of firms by import-export status. To be able to match these moments, I allow firms to differ in their efficiency as well as in their fixed costs of importing and exporting.[4]

Using the calibrated model, I study a counterfactual depreciation of the real exchange rate of the magnitude experienced in Mexico.[5] A real depreciation makes imported inputs relatively more expensive and at the same time effectively increases foreign demand for domestic products. In the calibrated model, the depreciation generates an increase in the aggregate import share, consistent with the empirical findings discussed above. The model also predicts an increase in the aggregate export share, the fractions of exporters-only and exporters-importers, as well as a decrease in the fraction of importers-only. These patterns are all consistent with the Mexican experience.[6] Additionally, I find that the growth in the aggregate import share generated by the model is mostly explained by compositional effects, namely the expansion of firms that have high import intensity before the shock.[7] These findings are consistent with micro evidence from the the Mexican and Indonesian devaluations.[8]

I compare these results to outcomes from two benchmark models: (i) a model of importing-only, which is close to the frameworks in the literature, and (ii) a framework with uncorrelated importing-exporting. In the first case, the fixed costs of exporting are assumed to be prohibitely high and the model is recalibrated to a subset of moments related to importing.[9] In the second case, I re-calibrate the model of importing-exporting to the same moments of the Mexican micro-data as above except for the correlation between import and export shares, which is set to zero.[10] Both models generate a large decrease in the aggregate import intensity following the real depreciation. This decrease is mostly explained by negative compositional effects, by which firms with high import intensity contract. Finally, both models predict an increase in the consumer price index that is larger than in the benchmark model of importing-exporting. Intuitively, in the models of importing-only or uncorrelated importing-exporting, the devaluation disproportionally affects the initially intense importers, which tend to be efficient firms. Introducing the exporting dimension mitigates this effect, by protecting the most efficient firms from the cost shock and incentivizing them to expand and increase their import intensity.

Related literature. The paper is related to a large literature that incorporates input trade into quantitative models. First and foremost, the paper is closest to the recent frameworks that study the effect of imported inputs on firm and aggregate productivity - see Halpern et al. (2015), Gopinath and Neiman (2014), Blaum et al. (2016) or Ramanarayanan (2017). While different in their focus, this class of frameworks features an import demand system with an aggregate elasticity of substitution that exceeds unity. As foreign inputs become more expensive, these frameworks predict a decrease in the overall import-intensity of the economy

[4]The firm-specific fixed costs of importing and exporting are allowed to be correlated, which can also generate an association between import and export intensities, beyond the complementarity discussed above.

[5]The real exchange rate is exogenous because the model is static.

[6]The increase in the aggregate export share after the devaluation is not only a feature of the Mexican case, but is also present in the experiences of Brazil, Korea, Indonesia and Turkey. Using data from input output tables, I find that, on average across these countries, the aggregate export share is 40% higher five years after the devaluation relative to the year before.

[7]The effect of changes within the firm tends to decrease the aggregate import share. That is, holding initial firm size constant, firms tend to decrease their import shares.

[8]The model predicts a positive contribution of net entry, although quantitatively very small.

[9]I target the aggregate import share, the fraction of importers, as well as the dispersions in value added, import intensity and their correlation.

[10]The model can generate uncorrelated import and export shares by assigning negatively correlated fixed costs of importing and exporting across firms.

and a pattern of reallocation by which initially intense importers contract.[11] I provide evidence that these predictions are at odds with data from large devaluations. To be consistent with the data, I show that firms' export and import behavior need to be studied simultaneously. I also show that doing so matters for the normative implications of devaluations.

Gopinath and Neiman (2014) is particularly related as they focus on a large currency devaluation. Using customs-level data for Argentina, they document how firms stopped importing their products from particular countries in the aftermath of the 2001 devaluation and argue that this constituted a central mechanism to explain the fall in aggregate productivity. I build on their mechanism of how devaluations affect productivity and provide additional evidence on the aggregate degree of substitution between domestic and foreign inputs as well as the pattern of firm reallocation following the crises.[12] I argue that taking into account firms' export activity, in addition to its import behavior, can significantly affect the aggregate consequences of the devaluation.

The paper is also related to a literature that studies sudden stops in emerging market economies, which feature sharp reversals in the current account, deep recessions and large real depreciations - see Korinek and Mendoza (2014) for a survey. In this literature, imported inputs play a key role in explaining the initial output collapse in the crises, which is mainly accounted by a fall in measured aggregate productivity - see Mendoza (2006). These frameworks typically feature an elasticity of substitution between domestic and foreign inputs that is greater than or equal to unity - see Mendoza (2010) or Mendoza and Yue (2012). They also abstract from complementarities between importing and exporting. I argue that this omission can have meaningful implications for the effects of shocks to the price of foreign inputs.

This paper is related to a literature that highlights the connection between importing and exporting, althought with a different focus. Amiti et al. (2014) focus on the disconnect between exchange rates and the prices of tradable goods. They show theoretically and empirically that a low exchange rate pass-through into export prices can be explained by the fact that intense exporters are intense importers. Fieler et al. (2017) focus on the large increase in the skill premium observed after trade liberalizations in developing countries. In their model, importing, exporting and the choice of quality are interconnected and jointly help explain the increase in demand for skilled labor. Lapham and Kasahara (2013) study how the complementarity between importing and exporting affects the gains from trade, but do not focus on devaluations.

The elasticity of substitution between home and foreing goods has recieved considerable attention in international economics. International business cycle models require small values of this elasticity to generate high volatility in the terms of trade and the real exchange rate together with low movements in relative quantities. For example, Backus et al. (1994) and Heathcote and Perri (2002) use values around 1. Similarly, a large empirical literature has estimated the price elasticity of import demand focusing on the home-foreign substitution - see Goldstein and Khan (1985) or Marquez (2013) for surveys. This literature also relies on high frequency data, using typically monthly or quarterly data, and tends to find relatively low values of the elasticity of substitution.[13] On the other hand, a vast literature in international trade has estimated this paratemer from variation in trade flows and trade costs, yielding estimates larger than 4 - see e.g. Eaton and Kortum (2002)

[11] Other recent quantitative frameworks that incorporate input trade, which abstract from importer heterogeneity, also feature an import demand system with an aggregate elasticity that exceeds unity - see e.g. Eaton et al. (2011), Caliendo and Parro (2014) or Costinot and Rodríguez-Clare (2014). Eaton et al. (2011) feature firm heterogeneity in export behavior, but no heterogeneity in firms' imported input shares. Caliendo and Parro (2014) and Costinot and Rodríguez-Clare (2014) feature sectoral heterogeneity and a representative importer within sectors. In these frameworks, at their estimated parameters, an increase in trade costs that makes imports effectively more expensive in one country leads to a decrease in the aggregate import share of this country, regardless of any changes to trade costs to export goods.

[12] As in Gopinath and Neiman (2014), I find that the value of aggregate imports, as well as an index of aggregate import volume, both tend to decrease after the devaluation. The fact that at the same time the aggregate expenditure share on imported inputs increases speaks to the economy-wide degree of substitution between domestic and foreign inputs.

[13] For example, Gallaway et al. (2003) finds estimates in the range of 1-5 on average across four-digit industries using monthly US data for 1989-1995.

or Simonovska and Waugh (2014).

The paper is also related to the empirical literature that provides evidence on the connection between imported inputs and firm productivity by studying episodes of trade liberalizations - see Amiti and Konings (2007), Pavcnik (2002) and Goldberg et al. (2010). The productivity-enhancing role of foreign inputs is a central piece of my analysis.

The paper is organized as follows. Section 2 documents the behavior of the aggregate import share after large devaluations. Sections 3 and 4 contain the model and quantitative exercise, respectively. Section 5 concludes.

2 Empirical Evidence

2.1 Data Sources

I rely on input output tables from three sources. First, the OECD national input-output tables, which provide information on domestic and imported flows at the sector level for all OECD countries as well as 27 non-member economies between 1995 and 2011. Sectors are defined at the 2 digit according to the ISIC Rev. 3, resulting in 34 sectors. Second, I rely on the World Input Output Database (WIOD) which provides input-output tables for 40 of countries and 35 sectors. Finally, I rely on data from Johnson and Noguera (2016) which provides data going back to 1970 for 42 countries and 4 broad sectors.[14] The empirical results of Section 2.2 below are robust to using any of these sources to compute imported input shares.

I identify currency crises in the period 1970–2011 from Laeven and Valencia (2012). Currency crises are defined as nominal depreciations of the currency relative to the US dollar of at least 30% or more, which is also at least 10 percentage points higher than the rate of depreciation in year before. This dataset also provides information on systemic banking and sovereign debt crises.[15]

I rely on micro data from Mexico and Indonesia. The data for Mexico is taken from the Encuesta Industrial Anual (EIA), administered by the Instituto Nacional de Estadistica, Geografia e Informatica (INEGI). The EIA is a survey of manufacturing establishments (excluding Maquiladoras) which covers roughly 85% of the the value of output in each 6-digit industry. The Indonesian dataset is the Manufacturing Survey of Large and Medium-sized firms (Survei Industri, SI), which is an annual census of all manufacturing firms in Indonesia with at least 20 employees. Both datasets provide information on spending in domestic and foreign materials.

I measure tariffs with an average (simple or import-value weighted) of effectively applied tariffs across all products, taken from the UNCTAD's TRAINS database.

Quarterly data for imports of goods and services, nominal and real GDP, the volume of imports, the real effective exchange rate, and the consumer price index are taken from the IMF's International Financial

[14] Tables 14, 15 and 17 in the Appendix provide a list of countries in the OECD, WIOD and Johnson and Noguera (2016) databases. See Timmer et al. (2015) for a description of WIOD.

[15] Systemic banking crises satisfy the following two conditions (i) significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and/or bank liquidations) and (ii) significant banking policy intervention measures in response to significant losses in the banking system. Examples of significant policy interventions are extensive liquidity support, bank restructuring costs of at least 3 percent of GDP, bank nationalizations or deposit freezes. See Laeven and Valencia (2012) for details.

Country	Crises Years	Country	Crises Years
Argentina	1975, 1981, 2002	Romania	1996
Brazil	1976, 1983, 1991, 1999	Russia	1998
Chile	1972, 1982	South Africa	1984
Finland	1993	Spain	1983
Indonesia	1979, 1998	Sweden	1993
Israel	1975	Thailand	1998
Korea	1998	Turkey	1980, 1994, 2001
Mexico	1977, 1982, 1995	Vietnam	1972, 1981

Table 1: Sample of Large Devaluations

Statistics (IFS) database.[16,17,18] To construct aggregate total factor productivity, I rely on data on capital and labor usage at constant prices from the Penn World Tables. Labor usage is broken down into measures of total number of employees, total hours, and average human capital.

2.2 The Behavior of Imports around Large Devaluations

In this section, I document the behavior of the aggregate imported input share around large devaluations. The aggregate imported input share is defined as the ratio of imported intermediate inputs to total intermediate inputs (domestic and imported). I measure the imported input share with data from input output tables, which provide information on import value of intermediate goods as well as domestic input spending.

Sample Construction. I start from the list of currency crises provided by Laeven and Valencia (2012) for 1970-2011. I identify the episodes for which data from input output tables is available. I rely mainly on Johnson and Noguera (2016) because their input output tables go back to 1970. This results in a sample of 39 currency crises. I further require that the crises features a depreciation of the real exchange rate of at least 10 percent on impact.[19] The final sample contains 28 devaluations which are listed in Table 1. I also consider a subsample of events for which data from the OECD and WIOD input output tables is available. These sources provide input output tables at the two-digit sector starting in 1995. The resulting sample of 9 recent events is contained in Table 2.[20]

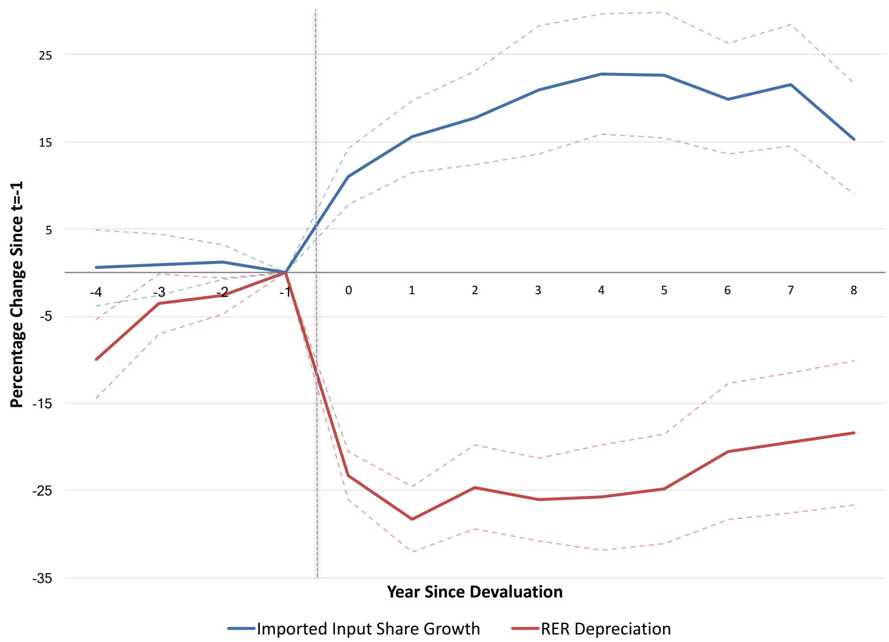
[16] The real effective exchange rate is the nominal effective exchange rate adjusted for relative movements in the price index (or a measure of manufacturing labor costs) in the home and selected foreign countries. The nominal effective exchange rate is an index of the value of a currency against a weighted average of foreign currencies of the main trading partners. I also consider a measure of the bilateral real exchange rate with the US, which I construct by adjusting the nominal exchange rate by the consumer price indeces in the respective country and the US. A decrease of either measure of the real exchange rate represents a depreciation of the local currency.

[17] The data was seasonally adjusted using the X-12-ARIMA software developed by the US Census Bureau. Alternatively, as a robustness, the series were also adjusted with a seasonal dummy model using data for 1960-2015.

[18] An index for the volume of imports is not available for Chile, Indonesia, Mexico and Argentina. For these countries, I rely on the import volume index from the World Bank's World Development Indicators, defined as the ratio of the import value index to the unit value index.

[19] The events in Laeven and Valencia (2012) feature a nominal exchange rate depreciation of 30 percent on the year of the crisis. In some cases, the real depreciation was much smaller as local prices quickly adjusted. To focus on large devaluations, I remove events with real depreciations smaller than 10 percent. The results of this section are robust to moving this threshold. In fact, they also hold on the sample of 39 events with all the currency crises in Laeven and Valencia (2012) for which imported input share data is available.

[20] The OECD and WIOD databases provide data for the events of Colombia 1999 and Malaysia 1997 - which were absent in Johnson and Noguera (2016). I require that data is available for at least 2 years before the devaluation - this results in Romania 1996 and Mexico 1995 being dropped. The resulting sample of episodes is close to the one in Alessandria et al. (2015).



Notes: The blue line is the rate of growth in the aggregate imported input share between a given year and the year before the devaluation (labeled -1). The year of the devaluation is labeled 0. The red line depicts the rate of growth in the real exchange rate. The lines in the Figure are averages of the experiences of the episodes in Table 1. The dashed lines give standard errors of the corresponding average (i.e. the standard deviation divided by the square root of the sample size). Sources: Johnson and Noguera (2016), IFS.

Figure 2: Imported Input Share After Large Devaluation, Extended Sample

Country	Crisis Year	Country	Crisis Year
Argentina	2002	Malaysia	1997
Brazil	1999	Russia	1998
Colombia	1999	Thailand	1997
Indonesia	1997	Turkey	2001
Korea	1997		

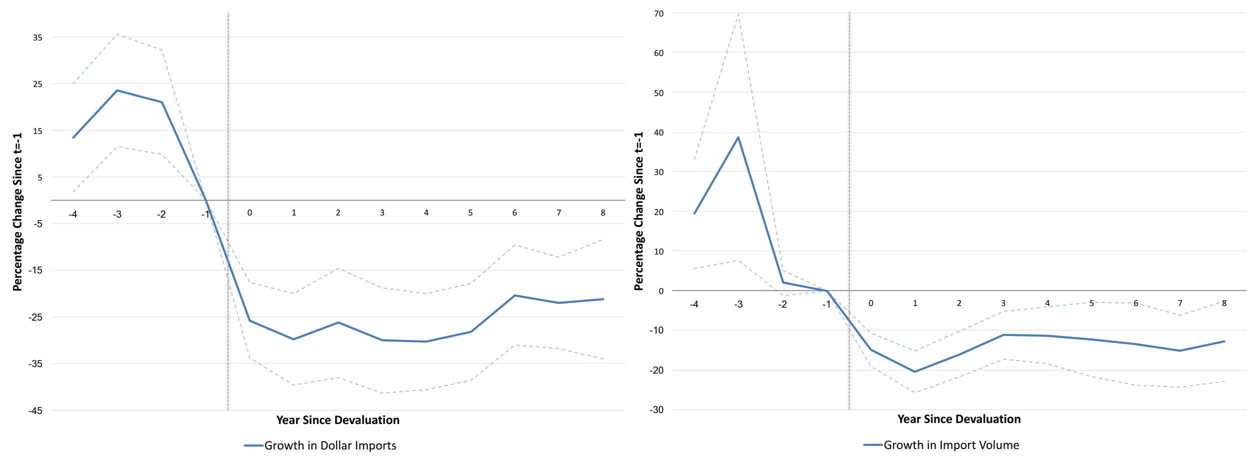
Table 2: Sample of Recent Large Devaluations

Aggregate Imported Input Share. For the sample of recent large devaluations in Table 2, Figure 1 in the Introduction depicts the evolution of the aggregate imported input share, as well as the real effective exchange rate (RER), in a window of 12 years around the devaluation. The graph shows the average experience over the 9 episodes.[21] We see that the RER falls by more than 30% on impact and then gradually increases, although it remains 15% below its original level even 8 years after the devaluation. Importantly, following the devaluation, the aggregate imported input share increases by about 30% within the first three years and remains about 20% higher than its pre-devaluation level after 8 years.[22]

Figure 2 confirms this pattern on the sample of 28 devaluations of Table 1. Figures 13-17 in the Appendix show each of the 28 episodes separately. The pattern of real appreciation before the crisis followed by a collapse in the real exchange and then gradual recovery seen in Figure 2 is consistent with the findings of Korinek and Mendoza (2014) for suddent stops in emerging markets.

[21] Figures 11 and 12 in the Appendix contain the dynamics of the import share for each of these countries separately.

[22] A similar pattern is found when restricting the analysis to the Manufacturing sector. Figure 22 in the Appendix depicts the evolution of the import share for the Manufacturing sector following large devaluations.



Notes: The left figure depicts the rate of growth in the value of aggregate imports (in current dollars) while the right figure depicts the rate of growth in an index of import volume. All growth rates are computed between a given year and the year before the devaluation (labeled -1). The year of the devaluation is labeled 0. Both figures decpitct averages of the experiences of the episodes in Table 1. The dashed lines give standard errors of the corresponding average (i.e. the standard deviation divided by the square root of the sample size). Source: IFS.

Figure 3: Imports Value and Volume After Large Devaluation, Extended Sample

An increase in the aggregate import share in a context where foreign inputs are relatively more expensive, as documented in the section, is grossly at odds with recent quantitative models of importing - see Halpern et al. (2015), Gopinath and Neiman (2014) or Blaum et al. (2016).

Imports, Output and TFP. It is well-known that large devaluations as the ones studied above are characterized by collapses in import values, real output and aggregate total factor productivity (TFP). I confirm these patterns in the sample of 28 large devaluations considered above. I construct TFP as a the Solow residual, defined as output growth net of a share-weighted average of primary input growth, adjusted for non-constant returns to scale and variable labor and capital utilization as in Basu et al. (2006).[23] I remove a country-specific log linear trend from each series. I compute the percentage change in each variable relative to the year before the devaluation as in Figure 2 above. Figure 3 contains the results for the dollar value of imports and the volume index. The left panel shows that the dollar value of imports falls by about 25-30% and remains substantially depressed relative to trend for several years following the devaluation. The right panel shows that the volume of imports falls by about 20% within two-years and remains 10% depressed relative to trend 8 years after the devaluation.[24,25]

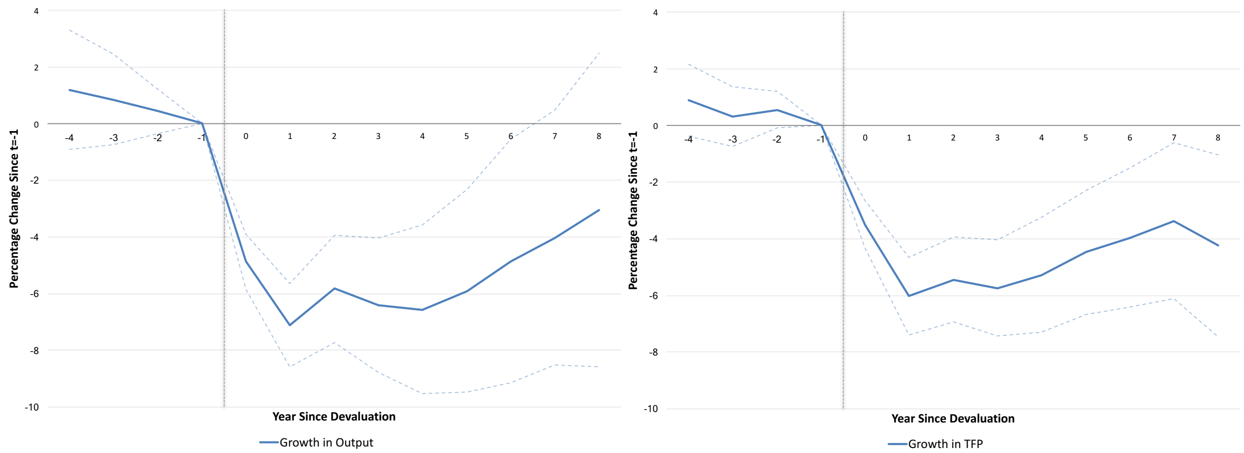
Real output shows a persistent decline of about 5% relative to trend - see left panel in Figure 4. More than 80% of this decline in output is explained by a decline in TFP relative to trend, as seen in the right panel.[26] Qualitatively, these findings are consistent with those in Meza and Quintin (2007), Korinek and Mendoza (2014) and Gopinath and Neiman (2014).

[23] Unlike Basu et al. (2006), I focus on an aggregate Solow residual and do not employ instrumental variables for input growth. Section 6.2 of the Appendix contains details of the construction of the TFP measure.

[24] The fall in import value and volume is almost twice as large if we go back two years before the crises. This is related to the fact that imports are pro-cyclical and the recession tends to precede the devaluation.

[25] Import volume data is available for 19 of the 28 episodes in Table 1. More precisely, import volume data is not available for the episodes of Argentina 1975, Chile 1972, Indonesia 1979, Mexico 1977, Romania 1996, Russia 1998, Turkey 1980 and Vietnam 1972 and 1981.

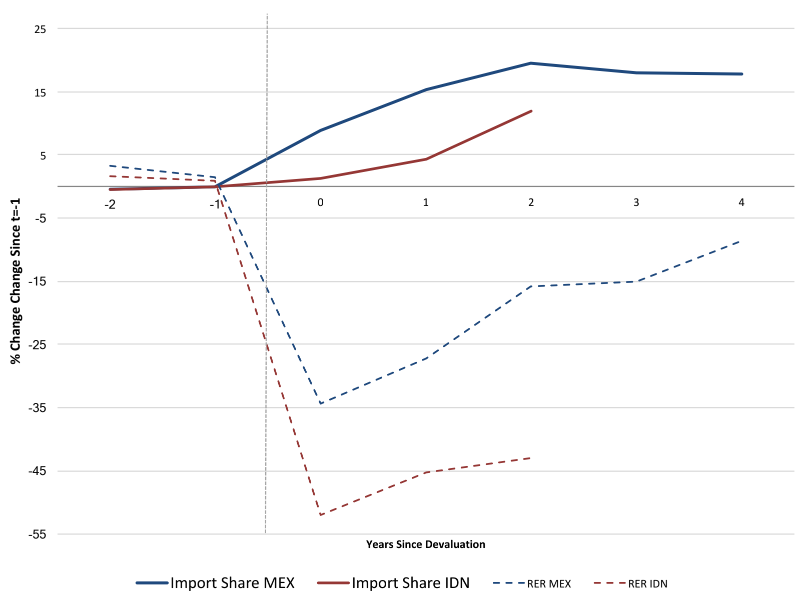
[26] Figure 18 depicts the output and TFP series together for graphical comparison.



Notes: The left figure depicts the rate of growth in real GDP while the right figure depicts the rate of growth in TFP. All growth rates are computed between a given year and the year before the devaluation (labeled -1). The year of the devaluation is labeled 0. Both figures decpitct averages of the experiences of the episodes in Table 1. The dashed lines give standard errors of the corresponding average (i.e. the standard deviation divided by the square root of the sample size). Section 6.2 of the Appendix contains details on the construction of the TFP measure. Source: Penn World Tables.

Figure 4: Output and TFP After Large Devaluation, Extended Sample

A Measure with Micro Data. As complementary evidence, I use micro data of Mexican and Indonesian manufacturing establishments around the time of the devaluations. For both episodes, I observe spending on domestic and foreign materials at the establishment level and can therefore compute the manufacturing sector aggregate import share. Figure 5 contains the growth in the aggregate share of imported materials (in total materials) after the Mexican and Indonesian devaluations of 1994 and 1998, respectively. For Mexico, the aggregate import share increases by about 20% in the first three years and remains above 15% after five years. For Indonesia, the import share is about 12% above its pre-devaluation value after 3 years.



Notes: The Figure shows the rate of growth in the ratio of total imported materials to total materials (imported plus domestic) in the Manufacturing sector for Mexico and Indonesia. The growth rate is computed relative to 1994 for Mexico and 1998 for Indonesia. Source: Survey of Manufacturing EIA and SI.

Figure 5: Aggregate Imported Input Share after Mexican and Indonesian Devaluations

In the case of Mexico, the devaluation happened soon after the introduction of NAFTA.[27] Distinguishing the effects of the devaluation from those of the trade agreement is therefore difficult. Nonetheless, there are two reasons why it is unlikely that the pattern in Figure 5 is driven by NAFTA. First, import tariffs were eliminated gradually over a period of 15 years. In fact, between 1995 and 1999, which is the post-devaluation period considered above, a simple average of effectively applied tariffs slightly increased - see Figure 25 in the Appendix.[28] Second, if the reduction in tariffs had offset the real depreciation, making the relative price of foreign inputs effectively lower, we should observe increases in the import shares by all firms. I show below that, holding initial firm size constant, firms' import shares tended to decrease three years or more after the devaluation. In other words, the increase in the aggregate import share in Mexico was not driven by a within-firm increase in import shares, but rather by between-firm reallocations.

2.3 Robustness

In this section, I assess whether the findings of Figures 1 and 5 are driven by potentially confounding factors. I consider changes in tariffs, long-run time trends, between-sector reallocation, financial crises and recessions, and show that neither of these factors can explain the findings of Section 2.2 above. I also consider a measure of overall import intensity that varies at the quarterly frequency.

Tariffs, time trends and sectoral rellocation. I now assess whether the findings of Figures 1 and 5 are driven by potentially confounding factors. One such factor is a reduction in import tariffs, which would tend to lower the relative price of foreign inputs. To the extent that the devaluation episodes considered above took place around times of trade liberalization, tariffs could naturally explain the above findings. Figures 23-25 in the Appendix document the evolution of tariffs in a window of 12 years around the devaluation for the sample of recent events of Table 2. For the average country, effectively applied tariffs were 11% and 9% (for the simple and weighted average measures, respectively) in the pre-devaluation period and 8.4% and 5.3%, respectively, in the post-devaluation period.

To address this concern, I assess the effect of the devaluation on the imported input share by estimating the following specification:

$$log(m_{jct}) = \alpha_c + \alpha_j + \alpha_t + \beta deva_{ct} + \gamma \tau_{ct} + \varepsilon_{ct}, \tag{1}$$

where m_{jct} is the imported input share in sector j of country c in year t, $deva_{ct}$ is an indicator variable that equals unity for five years at/after the devaluation and zero otherwise, α_c, α_j and α_t are country, sector and year fixed effects, and τ_{ct} are average effectively applied tariffs. I estimate (1) on the sample constructed from the OECD data which contains 34 sectors, 62 countries (including the 10 country episodes of Table 2) over 1995-2011.

Table 3 contains the results. We see that, after controlling for the effect of tariffs, interest rates and year and sector fixed effects, the aggregate imported input share is 9% higher in the 5 years following the devaluation. When replacing the devaluation indicator with an index of the real exchange rate, we find that a 30 percent depreciation is associated with a 7 percent increase in the import share - see column 3. We conclude that the findings of Figures 1 and 5 are not driven by changes in tariffs, time trends or a pattern of sectoral rellocation.

[27] In particular, the trade agreement came into effect in January of 1993 and the devaluation happened at the end of 1994.
[28] We also note that the Maquiladora sector is not included in the the Survey of Manufacturing used to construct Figure 5.

Dep. var. $log(m_{jct})$	(1)	(2)	(3)	(4)
$deva_{ct}$	0.10***	0.09***	0.09***	
	(0.01)	(0.01)	(0.01)	
τ_{ct}		-0.08***	-0.08***	-0.02**
		(0.03)	(0.01)	(0.01)
$Interest\ rate_{ct}$		-0.12***	-0.12***	-0.01
		(0.04)	(0.02)	(0.02)
$log(RER_{ct})$				-0.19***
				(0.01)
Country, Year, Sector FE	Yes	Yes	Yes	Yes
Year, Country x Sector FE	No	No	Yes	Yes
Obs	34,765	27,378	27,378	22,242
R^2	0.72	0.73	0.93	0.94

Table 3: Import Share after Large Devaluations

Notes: The dependent variable is the log of the aggregate import share. The sample covers 62 countries in the 1995-2011 period, including the ten episodes listed in Table 2. The import share is computed from the OECD input-output tables. RER is the real effective exchange rate index (with lower values associated with a depreciated currency) and is taken from IFS. The measure of tariffs (τ) is from WDI and corresponds to a weighted average across all products of applied tariff rates, at the yearly frequency. Robust standard errors in parenthesis with ***, ** and * respectively denoting significance at the 1%, 5% and 10% levels.

Long run time trends. A potential concern is that the results of Table 3 do not properly control for time trends in the import share as the pre-devaluation period is not long enough: the OECD sample starts in 1995 and several devaluation episodes ocurr around 1997/1998. To address this concern, I turn to the input output tables of Johnson and Noguera (2016) which go back to 1970.[29] Figure 26 in the Appendix lengthens the pre-devaluation window to 24 years. Indeed, the import share features a positive long-run time trend: a simple linear trend estimated on the pre-devaluation period (displayed in the graph) features a positive slope. When extrapolating this linear trend to the post-devaluation period, we see that the imported input share is above the predicted trend. While this suggests that the pattern of Figures 1 and 5 above is not driven by a time trend, this procedure may be sensitive to the pre-devaluation period where the trend is estimated. For example, in the 10 years before the devaluation, which tend to coincide with 1990s, the imported input share grows at a faster rate. To deal with this issue, I run a version of the specification in (1) at the country-level with year and country fixed effects. Table 4 contains the results. Again we confirm that the devaluation is associated with an increase in the imported input share of about 10%.

Imports-to-GDP Ratio at Quarterly Frequency. A shortcoming of the input output tables is that the data is at the yearly frequency. To increase the frequency of the data, I now proxy the aggregate import share by the ratio of total imports of goods and services to GDP, denoted by M/Y. This is an imperfect measure because the numerator includes imports of final goods, instead of intermediate inputs only, and the denominator is total value added, instead of total spending in inputs. This measure, however, allows us to study the behavior of the overall import intensity around the time of the crises at the quarterly frequency.

Figure 27 in the Appendix contains the evolution of M/Y and the real exchange rate in a window of 28 quarters around the devaluation (labeled as period 0), averaged over the 10 episodes in the sample. The Figure shows the growth rate in M/Y and RER between each quarter and the quarter before the devaluation (labeled as period -1). We see that M/Y jumps in the quarter of the devaluation, grows by about 20% within

[29] The disadvantage of this data, relative to the OECD and WIOD, is its broad level of sectoral aggregation (4 major sectors).

Dep. var. $log(m_{ct})$	(1)	(2)	(3)	(4)
$deva_{ct}$	0.06***	0.13***		
	(3.04)	(0.02)		
τ_{ct}		-0.05		-0.01
		(0.04)		(0.02)
$log(RER_{ct})$			-0.25***	-0.13**
			(0.042)	(0.06)
Country, Year FE	Yes	Yes	Yes	Yes
Obs	1,566	741	1,050	615
R^2	0.87	0.94	0.93	0.95

Table 4: Import Share after Large Devaluations

Notes: The dependent variable is the log of the aggregate import share. The data is taken from Johnson and Noguera (2016) and covers 42 countries in the 1970-2010 period, including the episodes listed in Table 2, except Russia, Colombia and Malaysia. RER is the real effective exchange rate index (with lower values associated with a depreciated currency) and is taken from IFS. The measure of tariffs (τ) is from WDI and corresponds to a weighted average across all products of applied tariff rates, at the yearly frequency. Robust standard errors in parenthesis with ***, ** and * respectively denoting significance at the 1%, 5% and 10% levels.

Dep. var. $log(m_{ct})$	(1)	(2)	(3)	(4)	(5)
$deva_{ct}$	0.03	0.03	0.05***	0.07***	0.09***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
$banking_{ct}$		-0.01	-0.01	-0.01	-0.05***
		(0.2)	(0.02)	(0.02)	(0.01)
$default_{ct}$			-0.14***	-0.14***	0.04
			(0.03)	(0.03)	(0.05)
$restructuring_{ct}$				0.06*	-0.05
				(0.03)	(0.03)
$log(\tau_{ct})$					-0.02
					(0.02)
Year, Country FE	Yes	Yes	Yes	Yes	Yes
Obs	1,566	1,566	1,566	1,566	731
R^2	0.87	0.87	0.87	0.87	0.95

Table 5: Imported Input Share in Currency, Banking and Sovereign Debt Crises

3 quarters and remains 10% above its pre-devaluation level after 5 years.[30,31,32]

I confirm that the devaluations are associated with higher imports-to-GDP ratios by estimating a specification akin to (1) on a sample of 64 countries (including the 10 episodes considered above) between 1960 and 2015. I remove a country-specific log linear trend from the imports-to-GDP ratio and then, pooling all countries, estimate (1) with country and quarter-year fixed effects. Table 16 in the Appendix contains the results. Column 1 shows that the devaluation period (defined as the 20 quarters following the onset of the depreciation) is associated with a 9 percent increase in the imports-to-GDP ratio. The coefficient on the devaluation indicator is barely changed after controlling for tariffs in column 2.[33] Qualitatively similar results are obtained when including a measure of the real exchange rate instead of the devaluation indicator, as year-to-year depreciations are associated with increases in import intensity - see column 3. Quantitatively, a 30 percent real depreciation implies a 5 increase in the imports-to-GDP ratio.

Financial Crises and Recessions. The devaluation episodes considered above were accompanied by severe contractions in output as well as distress in financial markets. I now assess the effect of each type of crises on the economy's import intensity. Note first that the recessions tend to lower the import-to-GDP ratio, as shown in Table 16 in the Appendix. This is consistent with models of importing with firm heterogeneity, such as Halpern et al. (2015) or Gopinath and Neiman (2014), where a contraction in total domestic spending tends to lower the aggregate import share due to the presence fixed costs to importing.

Regarding financial crises, consider first the 1999 devaluation in Brazil, an example of a recent devaluation which was not accompanied by a banking crises. Figure 28 in the Appendix shows that the aggregate imported input share in Brazil displays a similar pattern around the devaluation as the pattern of the average country in the sample of Figures 1 and 2. Next, I focus on 16 countries which experienced a financial crises in 2008, but did not experience a currency crisis.[34] Figure 29 shows that the aggregate imported input share tends to decrease after the financial crisis of 2008.

To assess whether these results hold more broadly, I rely on Laeven and Valencia (2012) who provide information on the occurence of systemic banking crises as well as sovereign crises. I combine this information with the input output tables of Johnson and Noguera (2016) to obtain a sample with 39 devaluations, 50 banking crises and 12 sovereign debt crises - see Table 17 in the Appendix for a complete list of episodes. While crises tend to come in waves, with financial crises typically preceeding currency crises, as argued by Reinhart and Rogoff (2011), there is substantial independent variation in the occurrence of crises. For example, out of the 39 currency crises in the sample, 23 were not accompanied by a banking crises - see Table 18 in the Appendix for a list of episodes. I regress the aggregate imported input share on an indicator variables of currency crisis, banking crisis, sovereign default and restructuring, including country and year fixed effects. Table 5 contains the results. Column 3 shows that, controlling for the effect of financial and sovereign debt

[30] The movements in M/Y documented in Figure 1 may reflect changes in the share of inputs to total value added, or in the share of total imports accounted by inputs, even when the share of imported inputs in total inputs is constant.

[31] Figures 19-20 in the Appendix report the experiences for each of the ten country episodes in the sample. We see that there is some heterogeneity underlying the average pattern of Figure 1. Some countries feature a clear increase in their import intensity throughout the entire post devaluation period (e.g. Argentina, Brazil or Russia), while others feature a more mixed pattern, with a short period of depressed import intensity (e.g. Thailand or Korea). Overall, there is a tendency for the country import intensity to increase, both in the short and medium run.

[32] Figure 10 in the Appendix shows the behavior of an index of import volume as well as real GDP at the quarterly frequency. For both series a log linear trend was removed. We see that the volume of imports decreases by as much as 40 percent on impact and, while it gradually recovers, it is still 10 percent depressed after 20 quarters. The Figure also shows that real output decreases by about 10 percent during the first year after the devaluation and is still 7 percent below trend after 20 quarters. These patterns are consistent with the findings at the yearly frequency in Section 2.2 above.

[33] The number of observations in columns 2 and 3 drops because tariff data is not available for all the countries and time periods considered in Figure 1 above. Note also that tariffs are available only at the yearly frequency.

[34] More specifically, I consider the experiences of Austria, Belgium, Denmark, France Germany, Greece, Hungary, Ireland, Latvia, Luxembourg, Netherlands, Portugal, Russia, Slovenia, Spain, Sweden.

crises, a currency crises is associated with a 6% increase in the imported input share. Consistent with the results in Figure 29, systemic banking crises are associated with lower import shares, although this relationship is not statistically significant. Sovereign defaults are associated with a large fall in the import share, which is precisely estimated, while debt restructuring has the opposite effect.

Finally, I exploit firm-level measures of financial constraints which are available in the Indonesian data to show that firms that were unconstrained before the devaluation did not exhibit higher growth in the import shares.

2.4 Accounting for the Increase in Aggregate Import Intensity

In this section, I exploit the Mexican and Indonesian micro data to unpack the sources of the increase in the aggregate import intensity documented above. Following Baily et al. (1992), I decompose the change in the aggregate import share into the contribution of continuing importers (CI), new importers (E) and firms that stop importing (X). New importers can be firms that entered the economy after the devaluation or firms that were present before but did not import. Likewise, firms that stop importing can be either firm that exit the sample after the devaluation, or firms that remain in the sample but are no longer importers. In turn, the contribution of the continuing importers is decomposed into a sum of the changes in import shares holding firm size constant (within-firm component), the changes in firm size holding initial import intensity constant (a between-firm component), and term capturing the covariance between changes in import shares and changes in firm size:

$$\frac{\Delta s_{AGG}}{s_{AGG1}} = \{\underbrace{\sum_{CI} m_{i1}\left(s_{i2}-s_{i1}\right)}_{Within} + \underbrace{\sum_{CI}\left(m_{i2}-m_{i1}\right)s_{i1}}_{Between} + \underbrace{\sum_{CI}\left(m_{i2}-m_{i1}\right)\left(s_{i2}-s_{i1}\right)}_{Covariance}$$
$$\underbrace{\sum_{E} m_{i2}s_{i2}}_{Entry} - \underbrace{\sum_{X} m_{i1}s_{i1}}_{Exit}\}\frac{1}{s_{AGG1}}, \tag{2}$$

where s_{AGGt} denotes the aggregate import share, m_{it} denotes the share of firm i in total manufacturing materials, s_{it} is the share of imported materials in total materials of firm i, and $t = 1, 2$ denote the periods before and after the devaluation.

Table 6 contains the results of the decomposition. Three features stand out. First, the within component tends to be negative over sufficiently long horizons. For Mexico, the within is positive over short horizons (i.e. 1994 to 1995 or 1996) and then monotonically decreases becoming negative over longer horizons. This is consistent with an elasticity of substitution that is smaller than unity in the short run, but increases with the time horizon to be larger than unity after 3 years or more. For Indonesia, the within is negative over all horizons. Second, the between and covariance terms are positive and grow in magnitude with the time horizon. Three years after the devaluation, they jointly account for more than 70% of the total increase in the aggregate import share in either country. Third, net entry, defined as the difference between the entry and the exit components, contributes positively to the increase in the aggregate import share, accounting for about one third of the total effect three years after the devaluation.

Taken together, these results suggest that the increase in the aggregate import share following large devaluations documented in Section 2.2 above is not explained by changes within the firm together with a low elasticity of substitution. Rather, it is the consequence of compositional effects by which intense importers expand, as well as by the entry of firms into importing.

Panel A: Mexico

Year	Within	Between	Covariance	Net Entry	All
1995	2.91	6.71	0.32	-0.99	8.95
1996	1.55	5.36	2.87	5.48	15.27
1997	-0.98	10.89	2.93	6.56	19.41
1998	-1.91	9.58	4.32	5.93	17.91
1999	-2.79	9.99	4.27	6.24	17.70

Panel B: Indonesia

Year	Within	Between	Covariance	Net Entry	All
1998	-2.09	2.03	2.01	-0.65	1.3
1999	-2.74	-0.02	1.71	5.37	4.32
2000	-1.99	8.86	1.26	3.8	11.92

Notes: The Table contains the decomposition of the aggregate import share given in (2) for Mexico. Each row performs the decomposition between 1994 and each of the subsequent five years. The column "All" reports the total increase in the aggregate import share ($\Delta s_{AGG}/s_{AGG1}$). All values are in percentage points. Source: Survey of Manufacturing, EIA.

Table 6: Accounting for the Change in the Aggregate Import Intensity

Sectoral reallocations. How much of the increase in the import share is due to changes within sectors vs changes across sectors? We now decompose the growth in the import share in the Mexican manufacturing sector into a component associated with increases in the sector-level import shares and a component associated with the expansion of import intensive sectors. More precisely, we consider the following decomposition:

$$\frac{\Delta s_{AGG}}{s_{AGG1}} = \{\underbrace{\sum_{j\in J} m_{j1}\left(s_{AGGj2} - s_{AGGj1}\right)}_{Within} + \underbrace{\sum_{j\in J}\left(m_{j2} - m_{j1}\right) s_{AGGj2}}_{Between}\} \frac{1}{s_{AGG1}},$$

where m_{jt} denotes the share of total materials accounted by sector j in period t , s_{AGGjt} denotes the aggregate import intensity of sector j in period t, and J is the total number of sectors in Manufacturing. I define sectors at the two digit level and perform the decomposition taking 1994 as initial year, and each of 1995-1999 as final year. Table 19 in the Appendix contains the results. On impact, most of the increase in the import share is accounted by within-sector increases in import intensity. Over time, the between component also helps explain the increase in the overall import intensity - by 1999, it accounts for about half of the increase in the overall import share. Table 20 shows the contribution of the different two digit industries to the within and between components for the 1994-1999 period. The first column shows that, with the exception of Wood, all sectors feature an increase in their import intensity.[35] The last two columns show that the large positive contribution of the between component is entirely explained by Metal Products, Machinery and Equipment, which displays a large expansion and is very import intensive in 1999. We conclude that both sectoral reallocations and within sector changes are important to account for the aggregate pattern in the Manufacturing sector.

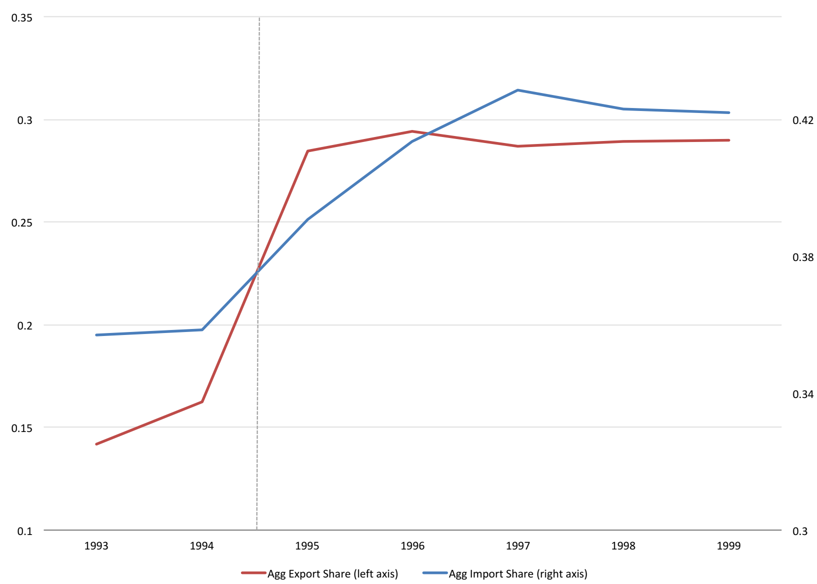
2.5 The Link to Exporting

What explains the compositional effects documented above? In this section, I argue that these effects are explained by the expansion of exporters, which tend to be intense importers, following the devaluation. The expansion (albeit sluggish) of total exports after large depreciations of the real exchange rate is documented in Alessandria et al. (2015). The fact that intense exporters tend to be intense importers is widely documented

[35]Wood and wood products shows a large decline in its import intensity, but accounts for a small share of total Manufacturing materials.

in the international trade literature - see Bernard et al. (2007) for the US, Lapham and Kasahara (2013) for Chile, Amiti et al. (2014) for Belgium, and Albornoz and Lembergman (2015) for Argentina, among others.

Figure 6 shows the evolution of the aggregate export share, defined as the ratio of foreign sales to total (domestic plus foreign) sales, following the Mexican devaluation of 1994. The data is for the Manufacturing sector. We see that the aggregate export share increase sharply after the devaluation, going from about 16 percent in 1994 to 29 percent in 1999, an increase of roughly 80 percent. This pattern is confirmed for the overall economy in the WIOD data for the episodes of Brazil 1998, Korea 1997, Indonesia 1998, Russia 1998 and Turkey 2001 - see Figure 31 in the Appendix.

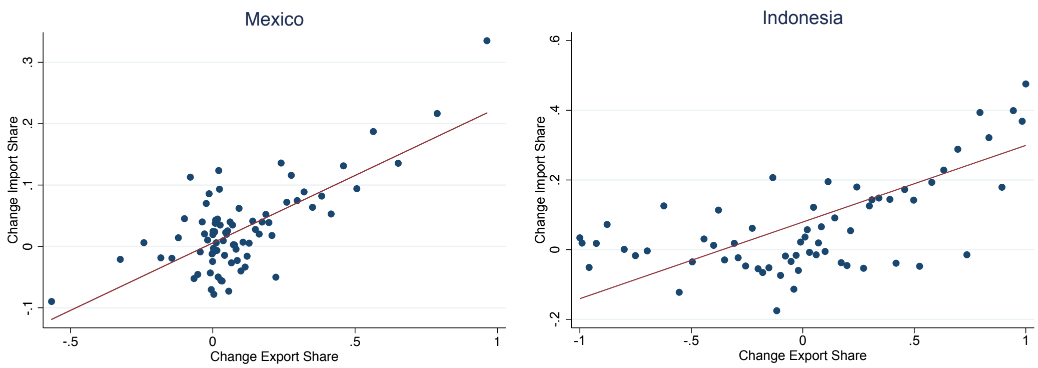


Notes: The Figure shows the evolution of the aggregate export share (red line, left axis) and the aggregate import share (blue line, right axis) following the currency depreciation of 1994. The data covers the Manufacturing sector. The aggregate export share is the ratio of total foreign sales to total sales (domestic plus foregin). The aggregate import share is the ratio of total imported materials to total materials (domestic plus foregin). Source: Survey of Manufacturing, EIA.

Figure 6: Aggregate Import and Export Shares after the Mexican Devaluation

To see whether the increase in the aggregate import intensity can be attributed to the expansion of exporters, Figure 7 depicts a scatter plot of the changes in the import and export intensities in the Mexican manufacturing establishments between 1994 and 1999. We see that firms that increase their export share tend to also increase their import share.[36]

[36]The correlation between the change in the import share and the change in the export share (among firms with non-zero changes) is 0.18.



Notes: The Figure depicts changes in import shares ($s_{i2} - s_{i1}$) and export shares ($s_{Xi2} - s_{Xi1}$) between 1994 and 1999 for Mexican manufacturing firms. Only firms with non-zero changes are included. Source: Encuesta Industrial Anual, Mexico.

Figure 7: Expanding Exporters and Importers After Mexican and Indonesian Devaluations

To further evaluate the link to exporting, I go back to the decomposition in (2) above and investigate whether the positive contribution of the compositional effects can be actually attributed to expanding exporters. More precisely, I measure the fraction of the between, covariance and entry components in (2) that is accounted by expanding exporters:

$$\underbrace{\sum_{CI} (m_{i2} - m_{i1})\, s_{i2}}_{\text{Between+Covariance}} = \underbrace{\sum_{CI} (m_{i2} - m_{i1})\, s_{i2} \times \mathbb{I}(s_{Xi2} - s_{Xi1} > 0)}_{\text{Expanding Exporters}} + \underbrace{\sum_{CI} (m_{i2} - m_{i1})\, s_{i2} \times \mathbb{I}(s_{Xi2} - s_{Xi1} \leq 0)}_{\text{Idle and Contracting Exporters}} \quad (3)$$

$$\underbrace{\sum_{E} m_{i2} s_{i2}}_{\text{Entry}} = \underbrace{\sum_{E} m_{i2} s_{i2} \times \mathbb{I}(s_{Xi2} - s_{Xi1} > 0)}_{\text{Expanding Exporters}} + \underbrace{\sum_{E} m_{i2} s_{i2} \times \mathbb{I}(s_{Xi2} - s_{Xi1} \leq 0)}_{\text{Idle and Contracting Exporters}}, \quad (4)$$

where s_{Xit} denotes firm i's export share in period t, defined as the ratio of foreign sales to total (domestic plus foreign sales).[37] Table 7 contains the results. We see that the positive contribution of the Between and Covariance terms, as well as that of Net Entry, can be (more than fully) accounted by the behavior of firms that increase their export intensity.[38]

3 A Theory of Joint Importing and Exporting

To account for the facts documented above, I propose a theory where firms make importing and exporting decisions simultaneously. I extend the theories of importing in Gopinath and Neiman (2014) and Halpern et al. (2015), which are standard frameworks to evaluate the effects of macroeconomic shocks, to the case where firms can export. A complementarity between importing and exporting arises naturally as profits are log supermodular in increases in demand and reductions in the unit cost. In addition, I allow for a complementarities that arise from correlated fixed costs of importing and exporting.

[37] The firms that do not export in either period (before and after the devaluation), or stop exporting are counted as idle or contracting exporters.

[38] For 1998-99, expanding exporters account for more than 100% of the sum of the Between and Covariance components, implying that these terms are negative for idle and contracting exporters.

Year	Between + Covariance		Net Entry	
	Total	Expanding Exporters	Total	Expanding Exporters
1995	7.03	5.43	-0.99	-0.25
1996	8.24	7.94	5.48	6.94
1997	13.82	13.50	6.56	8.39
1998	13.89	14.75	5.93	8.88
1999	14.26	15.53	6.24	9.55

Notes: The Table contains the breakdown of the Between + Covariance and Entry components in (2) into the part that is accounted by expanding exporters, according to (3)-(4). The data is for the Mexican Manufacturing sector. Each row corresponds to the decomposition between 1994 and each of the subsequent five years. The column "Total" reports the left hand side terms in (3)-(4). All values are in percentage points.

Table 7: The Change in the Aggregate Import Intensity and Expanding Exporters

3.1 Environment

Consider a small open economy, called Home, populated by a mass of firms that can import their inputs and export their final goods from/to a set of countries $\mathcal{C}$. The economy is small in the sense that firms in Home cannot affect world input prices or demand for their products in Foreign countries. The model is static.

Technology. The production side of the local economy follows closely the set up in Blaum et al. (2016). There is a mass of local firms, indexed by i, with technology given by

$$y_i = \varphi_i l^{1-\gamma} x^{\gamma}, \tag{5}$$

where φ_i is firm i's idiosyncratic efficiency, l is labor, γ is the share of intermediate inputs and x is the material input bundle given by

$$x = \left(\beta (q_D z_D)^{\frac{\varepsilon-1}{\varepsilon}} + (1-\beta) x_I^{\frac{\varepsilon-1}{\varepsilon}}\right)^{\frac{\varepsilon}{\varepsilon-1}}, \tag{6}$$

where β captures home bias, q_D and z_D are the quality and quantity of a bundle of domestic inputs, and x_I is a bundle of foreign inputs given by

$$x_I = \left(\int_{\Sigma} (q_c z_c)^{\frac{\kappa-1}{\kappa}} dc\right)^{\frac{\kappa}{\kappa-1}}, \tag{7}$$

where q_c and z_c are the quality and quantity of the input from country c and Σ denotes the sourcing strategy, defined as the set of countries from which the firm imports its inputs. The prices, denoted by p_c in domestic currency and p_c^* in foreign currency, and qualities of all foreign inputs are taken as given. We assume that $p_c = p$ and that q_c is distributed Pareto distributed with scale parameter $q_{min} > 0$ and shape parameter ξ.[39]

Demand by local consumers and firms. A representative consumer in the Home country consumes the mass of goods produced domestically with preferences given by[40]

$$U = \left(\int_i c_i^{\frac{\sigma-1}{\sigma}} di\right)^{\frac{\sigma}{\sigma-1}}. \tag{8}$$

[39] The assumption the prices are constant across source countries is without loss of generality, as firms only care about price-adjusted qualities q/p.

[40] I assume that the consumer cares only about domestically produced goods and therefore abstract from imports of final goods.

Additionally, there is a structure of roundabout production by which firms use the output of all other domestic firms as inputs in production. In particular, the domestic variety z_D is produced according to

$$z_D = \left(\int_i y_i^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}. \tag{9}$$

Domestic demand for a firm's output therefore stems from the consumer and all other domestic firms. It is straightforward to show that total domestic demand for the output of firm i is given by[41]

$$y_i = p_i^{-\sigma} P^{\sigma-1} S, \tag{10}$$

where p_i is the priced charged by the firm, $P \equiv \left(\int p_i^{1-\sigma} di\right)^{\frac{1}{1-\sigma}}$ is the price index associated with (8) and S is total domestic spending, which is the sum of consumer and intermediate spending at Home.

Demand by foreigners. When selling to foreign market j, the firm faces an aggregate demand given by:

$$y_{ij} = p_{ij}^{-\sigma} P_j^{\sigma-1} X_j,$$

where p_{ij} is the price charged by firm i in market j, P_j is the price index in market j, X_j is total spending in j. Unlike p_i, note that p_{ij}, P_j and X_j are all in foreign currency. For simplicity, it is assumed that all foreign transactions are made in a single foreign currency, regardless of the destination/origin, so that we need to keep track of a single exchange rate. Denote this exchange rate by e, quoted in local currency per unit of foreign currency.

Importantly, I assume that $b_j \equiv P_j^{\sigma-1} X_j$ is Pareto distributed with scale parameter $\underline{b} > 0$ and shape $\theta > 1$.

Trade costs. Exporting to any destination entails a fixed cost f_{Xi} per destination and a variable cost τ, which are assumed to be common across destinations for simplicity. Importing from any origin has a fixed costs of f_i, assumed to be common across origins for tractability.[42] Variable input costs are included in input prices p_c^*. In addition, there are fixed costs associated with the overal international strategy of the firm, given by F_M, F_X and F_{XM} to being an importer-only, exporter-only or importer-exporter, respectively.

Market Structure. Firms are price takers in input markets: they can buy any quantity z_c of the input from country c at given price p_c. In output markets, there is CES monopolistic competition.

3.2 Firm Problem

In this framework, the importing and exporting decisions are linked. The firm jointly decides its domestic price p_i, quantity produced y_i, sourcing strategy Σ_i, quantities of all inputs z_c, and export strategy, as well as prices and quantities in each destination. All of these decisions are interdependent. We start by characterizing the optimal sourcing decisions given the extensive margin of imports Σ_i.

Unit Cost given Sourcing Strategy. Given the sourcing strategy Σ, the firm chooses $\{l, z_D, \{z_c\}\}$ to solve:

$$C(y, \varphi_i, \Sigma) = \arg \min_{l, z_D, \{z_c\}} wl + P_D z_D + \int_\Sigma e p_c^* z_c dc$$

[41] Because the domestic aggregator z_D features the same functional form as consumer utility, the demands stemming from consumers and other firms can be easily aggregated into a single isoelastic function.

[42] Allowing for a fixed cost of importing the varies by country would substantially complicate the choice of the optimal sourcing strategy, as discussed in Blaum et al. (2013) and Antras et al. (2017), who a provide a solution algorithm to tackle this problem.

subject to (5)-(7). It can be shown that the expenditure on foreign inputs m_I satisfies[43]:

$$\begin{aligned} m_I &= \int_\Sigma e p_c^* z_c dc = \left(\int_\Sigma \left(e p_c^*/q_c \right)^{1-\kappa} dc \right)^{\frac{1}{1-\kappa}} x_I \\ &\equiv eA(\Sigma) x_I, \end{aligned}$$

where $A(\Sigma) \equiv \left(\int_\Sigma \left(p_c^*/q_c \right)^{1-\kappa} dc \right)^{\frac{1}{1-\kappa}}$ is the price index of foreign varieties in foreign currency. Standard calculations imply the following cost function:

$$C(y, \varphi_i, \Sigma) = \varphi_i^{-1} \left(\frac{w}{1-\gamma} \right)^{1-\gamma} \left(\frac{Q(\Sigma)}{\gamma} \right)^{\gamma} y$$

where Q is given by

$$Q(\Sigma; e) = \left(\beta^\varepsilon \left(p_D/q_D \right)^{1-\varepsilon} + (1-\beta)^\varepsilon e^{1-\varepsilon} A(\Sigma)^{1-\varepsilon} \right)^{\frac{1}{1-\varepsilon}}$$

Note that the share of material spending allocated to domestic inputs is

$$s_D \equiv \frac{p_D z_D}{p_D z_D + m_I} = Q(\Sigma; e)^{\varepsilon-1} \beta^\varepsilon \left(p_D/q_D \right)^{1-\varepsilon}$$

Thus, an increase in e, that is a real depreciation that makes all foreign inputs more expensive, tends to increase the price of materials Q, and to increase the domestic share.

Since input prices are common across countries, there is a strict ranking of source countries by their quality q_c. This implies that the firm will import from countries with quality higher than a cutoff quality level, which I denote by $\bar{q}$. In other words, the choice of the optimal sourcing strategy reduces to the choice of a scalar, i.e. $\Sigma = [\bar{q}, \infty)$. This property, together with the assumption that q_c is distributed Pareto, implies that the price index of the foreign bundle is:

$$A(\Sigma)^{1-\kappa} = p^{*1-\kappa} \frac{\xi q_{min}^\xi}{(1+\xi-\kappa)} \bar{q}^{\kappa-\xi-1},$$

if $\kappa - \xi - 1 < 0$. Letting $n \equiv P(q \geq \bar{q})$ be the mass of countries in the sourcing set, one can show that:

$$\bar{q} = q_{min} n^{-\frac{1}{\xi}} \text{ and } A(\Sigma) = z n^{-\eta},$$

where

$$z \equiv \frac{p^*}{q_{min}} \left(\frac{\xi}{1+\xi-\kappa} \right)^{1-\kappa} \text{ and } \eta \equiv \frac{1+\xi-\kappa}{\xi(\kappa-1)} > 0$$

With this structure for the set of imported inputs, the cost function becomes:

$$C(y, \varphi_i, n) \quad = \quad \varphi_i^{-1} \left(\frac{w}{1-\gamma} \right)^{1-\gamma} \left(\frac{p_D}{\gamma \beta^{\frac{\varepsilon}{\varepsilon-1}} q_D} \right)^{\gamma} \left(1 + \left(\frac{1-\beta}{\beta} \right)^\varepsilon e^{1-\varepsilon} \left(\frac{p_D}{q_D z} n^\eta \right)^{\varepsilon-1} \right)^{-\frac{\gamma}{\varepsilon-1}} y.$$

The domestic share is linked to the sourcing strategy n by

$$s_D \quad = \quad \left(1 + \left(\frac{1-\beta}{\beta} \right)^\varepsilon e^{1-\varepsilon} \left(p_D/q_D \right)^{\varepsilon-1} z^{1-\varepsilon} n^{\eta(\varepsilon-1)} \right)^{-1}. \tag{11}$$

[43] The derivations of the expressions in this section follow closely Blaum et al. (2016) and are therefore omitted.

Hence, the extensive margin of importing can be represented by the domestic expenditure share. Normalizing the wage to unity, we can express firm $i's$ unit cost as a function of its domestic share:

$$u_i = \varphi_i^{-1} \left(\frac{1}{1-\gamma} \right)^{1-\gamma} \left(\frac{p_D}{\gamma \beta^{\frac{\varepsilon}{\varepsilon-1}} q_D} \right)^{\gamma} s_{Di}^{\frac{\gamma}{\varepsilon-1}} \tag{12}$$

Export Decisions by Market given Export Status and Unit Cost. We now work out the export participation decisions for all destinations, as well as pricing and quantity decisions in all locations given the input sourcing strategy, summarized by the unit cost u_i, as well as the export status. Domestic variable profits, excluding any fixed costs from input sourcing, are:

$$\pi_{Di}^{v} = \max_{p_i} (p_i - u_i) \, p_i^{-\sigma} P^{\sigma-1} S_D$$

Standard calculations imply the usual constant markup pricing rule:

$$p_i = \frac{\sigma}{\sigma - 1} u_i \tag{13}$$

and domestic revenue and variable profits:

$$R_{Di} = \left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma} u_i^{1-\sigma} P^{\sigma-1} S_D$$

$$\pi_{Di}^{v} = \sigma^{-\sigma} (\sigma - 1)^{\sigma-1} u_i^{1-\sigma} P^{\sigma-1} S_D.$$

Consider now the optimal price and quantity decision conditional on being an exporter and exporting to market j:

$$\pi_{ij}^{v} = \max_{p_{ij}} (e p_{ij} - (1+\tau) \, u_i) \, p_{ij}^{-\sigma} b_j.$$

Standard calculations imply the price in local currency is set to be a constant markup over the marginal cost:

$$e p_{ij} = \frac{\sigma}{\sigma - 1} (1+\tau) \, u_i,$$

with associated revenue and variable profits from market j given by

$$R_{Xj} = e^{\sigma} \left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma} (1+\tau)^{1-\sigma} u_i^{1-\sigma} b_j$$

$$\pi_{ij}^{v} = R_{Xj}/\sigma = e^{\sigma} \sigma^{-\sigma} (\sigma-1)^{\sigma-1} (1+\tau)^{1-\sigma} u_i^{1-\sigma} b_j.$$

Conditional on being an exporter, exporting to market j is optimal if $\pi_{ij}^{v} > f_{Xi}$, which reduces to:

$$b_j > \underbrace{e^{-\sigma} \sigma^{\sigma} (\sigma-1)^{1-\sigma} (1+\tau)^{\sigma-1} u_i^{\sigma-1} f_{Xi}}_{\equiv b^*(u_i)} \tag{14}$$

The optimal export strategy is to export to destinations where demand is higher than a threshold, which depends on the fixed cost of exporting and the unit cost. In this way, more efficient exporters (low f_{Xi}), as well as more efficient importers (low f_i) or overall more efficient firms (high φ_i), will tend to export to more destinations. Additionally, there is a complementarity between overall production efficiency, as captured by the unit cost, and the efficiency as an exporter which enter multiplicatively in the threshold function in (14).

In other words, the benefits from exporting to a given destination are larger for intense importers.

Export/Import Status and Sourcing Strategy. The choice of the optimal domestic share s_{Di} determines the countries to which the firm will export, as per (14), and hence total export revenue and profits. I first characterize the optimal domestic share s_{Di} conditional on the firm's import-export status. I then characterize the optimal choice of import-export status.

Since b_j is distributed Pareto with scale $\underline{b}$ and shape θ, the total revenue from exporting to countries $b_j > b^*(u_i)$, conditional on being an exporter, is given by:

$$\begin{aligned} R_{Xi} &= \int_{b^*}^{\infty} R_j \theta \underline{b}^{\theta} b^{-\theta-1} db && (15) \\ &= e^{\sigma}\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}(1+\tau)^{1-\sigma} u_i^{1-\sigma} \underline{b}^{\theta} \frac{\theta}{\theta-1} b^{*1-\theta}, && (16) \end{aligned}$$

where b^* depends on u_i according to (14) and u_i depends on s_D according to (12). Similarly, the profits from exporting, net of fixed costs f_X but excluding F_X,F_M or input-sourcing fixed costs, are:

$$\begin{aligned} \pi_{Xi} &\equiv \int_{b^*}^{\infty}\left(\pi_{ij}^{v} - f_X\right)\theta \underline{b}^{\theta} b^{-\theta-1} db \\ &= \frac{1}{\theta-1}\underline{b}^{\theta} e^{\theta\sigma}\sigma^{-\theta\sigma}(\sigma-1)^{\theta(\sigma-1)}(1+\tau)^{-\theta(\sigma-1)} u_i^{-\theta(\sigma-1)} f_{Xi}^{1-\theta}. \end{aligned}$$

The total profits from being an importer-exporter are:

$$\Pi_{XM} = \pi_D + \pi_X - fn - F_{XM},$$

where n is the input sourcing strategy and can be linked to s_D via (11). The profits of the importer-exporter can be written as:

$$\begin{aligned} \tilde{\Pi}_{XM} = {} & \beta^{\frac{\varepsilon}{\varepsilon-1}\gamma(\sigma-1)}\varphi_i^{\sigma-1} s_{Di}^{-\frac{\gamma}{\varepsilon-1}(\sigma-1)} + \tilde{f}_{Xi}^{1-\theta}\frac{1}{\theta}\beta^{\frac{\varepsilon}{\varepsilon-1}\theta(\sigma-1)\gamma}\varphi_i^{\theta(\sigma-1)} s_{Di}^{-\theta(\sigma-1)\frac{\gamma}{\varepsilon-1}} && (17) \\ & -\tilde{f}\gamma\eta(\sigma-1)\left(\frac{\beta}{1-\beta}\right)^{\frac{\varepsilon}{\eta(\varepsilon-1)}}\left(s_{Di}^{-1}-1\right)^{\frac{1}{\eta(\varepsilon-1)}} - \tilde{F}_{XM}, \end{aligned}$$

where the variables with tilde have been re-scaled by general equilibrium variables (S and P) and parameters - see Section 6.3 in the Appendix for a derivation of 17 and definitions of the re-scaled variables.[44] The firm chooses its optimal sourcing strategy s_D to maximize the expression in (17). It can be shown that the optimal domestic share conditional on exporting-importing, denoted by s_D^{XM}, is given by:

$$\begin{aligned} & (1-\beta)^{\frac{1}{\eta}\frac{\varepsilon}{\varepsilon-1}}\beta^{\frac{1}{\eta}\frac{\varepsilon}{\varepsilon-1}(\eta\gamma(\sigma-1)-1)}\varphi^{\sigma-1} s_D^{\frac{1}{\eta}\frac{1}{\varepsilon-1}(1-\eta\gamma(\sigma-1))}(1-s_D)^{1-\frac{1}{\eta(\varepsilon-1)}} && (18) \\ & + (1-\beta)^{\frac{1}{\eta}\frac{\varepsilon}{\varepsilon-1}}\beta^{\frac{1}{\eta}\frac{\varepsilon}{\varepsilon-1}(\theta\eta\gamma(\sigma-1)-1)}\varphi^{\theta(\sigma-1)} s_D^{\frac{1}{\eta(\varepsilon-1)}(1-\theta\eta\gamma(\sigma-1))}(1-s_D)^{1-\frac{1}{\eta(\varepsilon-1)}}\tilde{f}_X^{1-\theta} \\ & = \tilde{f}_M, \end{aligned}$$

[44] For example, the re-scaled fixed cost of importing are given by:

$$\tilde{f} \equiv \frac{1}{\gamma}\frac{1}{\eta}\left(\frac{1}{1-\gamma}\right)^{(1-\gamma)(\sigma-1)}\left(\frac{p_D}{\gamma q_D}\right)^{\gamma(\sigma-1)}\frac{\sigma^{\sigma}}{(\sigma-1)^{\sigma}}\left(\frac{q_D}{p_D}\right)^{\frac{1}{\eta}} z^{\frac{1}{\eta}} e^{\frac{1}{\eta}} P^{1-\sigma} S_D^{-1} f.$$

Analog expressions for $\tilde{f}_X, \tilde{F}_{XM}, \tilde{F}_M, \tilde{F}_X, \tilde{\Pi}_{XM}, \tilde{\Pi}_{XM}, \tilde{\Pi}_{XM}$, as well as all derivations, are contained in Section 6.3 in the Appendix.

The remaining import-export strategies can be studied as special cases of (17)-(18). For example, the profits of a firm that only imports are given by (17) when $f_X \to +\infty$ and $\tilde{F}_X$ is omitted:

$$\tilde{\Pi}_M = \beta^{\frac{\varepsilon}{\varepsilon-1}\gamma(\sigma-1)}\varphi^{\sigma-1}s_{Di}^{-\frac{\gamma}{\varepsilon-1}(\sigma-1)} - \tilde{f}\gamma\eta\left(\sigma-1\right)\left(\frac{\beta}{1-\beta}\right)^{\frac{\varepsilon}{\eta(\varepsilon-1)}}\left(s_D^{-1}-1\right)^{\frac{1}{\eta(\varepsilon-1)}} - \tilde{F}_M.$$

The profits when the firm only exports are given by (17) with $s_D = 1$ and omitting $\tilde{F}_M$:

$$\tilde{\Pi}_X = \beta^{\frac{\varepsilon}{\varepsilon-1}\gamma(\sigma-1)}\varphi^{\sigma-1} + \tilde{f}_X^{1-\theta}\frac{1}{\theta}\beta^{\frac{\varepsilon}{\varepsilon-1}\theta(\sigma-1)\gamma}\varphi^{\theta(\sigma-1)} - \tilde{F}_X.$$

Likewise, the profits of being purely domestic are:

$$\tilde{\Pi}_D = \beta^{\frac{\varepsilon}{\varepsilon-1}\gamma(\sigma-1)}\varphi^{\sigma-1}$$

The firm selects the import-export status that yields the highest profits:

$$\pi = \max\left\{\tilde{\Pi}_D, \tilde{\Pi}_X, \tilde{\Pi}_M, \tilde{\Pi}_{XM}\right\}. \tag{19}$$

3.3 Equilibrium, Prices and Welfare

To close the model, we assume that (i) the supply of foreign inputs is perfectly elastic at price p_c^* and (ii) all fixed costs are in units of labor. The equilibrium is defined as follows. Given a real exchange rate e, foreign input prices $[p_c]$, and a level of transfers T, an equilibrium is a wage w, a set of local and export prices for all export destinations $[p_i, p_{ij}]$, differentiated product quantities for home and all export destinations $[c_i = x_i, x_{ij}]$, labor demands for production and fixed costs $\left[l_i, l_i^F\right]$, domestic and international input demands by local firms $[y_{vi}], [z_{ci}]$ and sourcing strategies $[n_i]$ such that:

1. Firms maximize profits,
2. Consumers maximize utility given in (8) subject to

$$\int_i p_i c_i di = wL + \int_i \pi_i di + T,$$

   where π_i is given by (19).

3. Labor and good markets clear

$$L = \int_i l_i di + \int_{i\in M}\left(f_i n_i + F_M\right)di + \int_{i\in X}\left(f_{Xi}n_{Xi} + F_X\right)di$$
$$+\int_{i\in XM}\left(f_i n_i + f_{Xi}n_{Xi} + F_X + F_M\right)di,$$
$$y_i = c_i + R_{Xi} + \int_\nu y_{vi}dv.$$

where R_{Xi} is firm i's export revenue, given by (15), M, X and XM are the sets of importers-only, exporters-only, and importer-exporters, respectively, l_i is labor demand by firm i, n_{Xi} is the mass of countries to which firm i exports, and L is the inelastic labor supply. The trade balance is determined residually by:

$$TB = \int_i R_{Xi} di - \int_i (1 - s_{Di}) m_i di.$$

The following two results characterize the consumer price index and welfare.

Proposition 1. *Given firms' domestic expenditure shares $[s_{Di}]$, the domestic price index associated with preferences in (8) can be expressed as:*

$$P = \left(\frac{\sigma}{\sigma-1}\right)^{\frac{1}{1-\gamma}} (1-\gamma)^{-1} \left(\gamma \beta^{\frac{\varepsilon}{\varepsilon-1}} q_D\right)^{-\frac{\gamma}{1-\gamma}} \left(\int_i \varphi_i^{\sigma-1} s_{Di}^{\frac{\gamma}{\varepsilon-1}(1-\sigma)} di\right)^{-\frac{1}{(1-\gamma)(\sigma-1)}}. \tag{20}$$

Proof. The result follows from combining the expression for the unit cost in (12), the pricing rule in (13), and the definition of the price index $P^{1-\sigma} = \int_i p_i^{1-\sigma} di$. □

Proposition 2. *Given firms' import and export shares (s_{Di}, s_{Xi}), as well as re-scaled fixed costs $(\tilde{f}_i, \tilde{f}_{Xi}, \tilde{F}_M, \tilde{F}_X, \tilde{F}_{XM})$, consumer income I is given by*

$$I = (L+T)\left(\frac{1 - \gamma\frac{(\sigma-1)}{\sigma}\int_i s_{Di}\omega_{Di}di - \gamma\frac{(\sigma-1)}{\sigma}\kappa_1 \Gamma P^{(\sigma-1)(1-\gamma)}}{1 - \frac{1}{\sigma} - \gamma\frac{(\sigma-1)}{\sigma}\int_i s_{Di}\omega_{Di}di - \frac{1}{\sigma}\kappa_1 \Upsilon P^{(\sigma-1)(1-\gamma)} - \gamma\frac{(\sigma-1)}{\sigma}\kappa_1 \Gamma P^{(\sigma-1)(1-\gamma)} + \Psi P^{(\sigma-1)(1-\gamma)}}\right).$$

where Γ, Υ, and Ψ are functions of firms' import and export shares

$$\Upsilon = \int_i \varphi_i^{\sigma-1} \frac{s_{Xi}}{1-s_{Xi}} s_{Di}^{\frac{\gamma}{\varepsilon-1}(1-\sigma)} di$$

$$\Gamma = \int_i \varphi_i^{\sigma-1} \frac{s_{Xi}}{1-s_{Xi}} s_{Di}^{1+\frac{\gamma}{\varepsilon-1}(1-\sigma)} di$$

$$\Psi \equiv \int_i \left(\kappa_2 \left(s_{Di}^{-1} - 1\right)^{\frac{1}{\eta(\varepsilon-1)}} \tilde{f}_i + \kappa_3 \left(\frac{\theta-1}{\theta}\right)\left(\frac{s_{Xi}}{1-s_{Xi}}\right)^{\frac{\theta}{\theta-1}} \tilde{f}_{Xi} + \kappa_3 \mathbb{I}_{Mi}\hat{F}_M + \kappa_3 \mathbb{I}_{Xi}\hat{F}_X + \kappa_3 \mathbb{I}_{XMi}\hat{F}_{XM}\right) di$$

and κ_1, κ_2 and κ_3 are constants determined by model parameters defined in (30), (33) and (34) below. Consumer welfare is given by I/P where P is given by (20).

Proof. See Section (6.5) of the Appendix. □

Section 6.5 in the Appendix contains a description of the algorithm used to solve for the equilibrium the model.

4 Quantitative Exercise

In this Section, I calibrate the model of joint importing-exporting outlined above to salient features of the Mexican micro data pre-devaluation. In particular, I target moments of the joint distribution of firm size, import and export intensities.

To generate rich distributions in the model, I allow for three dimensions of firm heterogeneity: efficiency φ_i, and fixed costs of importing f_i and exporting f_{Xi}. I assume that these variables are jointly log-normal, with means $\mu_\varphi, \mu_{f_c}, \mu_{f_x}$, variances $\sigma_\varphi^2, \sigma_{f_c}^2, \sigma_{f_x}^2$, and correlations $\rho_{\varphi f_c}, \rho_{\varphi f_x}$ and $\rho_{f_c f_x}$.[45] I choose these parameters

[45] These parameters refer to moments on the log of the corresponding variables. For example, $\mu_{f_c} \equiv \mathbb{E}[log(f_c)]$, $\sigma_{f_c}^2 \equiv \mathbb{V}[log(f_c)]$ and $\rho_{\varphi f_c} \equiv Corr(log(f_c), log(\varphi))$. I normalize mean efficiency to unity, so that $\mu_\varphi = \sigma_\varphi^2/2$.

to match the following moments of the Mexican pre-devaluation Manufacturing sector: the aggregate import and export share, the dispersion in firm size (as measured by value added share), the dispersion in import and export intensities, as well as their correlation, the correlation between firm value added and import intensity, and the fractions of importers, exporters and importer-exporters. The values for σ, ε,γ, and η are taken from Blaum et al. (2016) and summarized in Table 21 in the Appendix.[46] I set $\theta = 1.03$ to match the growth in total exports of 110% between 1994-1999 in Mexico. Table 8 below contains the results of the calibration.

Parameter		Targeted Moment		
Description	Value	Description	Model	Data
Average importing fixed cost (μ_{f_M})	-0.44	Aggregate Import Share	0.36	0.36
Average exporting fixed cost (μ_{f_X})	104.93	Aggregate Export Share	0.16	0.16
Fixed cost import status (F_M)	0.01	Fraction Importers	0.25	0.25
Fixed cost export status (F_X)	0.019	Fraction Exporters	0.07	0.07
Fixed cost import-export (F_{XM})	0.02	Fraction Importer-Exporters	0.17	0.17
Dispersion in efficiency (σ_φ)	0.61	Dispersion va	1.71	1.71
Dispersion in importing fixed costs (σ_{f_M})	3.15	Dispersion s_i	0.27	0.27
Dispersion in exporting fixed costs (σ_{f_X})	71.63	Dispersion s_x	0.18	0.18
Correlation efficiency - importing fixed cost ($\rho_{\varphi f_M}$)	0.86	Correlation $va - s_i$	0.27	0.27
Correlation efficiency - exporting fixed cost ($\rho_{\varphi f_x}$)	0.48	Correlation $va - s_x$	0.15	0.15
Correlation importing - exporting fixed costs ($\rho_{f_M f_x}$)	0.19	Correlation s_i -s_x	0.18	0.18

Notes: Value added is always computed in logs. s_I denotes the import share and corresponds to $1 - s_D$ in the text.

Table 8: Model with Importing-Exporting: Calibration to Mexican Micro Data

The Effect of a Devaluation. I now explore the effect of counterfactual depreciations in the real exchange rate of 5, 10 and 20 percent. In the model, an increase in e is isomorphic to a uniform increase in the fixed cost of importing f together with a uniform decrease in the fixed cost of exporting f_X for all firms.[47] It is therefore clear that a real depreciation induces firms to export more and at the same time reduces the incentive to source inputs from abroad. Table 9 contains the effects of the devaluations for the model counterfactuals and the actual Mexican experience between 1994-1999. In what follows, I focus on the 20 percent real depreciation which is about the change experienced in Mexico.[48] We see that the calibrated model generates an increase in the aggregate import share of about 6.08 percentage points. While this amount is short of the 17.7 percent increase in Mexico, we note that it is line with the within-sector increase in import intensity documented above -see Table 19.

The devaluation also induces an increase in the aggregate export share, a decrease in the fraction of importers, and an increase in the fractions of exporters and importers-exporters, both in the model and in the

[46] I normalize $\underline{b} = 1$ and $\beta = 0.5$.

[47] This can be seen formally from the definition of the re-scaled fixed costs, which depend on e:

$$\tilde{f} \equiv \frac{1}{\gamma}\frac{1}{\eta}\left(\frac{1}{1-\gamma}\right)^{(1-\gamma)(\sigma-1)}\left(\frac{p_D}{\gamma q_D}\right)^{\gamma(\sigma-1)}\frac{\sigma^\sigma}{(\sigma-1)^\sigma}\left(\frac{q_D}{p_D}\right)^{\frac{1}{\eta}} z^{\frac{1}{\eta}} e^{\frac{1}{\eta}} P^{1-\sigma} S_D^{-1} f$$

$$\tilde{f}_X^{1-\tilde{\theta}} \equiv P^{(1-\sigma)} S_D^{-1} \frac{\tilde{\theta}}{\tilde{\theta}-1} \underline{b}^{\tilde{\theta}} e^{\tilde{\theta}\sigma} \sigma^{-\sigma(\tilde{\theta}-1)} (\sigma-1)^{(\tilde{\theta}-1)(\sigma-1)} \times$$
$$\times \left(\frac{1}{1-\gamma}\right)^{(\sigma-1)(1-\gamma)(1-\tilde{\theta})} \left(\frac{p_D}{\gamma q_D}\right)^{(\sigma-1)\gamma(1-\tilde{\theta})} (1+\tau)^{-\tilde{\theta}(\sigma-1)} f_X^{1-\tilde{\theta}}$$

[48] I change the exogenous deficit parameter D to match the observed reduction in the trade deficit as a share of absorption in Mexico. The trade deficit is reduced by about 9 percentage points of domestic absorption both in the model and data - see Table 22 in the Appendix.

Depreciation of ...	Within	Between	Covariance	Net Entry	Total
... 5%	-0.52	1.12	0.04	0.05	0.69
... 10%	-1.01	2.91	0.13	0.08	2.12
... 20%	-1.97	7.39	0.49	0.16	6.08
Mexico 94-99	-2.79	9.99	4.27	6.24	17.70

Notes: The Table contains the Baily et al. (1992) decomposition in (2) performed on model-generated data of counterfactual devaluations, for the model with importing and exporting as calibrated in Table 8. All entries are in percentage points.

Table 10: Accounting for the Increase in Aggregate Import Intensity: Counterfactual Data

data. Quantitatively, the model underpredicts the increase in the export share and the fall in the fraction of importers, and over predicts the increase in the fractions of exporters and importers-exporters.

In terms of normative implications, the model predicts an increase in the ideal consumer price index of about 5.8 percent. The increase in consumer income associated with the enhanced exporting opportunities is sufficient to offset the higher price index, resulting in an increase in welfare of 0.30 percentage points.

	Depreciation of ...			Mexico
Rate of growth in ...	5%	10%	20%	94-99
Aggregate Import Share	0.69	2.12	**6.08**	17.7
Aggregate Export Share	15.60	32.34	66.19	78.36
Fraction Importers	-3.70	-7.16	-14.26	-37.42
Fraction Exporters	9.98	19.32	38.24	27.25
Fraction Importer-Exporters	10.98	22.14	44.43	35.45
Price Index	1.63	3.13	**5.80**	-
Welfare	-0.25	-0.28	0.30	-

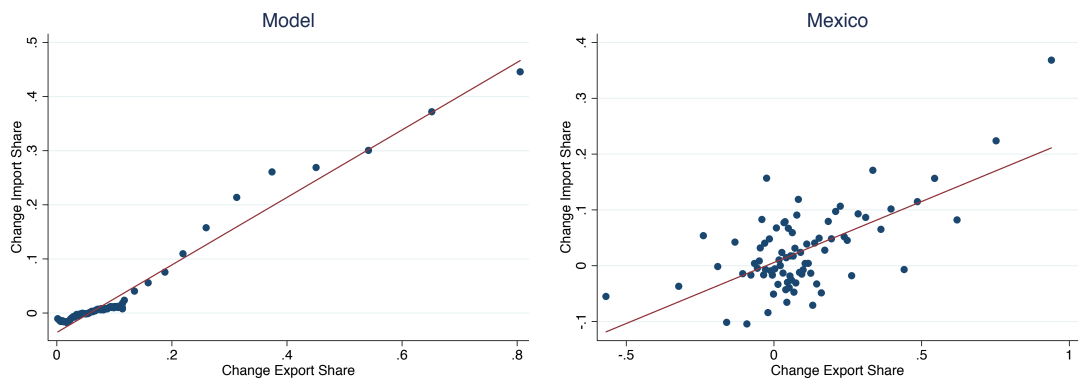
Table 9: Effects of a Devaluation

To better understand the mechanics of the model, I decompose the increase in the aggregate import share using the methodology in (2). Table 10 contains the results. The third and fourth rows correspond to the 20 percent model devaluation and the Mexican experience between 1994-1999, respectively. The model generates a within component that is negative and of similar magnitude that in the data.[49] Importantly, the model generates compositional effects that are in line with the data: the between and covariance terms are both positive and jointly contribute to an increase in the aggregate import share of about 8 percentage points. Note that the between component is positive whenever the firms that are initially very import intensive tend to expand. The covariance term is positive whenever the firms which become more import intensive tend to be the ones that expand. Both of these effects are present in the model generated data, and have empirical support in the Mexican micro data. Finally, the contribution of net entry in the model is positive but very small. In the data, however, this is an important margin.[50]

Figure 8 below depicts a scatter plot of the changes in the import and export intensities associated with the 20 percent real devaluation in the model. We see that the firms that increase their export intensity tend to increase their import intensity as well, consistent with the pattern seen for Mexican manufacturing firms,

[49] This suggests that the estimate of the elasticity of substitution between domestic and foreign inputs, ε, taken from Blaum et al. (2016), may be appropriate for the Mexican manufacturing sector.

[50] Recall that entry and exit are defined relative to the importing status. In the data, I cannot measure entry (exit) into (out of) the economy, as survey of Mexican manufacturing excludes small firms.



Notes: The Figure depicts changes in export and import intensities associated with the 20 percent counterfactual devaluation of Table 9.Only firms with non-zero changes are included.

Figure 8: Expanding Importers and Exporters in Counterfactual Devaluation: Model vs Data

reproduced in the right panel. Quantitatively, the model predicts a tighter relationship between changes in import and export shares than observed in the Mexican episode.

A Model with Only Importing. In this section, I show that a model with importing only cannot come to terms with the facts of Section 2 above. The standard model with importing only, as in Gopinath and Neiman (2014); Halpern et al. (2015); Blaum et al. (2016), corresponds to the framework in Section 3 with prohibitively large costs of exporting, $F_X \to +\infty$. I recalibrate the model with importing only to a subset of the moments targeted above, namely: the aggregate import share, the fractions of importers, the dispersions of value added and import intensity, and their correlation. Table 11 contains the results of the calibration. Table 13 contains the effect of the counterfactual devaluations of 5, 10 and 20 percent. We see that, across all scenarios, the aggregate import share falls. In the 20 percent depreciation, the aggregate import share falls by about 15 percent and the consumer price index increases by 7.9 percent. Thus, we conclude that the model with importing-only over predicts the increase in the consumer price index by about 35%.

To uncover the mechanics of the importing-only model, I decompose the change in the aggregate import share following the methodology in (2). Table 13 contains the results. We see that the model with importing-only is consistent with the within-firm decrease in import intensity observed in the data - see the negative within component. However, the model predicts reallocations that are inconsistent with the data. In particular, it predicts that firms that are initially import intensive tend to contract, as evidenced by the negative between component, a feature that is at odds with the Mexican data. Because initially import intensive firms are on average more productive, this pattern of reallocation explains why the model predicts a large impact of the devaluation on the consumer price index.[51]

The pattern of reallocation of the model can also be seen graphically. To illustrate the importance of the between effect, Figure 9 depicts the changes in firm size by quartile of initial import intensity. More precisely, for each quartile of initial import intensity, the figure depicts the 25th, 50th and 75th percentiles of the distribution of growth in the material share m_i. In the model with importing-only, depicted in the upper left panel, there is a stark pattern of reallocation: firms with initially high import intensity lose market share, while those with low initial import intensity expand. Intuitively, the initial import intensity measures

[51] Finally, we note that, like the model with importing-exporting, the model of importing-only predicts a role of net entry that is much smaller that in the data.

Parameter		Targeted Moment		
Description	Value	Description	Model	Data
Average importing fixed cost (μ_{f_c})	1.659	Aggregate Import Share	0.36	0.35
Fixed cost import status (F_M)	0.112	Fraction Importers	0.42	0.42
Dispersion in efficiency (σ_φ)	0.636	Dispersion va	1.71	1.71
Dispersion in importing fixed costs (σ_{f_c})	3.678	Dispersion s_i	0.27	0.27
Correlation efficiency - importing fixed cost ($\rho_{\varphi f_c}$)	0.896	Correlation $va - s_i$	0.27	0.27

Notes: The dispersion in value added is the standard deviation of the log of value added. The dispersion in import shares is the standard deviation of import shares. The correlation of value added and import shares is the coefficient of correlation between log value added and import shares (in levels).

Table 11: Model with Importing-Only: Calibration to Mexican Data

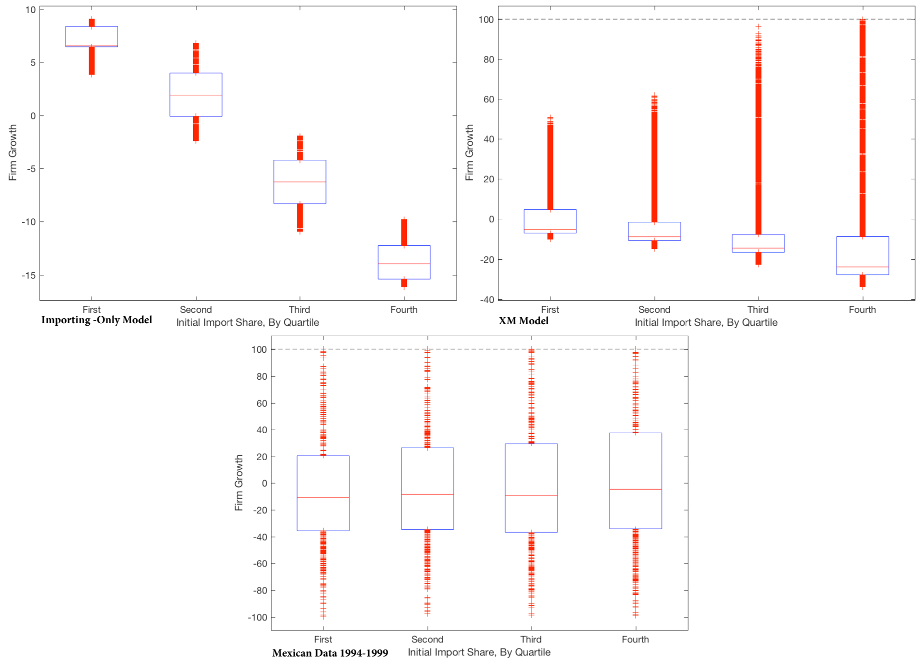
	Increase in RER of ...			Mexico
Rate of growth in ...	5%	10%	20%	94-99
Aggregate Import Share	-3.98	-7.79	-14.97	17.7
Aggregate Export Share	-	-	-	78.36
Fraction Importers	-0.37	-0.68	-1.53	-37.42
Fraction Exporters	-	-	-	27.25
Fraction Importer-Exporters	-	-	-	35.45
Price Index	2.10	4.11	7.89	-
Welfare	-1.40	-2.67	-4.87	-

Table 12: Model of Importing-Only: Effects of a Devaluation

Increase in RER of ...	Within	Between	Covariance	Entry	Exit	Total
... 5%	-0.35	-3.61	0	0	0.02	-3.98
... 10%	-0.69	-7.07	0.01	0	0.04	-7.79
... 20%	-1.36	-13.57	0.04	0	0.08	-14.97
Mexico 94-99	-2.79	9.99	4.27	13.53	7.30	17.70

Notes: The Table contains the Baily et al. (1992) decomposition in (2) performed on model-generated data of counterfactual devaluations. All entries are in percentage points.

Table 13: Models of Importing-Only: Decomposition of Increase in Import Share



Notes: Each panel depicts the growth rate in firm size, measured as $(m_{i2} - m_{i1})/m_{i1} \times 100$ where m_{it} is the share of firm i in total industry materials in period t, by quartile of initial import intensity s_{i1}. The vertical edges of the each box correspond to the 25th and 75th percentile of firm growth. The red line inside the box represents the median. The points outside the box represent outliers, defined as any observation greater than the 75th percentile or smaller than the 25th. The upper panels depict data generated by a 20 percent counterfactual devaluation in the model with importing-only (left panel) and importing-exporting (right panel). The bottom panel corresponds to the Mexican data between 1994-1999.

Figure 9: Pattern of reallocation: Models vs Data

the degree of exposure of the firm to the cost shock induced by the devaluation.

In contrast, the pattern of reallocation in the model with importing-exporting is more nuanced, as seen in the upper right panel of Figure 9. While there is a tendency for the median and 25th percentile growth rate to decrease with initial import intensity, there is much more heterogeneity, with some firms growing and some contracting within each quartile of initial import intensity.[52] Finally, the bottom panel of Figure 9 depicts the pattern of reallocation in the Mexican data for the 1994-1999 period. The data displays a much stronger degree of heterogeneity, with a positive 75th percentile and a negative 25th percentile growth rate in all quartiles. We conclude the pattern of reallocation in the model with importing-exporting is closer to the pattern seen in the data than the one generated by the importing only model.

5 Conclusions

International input sourcing decisions have significant effects on firm and aggregate productivity. When the real exchange rate changes, firms' importing responses are therefore important to understand how aggregate productivity is affected. At the same time, the real exchange rate is an important determinant of firms' decisions to sell abroad vs. domestically. In this paper, I have argued that these two phenomena cannot be studied separately. Firms' international sourcing and exporting strategies are intimately linked, as the benefits from importing are larger when the firm exports and vice versa. Focusing on the case of large devaluations, I have argued that incorporating this complementarity into the analysis significantly affects our understanding

[52] In fact, note that, within the highest quartile of initial import intensity, the 75th percentile of firm growth is positive.

of the effect of large crises on aggregate productivity.

The starting point of the analysis is the realization that the aggregate import intensity tends to increase after large real depreciations. I have documented this fact in a sample of ten recent events of large devaluations in emerging market economies. This fact cannot be reconciled with standard theories of importing, which typically feature large estimates of the elasticity of substitution between domestic and foreign inputs. Using micro data for the cases of Mexico and Indonesia, I have shown that the increase in the aggregate import intensity is accounted by the expansion and entry of import-intensive firms, which tend to be expanding exporters.

I have proposed a theory of joint importing-exporting where foreign inputs are a vehicle to reduce unit costs and exporting is a means to expand demand. A complementarity between both international activities arises naturally as profits are multiplicative in unit costs and the size of demand. I allow for multiple sources of firm heterogeneity (efficiency, fixed costs of importing and exporting) and calibrate the model to salient moments of the joint distribution of import and export intensities in the Mexican pre-devaluation economy. I also consider a version of the model where firms do not have an exporting decision, as in the literature. In the model without exporting, the devaluation generates an increase in the consumer price index that is larger than the one predicted by the model with importing-exporting. This suggests that accounting for firms' joint importing-exporting behavior is important to understand the aggregate consequences of changes in the real exchange rate.

References

Albornoz, F. and E. G. Lembergman (2015). Importing after Exporting. Technical report.

Alessandria, G., S. Pratap, and V. Z. Yue (2015). Export Dynamics in Large Devaluations.

Amiti, M., O. Itskhoki, and J. Konings (2014). Importers, exporters, and exchange rate disconnect. *American Economic Review 104*(7), 1942–78.

Amiti, M. and J. Konings (2007). Trade liberalization, intermediate inputs, and productivity: Evidence from Indonesia. *The American Economic Review 97*(5), 1611–1638.

Antras, P., T. C. Fort, and F. Tintelnot (2017). The Margins of Global Sourcing: Theory and Evidence from US Firms. *American Economic Review 107*(9).

Backus, D. K., P. J. Kehoe, and F. E. Kydland (1994). Dynamics of the Trade Balance and the Terms of Trade: The J-Curve? *The American Economic Review 84*(0), 84–103.

Baily, M. N., C. Hulten, D. Campbell, T. Bresnahan, and R. E. Caves (1992). Productivity Dynamics in Manufacturing Plants. *Brookings Papers on Economic Activity. Microeconomics 1992*, 187.

Basu, S., J. G. Fernald, and M. S. Kimball (2006). Are Technology Improvements Contractionary? *The American Economic Review 96*(5), 1418–1448.

Bernard, A., J. Eaton, J. B. Jensen, and S. Kortum (2003). Plants and productivity in international trade. *American Economic Review 93*(4), 1268–1290.

Bernard, A. B., J. B. Jensen, S. J. Redding, and P. K. Schott (2007). Firms in international trade. *The Journal of Economic Perspectives 21*(3), 105–130.

Blaum, J., C. Lelarge, and M. Peters (2013). Non-Homothetic Import Demand: Firm Productivity and Quality Bias. *Unpublished paper*.

Blaum, J., C. Lelarge, and M. Peters (2016). THE GAINS FROM INPUT TRADE WITH HETEROGENEOUS IMPORTERS.

Broda, C. and D. E. Weinstein (2006). Globalization and the gains from varieties. *Quarterly Journal of Economics 121*(2), 541–585.

Caliendo, L. and F. Parro (2014). Estimates of the Trade and Welfare Effects of NAFTA. *The Review of Economic Studies*, rdu035.

Costinot, A. and A. Rodríguez-Clare (2014). Trade theory with numbers: Quantifying the consequences of globalization. In *Handbook of International Economics*.

Eaton, J. and S. Kortum (2002). Technology, geography, and trade. *Econometrica 70*(5), 1741–1779.

Eaton, J., S. Kortum, and F. Kramarz (2011). An Anatomy of International Trade: Evidence From French Firms. *Econometrica 79*(5), 1453–1498.

Fieler, A. C., M. Eslava, and D. Xu (2017). Trade, Skills, and Quality Upgrading: A Theory with Evidence from Colombia. *American Economic Review*.

Gallaway, M. P., C. A. McDaniel, and S. A. Rivera (2003). Short-run and long-run industry-level estimates of US Armington elasticities. *The North American Journal of Economics and Finance 14*(1), 49–68.

Goldberg, P., A. Khandelwal, N. Pavcnik, and P. Topalova (2010). Imported intermediate inputs and domestic product growth: Evidence from india. *Quarterly Journal of Economics 125*(4), 1727–1767.

Goldstein, M. and M. S. Khan (1985). Income and price effects in foreign trade. In *Handbook of International Economics*, Volume 2, pp. 1041–1105. Elsevier.

Gopinath, G. and B. Neiman (2014). Trade Adjustment and Productivity in Large Crises. *The American Economic Review 104*(3), 793–831.

Halpern, L., M. Koren, and A. Szeidl (2015, December). Imported Inputs and Productivity. *American Economic Review 105*(12), 3660–3703.

Heathcote, J. and F. Perri (2002). Financial autarky and international business cycles. *Journal of Monetary Economics 49*(3), 601–627.

Johnson, R. C. and G. Noguera (2016). A portrait of trade in value added over four decades. *Review of Economics and Statistics* (0).

Korinek, A. and E. G. Mendoza (2014, August). From Sudden Stops to Fisherian Deflation: Quantitative Theory and Policy. *Annual Review of Economics 6*(1), 299–332.

Laeven, L. and F. Valencia (2012). Systemic banking crises database: An update.

Lapham, B. and H. Kasahara (2013). Productivity and the decision to import and export: Theory and evidence. *Journal of International Economics 89*(2), 297–316.

Marquez, J. (2013). *Estimating trade elasticities*, Volume 39. Springer Science & Business Media.

Melitz, M. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica 71*(6), 1695–1725.

Mendoza, E. G. (2006). Endogenous sudden stops in a business cycle model with collateral constraints: a Fisherian deflation of Tobin's Q. Technical report, National Bureau of Economic Research.

Mendoza, E. G. (2010, December). Sudden Stops, Financial Crises, and Leverage. *American Economic Review 100*(5), 1941–1966.

Mendoza, E. G. and V. Z. Yue (2012, May). A General Equilibrium Model of Sovereign Default and Business Cycles. *The Quarterly Journal of Economics 127*(2), 889–946.

Meza, F. and E. Quintin (2007). Factor utilization and the real impact of financial crises. *The BE Journal of Macroeconomics 7*(1).

Pavcnik, N. (2002). Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants. *The Review of Economic Studies 69*(1), 245–276.

Ramanarayanan, A. (2017). Imported Inputs and the Gains from Trade. Technical report, Citeseer.

Reinhart, C. M. and K. S. Rogoff (2011). From financial crash to debt crisis. *The American Economic Review 101*(5), 1676–1706.

Simonovska, I. and M. E. Waugh (2014). The elasticity of trade: Estimates and evidence. *Journal of international Economics 92*(1), 34–50.

Timmer, M. P., E. Dietzenbacher, B. Los, R. Stehrer, and G. J. de Vries (2015, August). An Illustrated User Guide to the World Input-Output Database: the Case of Global Automotive Production: User Guide to World Input-Output Database. *Review of International Economics 23*(3), 575–605.

OECD		Non-OECD	
Australia	Japan	Argentina	Philippines
Austria	Korea	Bulgaria	Romania
Belgium	Luxembourg	Brazil	Russian Federation
Canada	Mexico	Brunei	Saudi Arabia
Chile	Netherlands	China	Singapore
Czech Republic	New Zealand	Colombia	Thailand
Denmark	Norway	Costa Rica	Tunisia
Estonia	Poland	Cyprus	Chinese Taipei
Finland	Portugal	Hong Kong	Vietnam
France	Slovak Republic	Croatia	South Africa
Germany	Slovenia	Indonesia	
Greece	Spain	India	
Hungary	Sweden	Cambodia	
Iceland	Switzerland	Lithuania	
Ireland	Turkey	Latvia	
Israel	United Kingdom	Malta	
Italy	United States	Malaysia	

Table 14: Countries in OECD Input Output Tables

Australia	Estonia	Japan	Romania
Austria	Finland	South	Russia
Belgium	France	Latvia	Slovak
Brazil	Germany	Lithuania	Slovenia
Bulgaria	Greece	Luxembourg	Spain
Canada	Hungary	Malta	Sweden
China	India	Mexico	Taiwan
Cyprus	Indonesia	The	Turkey
Czech	Ireland	Poland	UK
Denmark	Italy	Portugal	USA

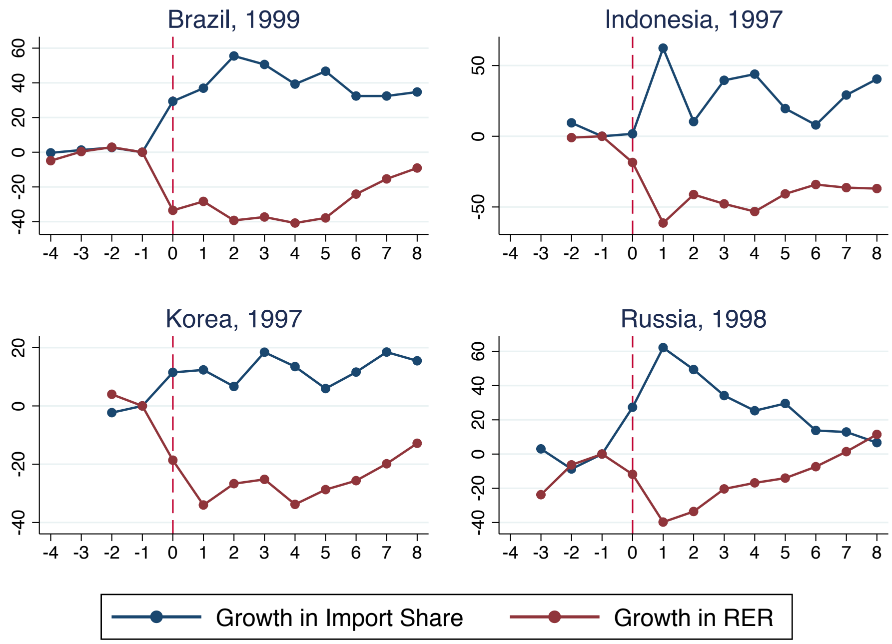
Table 15: Countries in WIOD

6 Appendix

6.1 Additional Figures and Tables

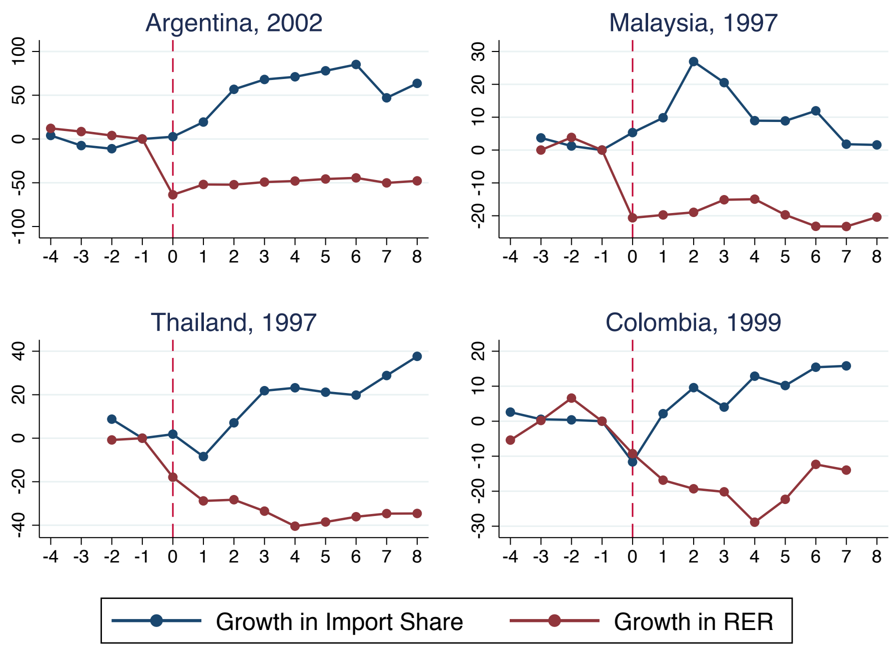
Notes: The Figure depicts the rate of growth of an index of import volume (left axis) and of real GDP (right axis) between a given quarter and the quarter before the devaluation (labeled -1). The quarter of the devaluation is labeled 0. Data for the volume of imports is available only for Argentina, Brazil, Korea, Thailand and Turkey. The import volume index is the ratio of the import value index to the unit value index. A log-linear trend was removed from the real output series, as well as the import volume series. The trend was calculated for each country using the full sample starting in 1960. Source: IFS and UNCTAD.

Figure 10: Import Volume and Real GDP after a Large Devaluation



Notes: The Figure depicts the rate of growth in the ratio of imported inputs to total (imported plus domestic) inputs between a given year and the year before the devaluation (labeled -1). The year of the devaluation is labeled 0. Source: WIOD.

Figure 11: Aggregate Import Share After Devaluations, By Country, Recent Events



Notes: The Figure depicts the rate of growth in the ratio of imported inputs to total (imported plus domestic) inputs between a given year and the year before the devaluation (labeled -1). The year of the devaluation is labeled 0. Source: OECD.

Figure 12: Aggregate Import Share After Devaluations, By Country (ctd), Recent Events

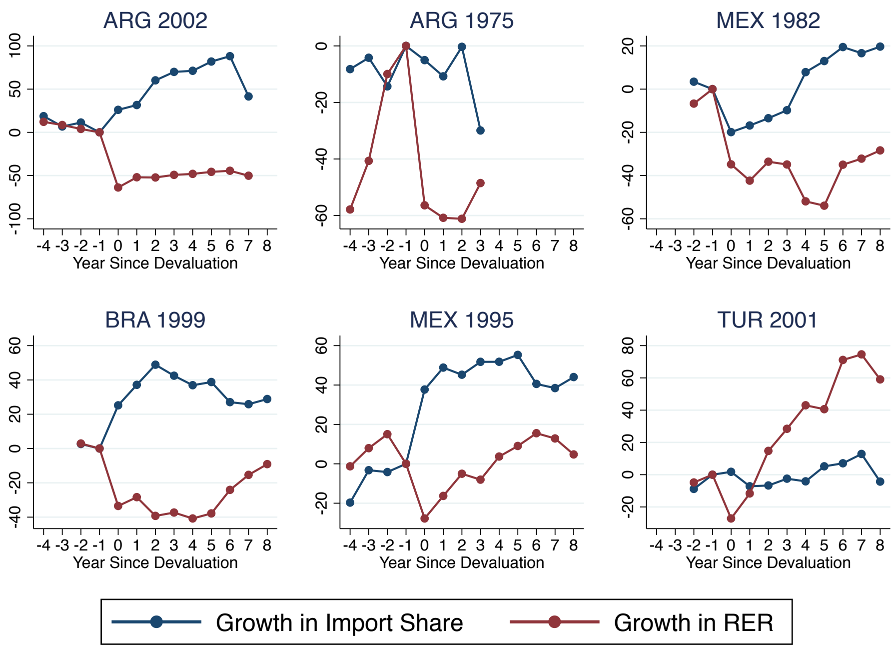


Figure 13: Aggregate Imported Input Share, By Country, Large Sample

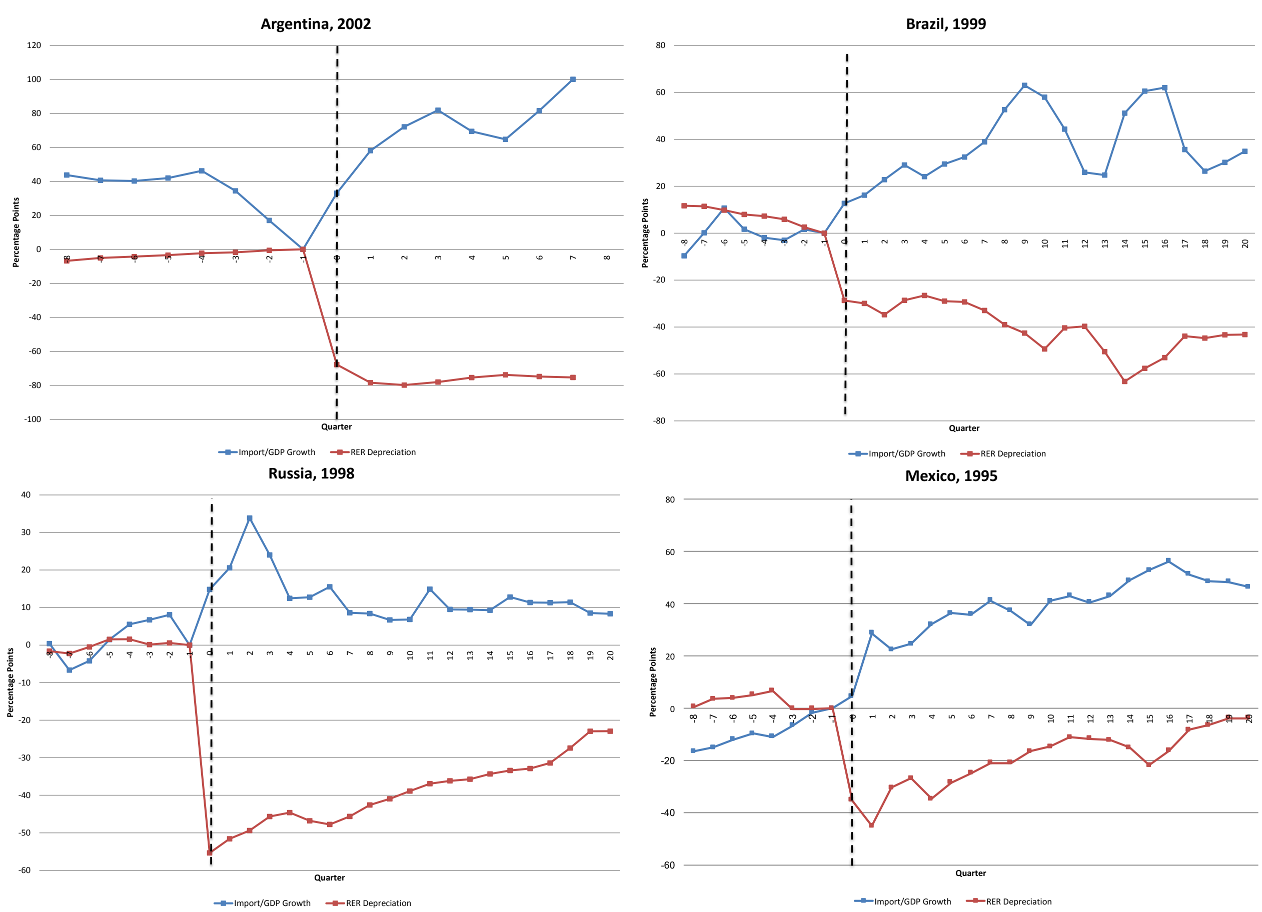


Figure 19: Imports to GDP Ratio After Large Devaluations, By Country

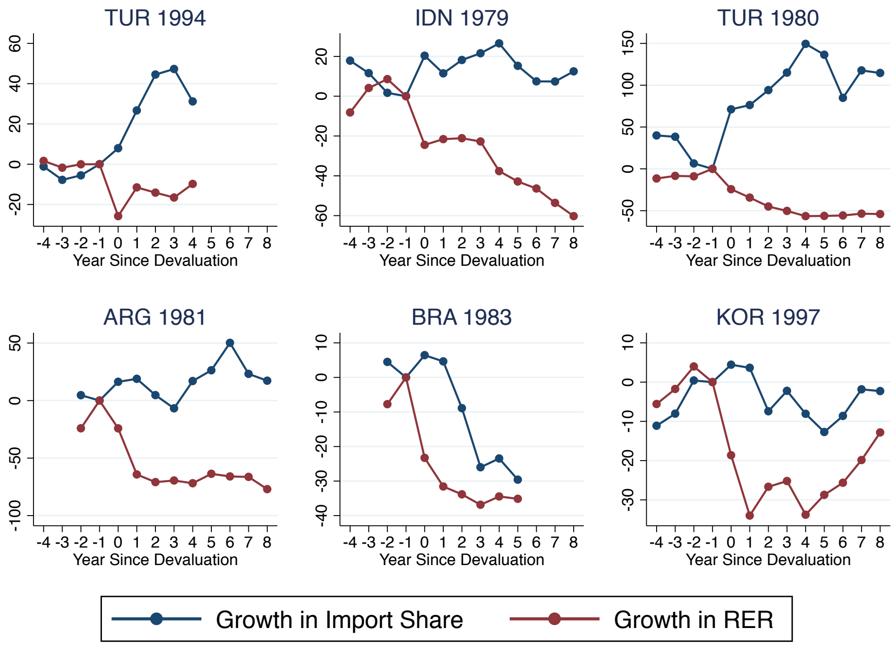


Figure 14: Aggregate Imported Input Share, By Country, Large Sample

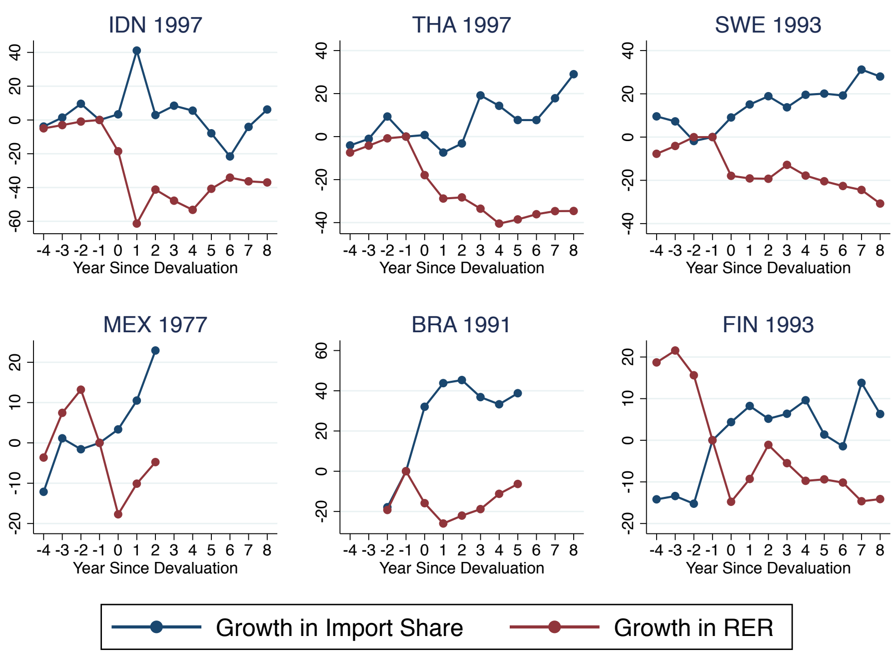


Figure 15: Aggregate Imported Input Share, By Country, Large Sample

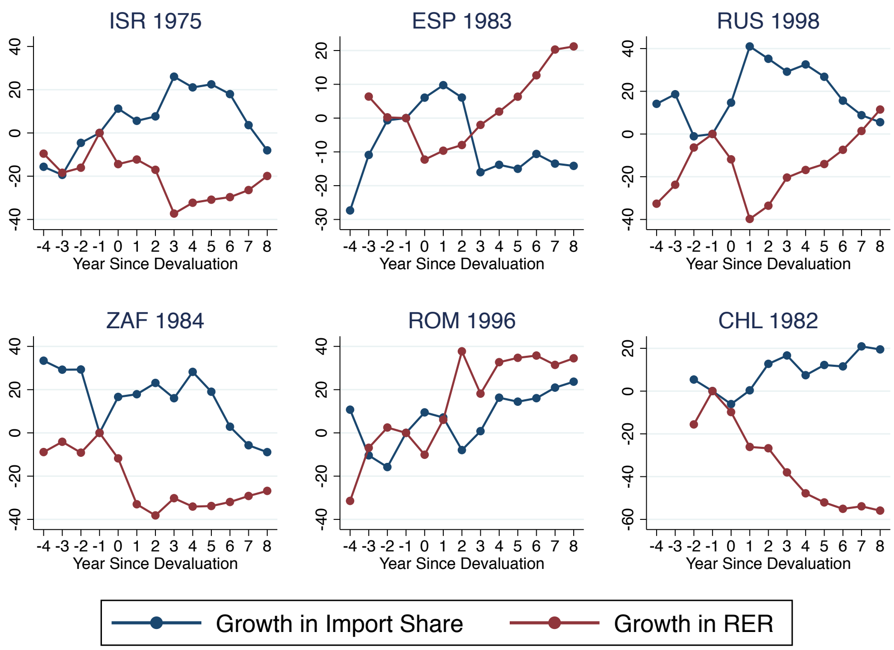


Figure 16: Aggregate Imported Input Share, By Country, Large Sample

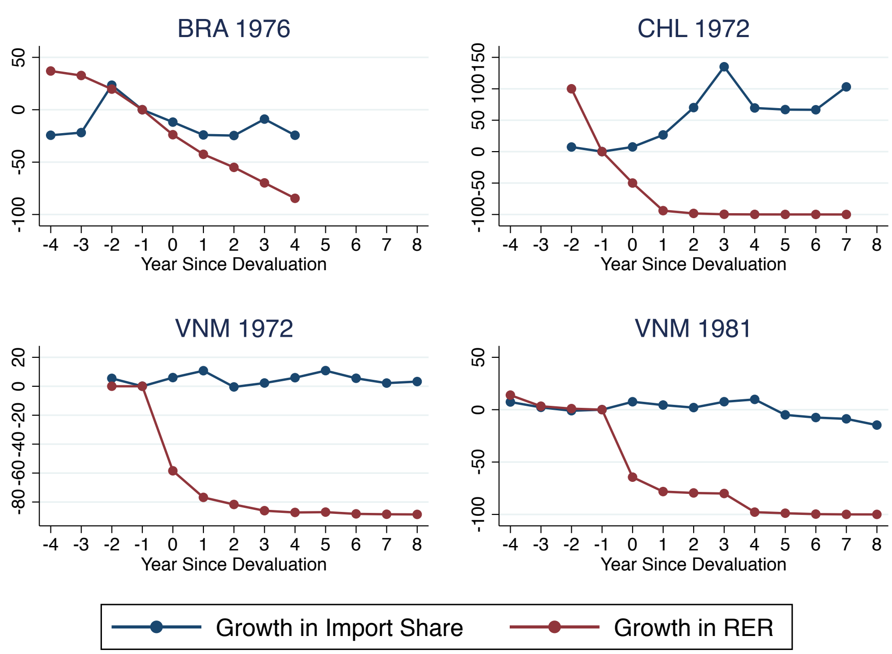
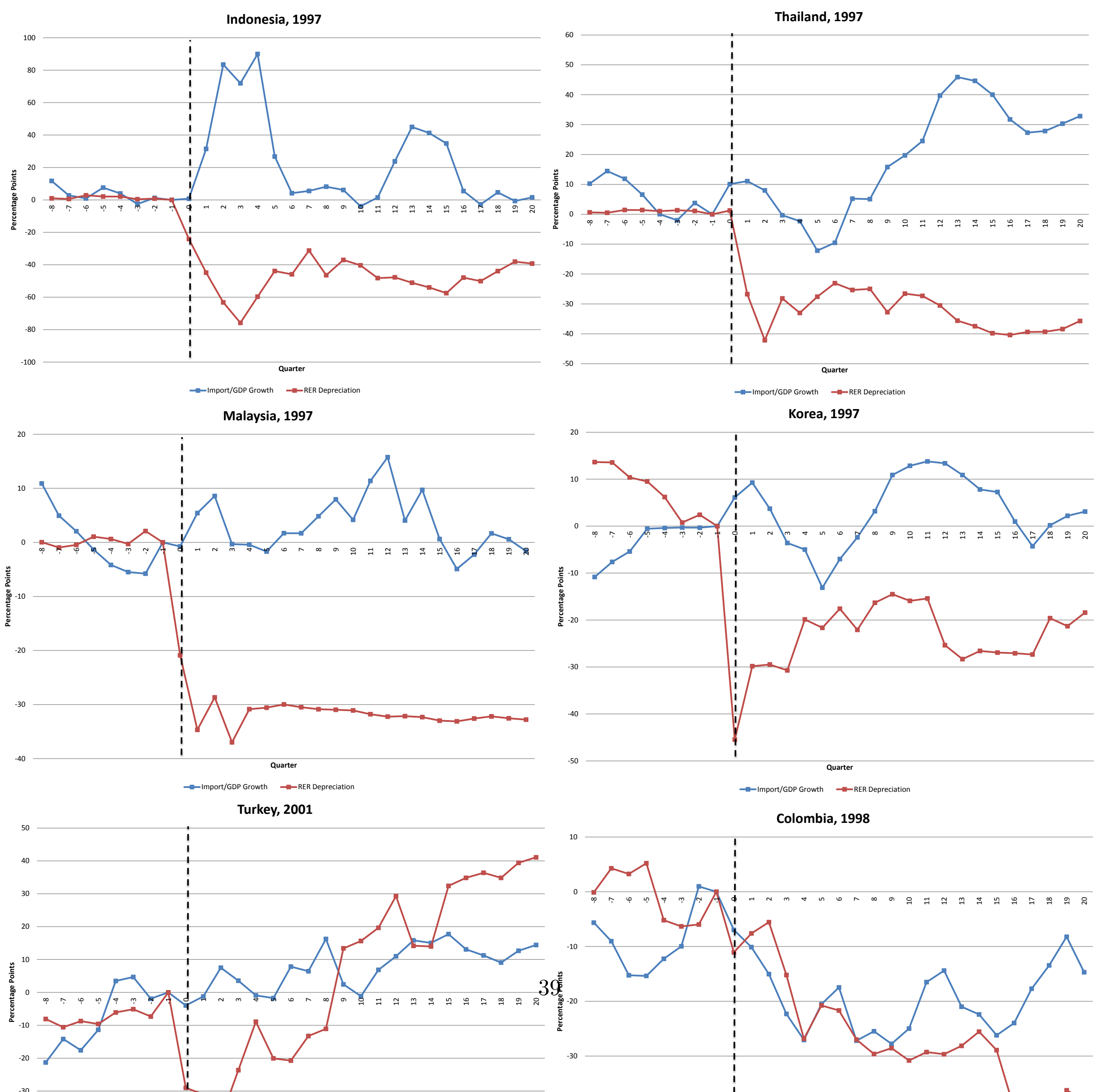


Figure 17: Aggregate Imported Input Share, By Country, Large Sample

Notes: The blue line is the rate of growth in the aggregate imported input share between a given year and the year before the devaluation (labeled -1). The year of the devaluation is labeled 0. The red line depicts the rate of growth in the real exchange rate. The lines in the Figure are averages of the experiences of the episodes in Table 1. The dashed lines give standard errors of the corresponding average (i.e. the standard deviation divided by the square root of the sample size). Sources: Johnson and Noguera (2016), IFS.

Figure 18: Output and TFP After Large Devaluation, Extended Sample



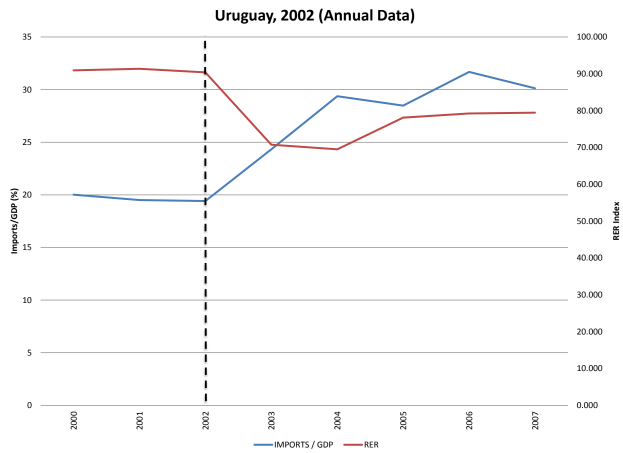
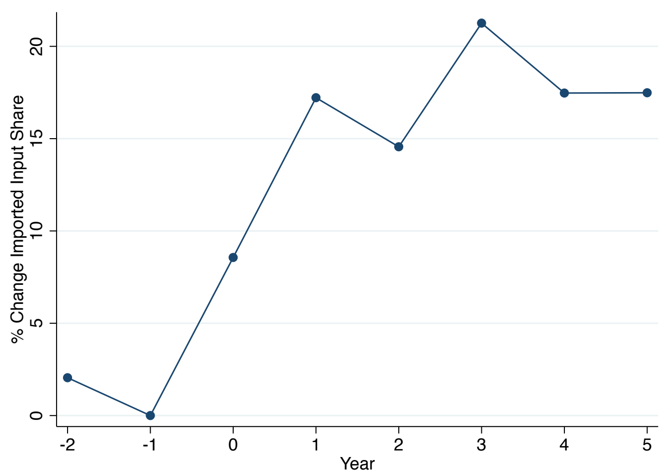
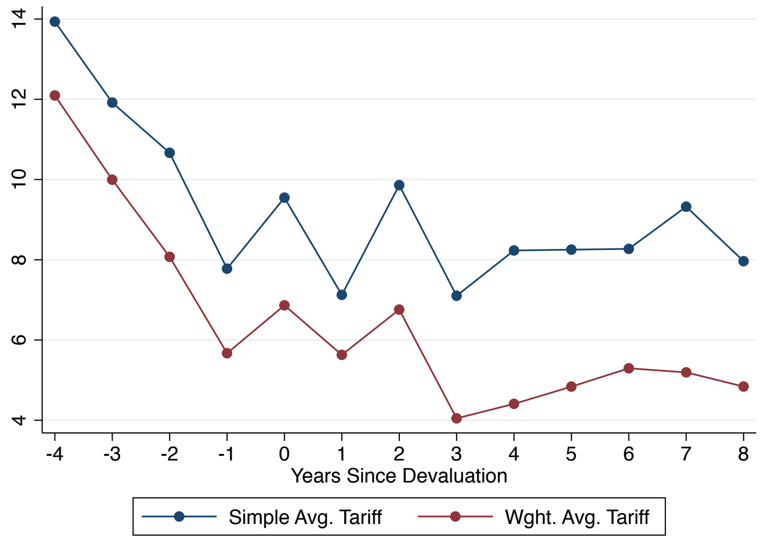


Figure 21: Imports to GDP Ratio, Uruguay



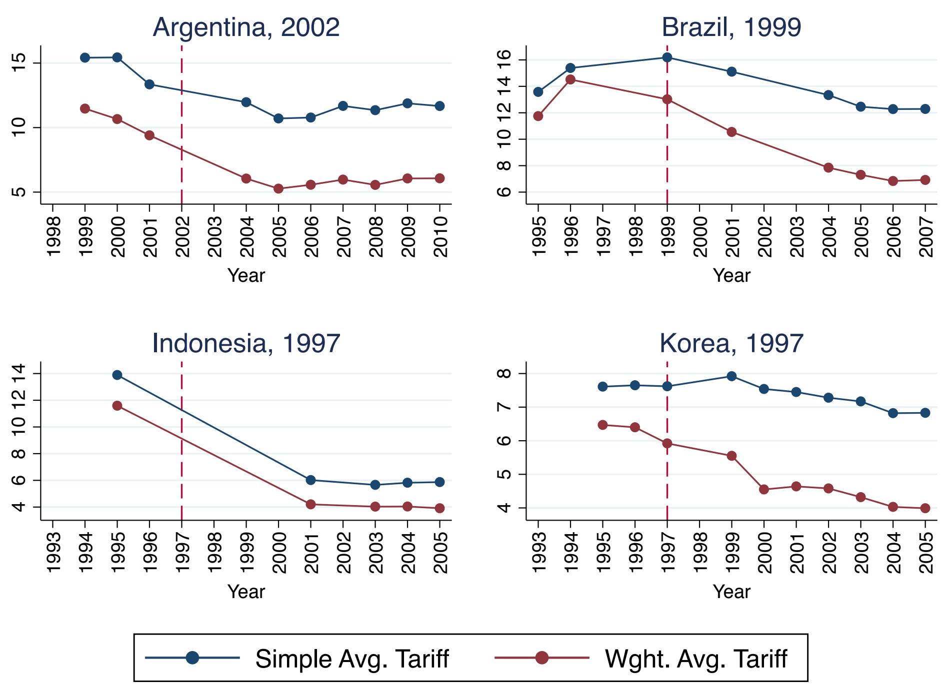
Notes: The Figure depicts the rate of growth in the ratio of imported inputs to total (imported plus domestic) inputs in the Manufacturing sector between a given year and the year before the devaluation (labeled -1). The year of the devaluation is labeled 0. The lines in the Figure is an average of the experiences of Brazil 1998, Indonesia 1998, Korea 1997, Russia 1998 and Turkey 2001. Source: WIOD.

Figure 22: The Aggregate Import Share After a Large Devaluation: Manufacturing Sector



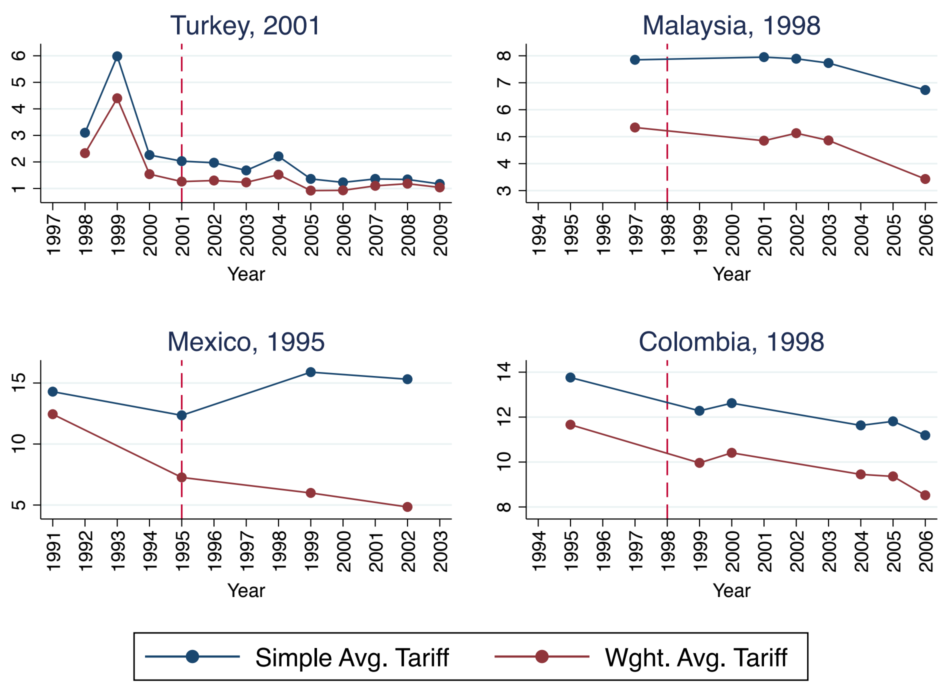
Notes: The Figure depicts the average ad valorem tariff rate (in percentage points) in the sample of countries of Table 2. The tariff rate is the effectively applied rate (i.e. the lowest available tariff) for non-agricultural products. "Simple Avg. Tariff" denotes that products are averaged with a simple average for each country. "Wght. Avg. Tariff" denotes an import-value weighted average across products for each country. The year of the devaluation is labeled 0. Source: WITS-TRAINS.

Figure 23: Tariffs After Devaluations



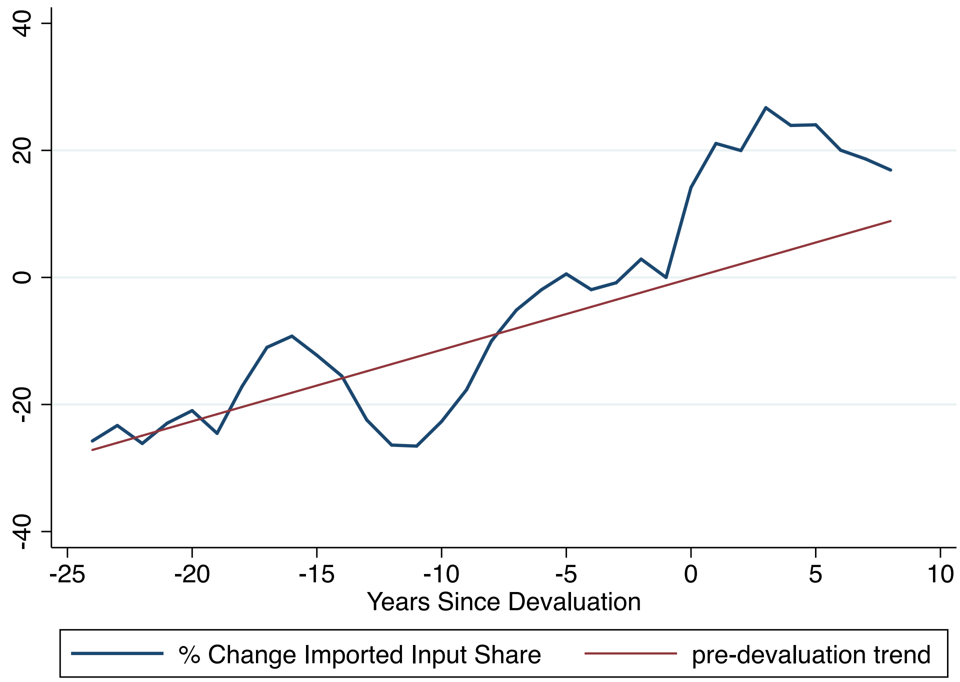
Notes: The Figure depicts the average ad valorem tariff rate (in percentage points) in the sample of countries of Table 2. The tariff rate is the effectively applied rate (i.e. the lowest available tariff) for non-agricultural products. "Simple Avg. Tariff" denotes that products are averaged with a simple average for each country. "Wght. Avg. Tariff" denotes an import-value weighted average across products for each country. The year of the devaluation is labeled 0. Source: World Development Indicators.

Figure 24: Tariffs After Devaluations, By Country



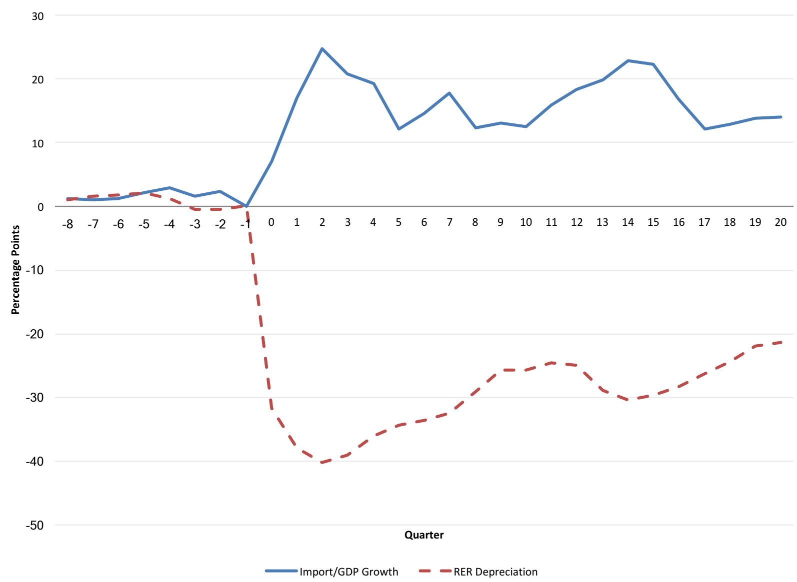
Notes: The Figure depicts the average ad valorem tariff rate (in percentage points) in the sample of countries of Table 2. The tariff rate is the effectively applied rate (i.e. the lowest available tariff) for non-agricultural products. "Simple Avg. Tariff" denotes that products are averaged with a simple average for each country. "Wght. Avg. Tariff" denotes an import-value weighted average across products for each country. The year of the devaluation is labeled 0. Source: World Development Indicators.

Figure 25: Tariffs After Devaluations, By Country (ctd)



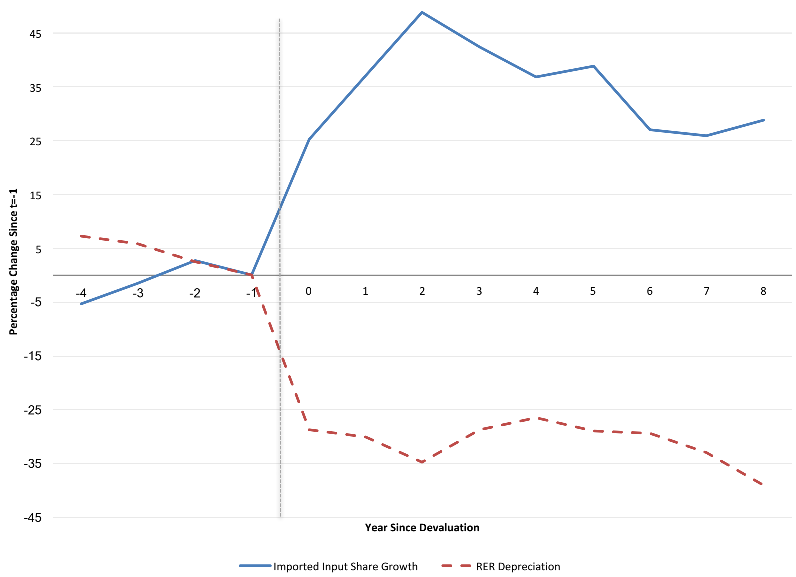
Notes: The Figure depicts the average ad valorem tariff rate (in percentage points) in the sample of countries of Table 2. For each country, the tariff rates is a simple average of the effectively applied rates for all products. The year of the devaluation is labeled 0. Source: World Development Indicators.

Figure 26: Aggregate Imported Input Share: Long Pre-Devaluation Period



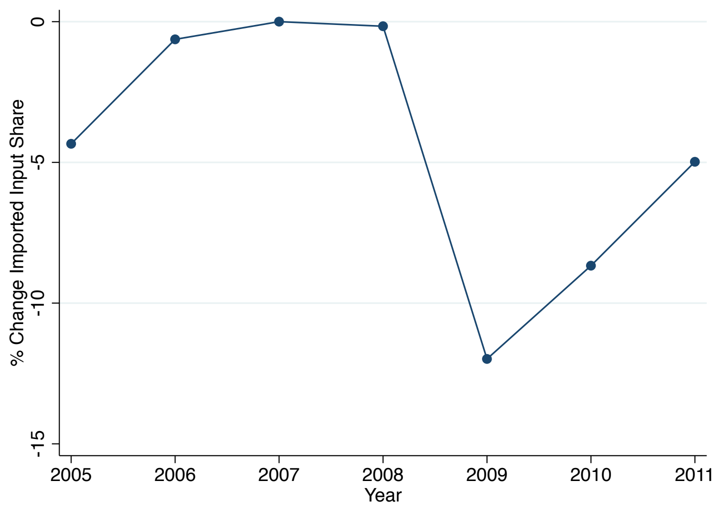
Notes: The blue line is the rate of growth in the ratio of total imports to GDP between a given quarter and the quarter before the devaluation (labeled -1). The quarter of the devaluation is labeled 0. The red line depicts the rate of growth in the real exchange rate. The lines in the Figure are averages of the experiences of Argentina in 2001, Brazil 1998, Colombia 1998, Indonesia 1998, Korea 1997, Malaysia 1997, Mexico 1994, Russia 1998, Thailand 1997 and Turkey 2001. Source: IFS.

Figure 27: Imports-to-GDP ratio After a Large Devaluation



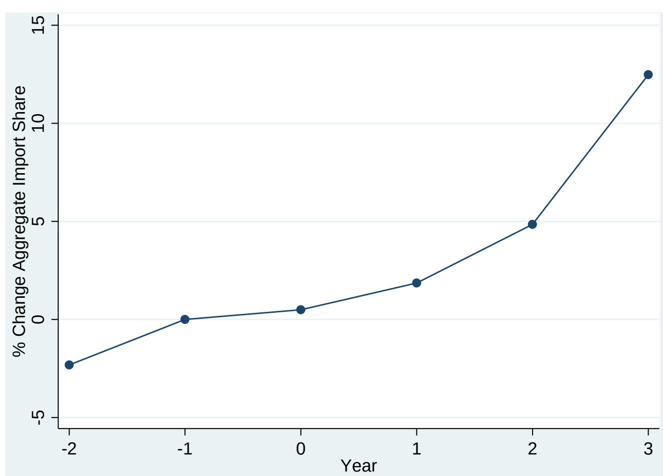
Notes: The blue line is the rate of growth in the aggregate imported input share between a given year and the year before the devaluation (labeled -1). The year of the devaluation was 1999 and is labeled 0. The red line depicts the rate of growth in the real exchange rate. Sources: Johnson and Noguera (2016), IFS.

Figure 28: Aggregate Imported Input Share After Brazilian Devaluation



Notes: The blue line is the rate of growth in the aggregate imported input share between a given year and the year before the financial crisis (i.e. 2007, labeled -1). The year of the financial crisis was 2008 and is labeled 0. The graph depicts the average experience of Austria, Belgium, Denmark, France Germany, Greece, Hungary, Ireland, Latvia, Luxembourg, Netherlands, Portugal, Russia, Slovenia, Spain, Sweden. Source: WIOD.

Figure 29: Aggregate Imported Input Share After Financial Crises of 2008



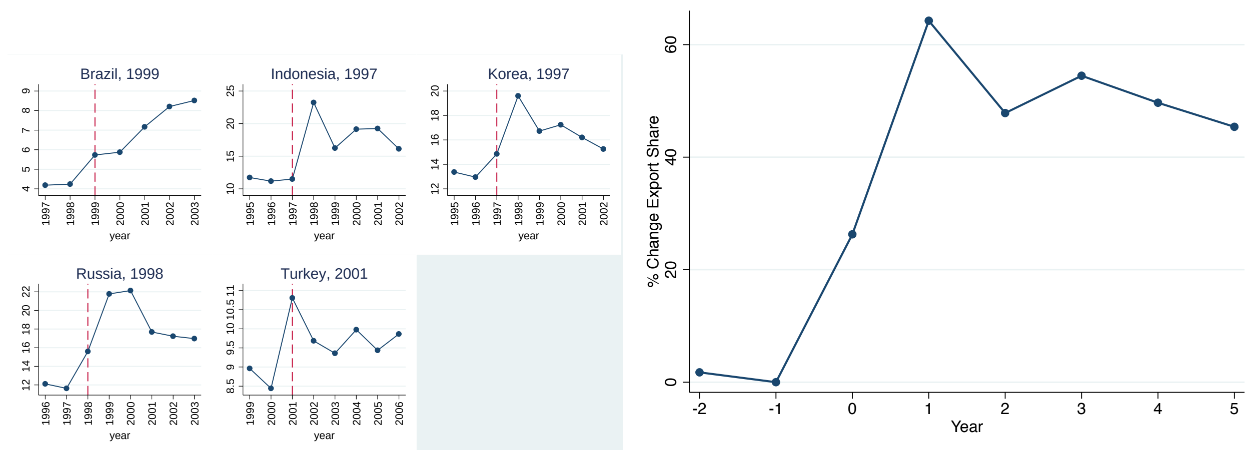
Notes: The Figure shows the rate of growth in the ratio of total imported materials to total materials (imported plus domestic) between a given year and 1997 (labeled -1) for the Manufacturing sector in Indonesia. Source: Survey of Manufacturing, SI.

Figure 30: The Aggregate Import Share in Manufacturing after the Indonesian Devaluation

Dep. var. $log(m_{ct})$	(1)	(2)	(3)
$deva_{ct}$	0.09***	0.11***	
	(0.01)	(0.01)	
τ_{ct}		-0.75***	-0.72***
		(0.13)	(0.19)
$log(RER_{ct})$			-0.08***
			(0.03)
$log(RGDP_{ct})$	0.05***	0.25***	0.02
	(0.02)	(0.05)	(0.04)
Country FE	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes
Obs	4,909	3,191	2,228
R^2	0.21	0.21	0.26

Table 16: Imports-to-GDP ratio after Large Devaluations

Notes: The dependent variable is the log of the imports-to-GDP ratio. The sample contains the ten country episodes listed in Table 2 and data for eight quarters before and twenty quarters after the devaluation. Data for imports of goods and services, nominal GDP and the real exchange rate (RER) is from IFS. RER is the real effective exchange rate index (with lower values associated with a depreciated currency). The measure of tariffs (τ) is from WDI and corresponds to a weighted average across all products of applied tariff rates, at the yearly frequency. Robust standard errors in parenthesis with ***, ** and * respectively denoting significance at the 1%, 5% and 10% levels.



Notes: The Figures depicts the rate of growth in the ratio of foreign sales to total (imported plus domestic) sales between a given year and the year before the devaluation (labeled -1). of The year of the devaluation is labeled 0. The left panel depicts the individual episodes in Brazil, Indonesia, Korea, Russia and Turkey, while the right panel depicts the growth rate averaged over these five episodes. Source: WIOD.

Figure 31: The Aggregate Export Share After a Large Devaluation

Parameter	Value	Identified from
σ	3.83	Revenue/Cost Data
ε	2.38	Prod. Function Estimation
γ	0.61	Prod. Function Estimation
η	0.38	Dom Share and Ext. Margin

Notes: The parameters above are taken from Blaum, Lelarge and Peters (2016).

Table 21: Other Parameters

Country	Systemic Banking	Currency	Default
Argentina	1980, 1989, 1995, 2001	1975, 1981, 1987, 2002	1982, 2001
Austria	2008		
Belgium	2008		
Brazil	1990, 1994	1976, 1982, 1987, 1992, 1999	1983
Chile	1976, 1981	1972, 1982	1983
China	1998		
Czech Republic	1996		
Denmark	2008		
Finland	1991	1993	
France	2008		
Germany	2008		
Greece	2008	1983	2012
Hungary	1991, 2008		
India	1993		
Indonesia	1997	1979, 1998	1999
Ireland	2008		
Israel	1977	1975, 1980, 1985	
Italy	2008	1981	
Japan	1997		
Korea	1997	1998	
Mexico	1981, 1994	1977, 1982, 1995	1982
Netherlands	2008		
New Zealand		1984	
Norway	1991		
Poland	1992		1981
Portugal	2008	1983	
Romania	1990	1996	1982
Russia	1998, 2008	1998	1998
Slovak Republic	1998		
Slovenia	1992, 2008		
South Africa		1984	1985
Spain	1977, 2008	1983	
Sweden	1991, 2008	1993	
Switzerland	2008		
Thailand	1983, 1997	1998	
Turkey	1982, 2000	1978, 1984, 1991, 1996, 2001	1978
United Kingdom	2007		
United States	1988, 2007		
Vietnam	1997	1972, 1981, 1987	1985

Table 17: Episodes of Banking, Currency and Sovereign Debt Crises

Country	Year	Country	Year
Argentina	1975, 1987	New Zealand	1984
Brazil	1976, 1982,1987,1999	Portugal	1983
Greece	1983	Romania	1996
Indonesia	1979	Turkey	1978, 1991, 1996
Israel	1975, 1985	Vietnam	1972, 1981, 1987
Italy	1981	Spain	1983
Mexico	1977	South Africa	1984

Table 18: Episodes of Currency Crises Without Banking Crises

Year	Within	Between	All
1995	9.65	-0.71	8.95
1996	11.91	3.36	15.27
1997	12.23	7.27	19.50
1998	10.29	7.62	17.91
1999	8.90	8.80	17.70

Table 19: Change in Import Share: Sector Level Decomposition

Industry	$\Delta s_{AGGj}/s_{AGG94}$	m_{j94}	$\Delta m_j/s_{AGG94}$	s_{AGGj99}
31 - Food, Beverages, Tobacco	2.36	0.24	-13.20	0.18
32 - Textiles, Apparel, Leather	18.44	0.06	-3.86	0.28
33 - Wood and Wood Products	-22.13	0.01	-0.76	0.11
34 - Paper, Paper Products, Printing	2.19	0.05	-1.65	0.34
35 - Chemicals, Plastics Products	21.27	0.16	-4.07	0.45
36 - Mineral Products (Non-Metallic)	20.31	0.02	-1.48	0.22
37 - Basic Metal Industries	1.89	0.10	-0.12	0.17
38 - Metal Products, Machinery, Equipment	9.40	0.37	25.32	0.60
39 - Other Manufacturing Industries	5.60	0.00	-0.19	0.45

Table 20: Sector Level Decomposition, Within and Between Component

Notes: The first two columns display the within component in, while the last two columns display the between component. Source: Mexican Survey of Manufacturing.

6.2 Construction of aggregate TFP

In this section, I provide details on the construction of the aggregate total factor productivity measure used in Figure xx. I will use the subscript i to refer to countries and t to time throughout. Let $x_{it} \in \{L_t, K_t\}$ be the primary factors of production and y_{it} denote real GDP in country i. Let $\kappa^x_{i,t}$ be the share of input x in country i total factor use - for example, $\kappa^L_{i,t}$ refers to total labor compensation in country i divided by the sum of total labor and capital compensations. I measure the growth in TFP, denoted by z_{it}, by estimating:

Consider the following equation:

$$\log\left[\frac{y_{i,t}}{y_{i,t-1}}\right] = \gamma_i + \beta\left[\sum_{x\in\{K,L\}} \frac{1}{2}(\kappa^x_{i,t+}\kappa^x_{i,t-1})\left(\log\frac{x_{i,t}}{x_{i,t-1}}\right)\right] + \log\left(\frac{z_{i,t}}{z_{i,t-1}}\right) \tag{21}$$

at the country-level. Here γ_i captures a trend in TFP growth and β captures departures from constant returns

Increase in RER of 20%	Importing-Exporting		Importing-Only		Data	
	Before	After	Before	After	Before (1994)	After (1999)
Exports / Absorption	17.42	30.1	-	-	16.12	31.39
Imports / Absorption	22.42	25.42	22.19	15.87	16.95	23.08
Trade Balance / Absorption	-5	4.68	-22.19	-15.87	-0.83	8.32
Difference		9.68		6.32		9.15

Notes: The Table depicts the changes in exports, imports and the trade deficit as a percentage of domestic absorption resulting from the devaluation. Absorption is computed as total manufacturing sales minus total exports plus total imports. The first two columns correspond a 20 percent real depreciation in the calibrated model with importing-exporting. The third and fourth columns correspond to a similar depreciation in the model with importing-only. The last two columns correspond to the Mexican data. All values are in percentage points.

Table 22: Trade Deficit: Models vs Data

to scale. I employ data for all variables from Penn World Tables. For capital K, I use the value of the capital stock at constant national prices. I construct labor L by multiplying the total number of employees by the average number of hours and by the human capital index. Including the number of hours into the measure of labor helps address the concern of labor hoarding - see e.g. Meza and Quintin (2007). I use the labor share provided in Penn World Tables, and compute the capital share as the residual. For each country, I normalize TFP to unity in the initial period and compute

$$TFP_{i,t+1} = \left[1 + \log\left(\frac{z_{i,t}}{z_{i,t-1}}\right)\right] TFP_{i,t}.$$

6.3 Derivation of Firm Profits

In this section, I show that the problem of the firm can be solved independently of the general equilibrium variables (P, S) by appropriately rescaling the fixed costs as follows:

$$\tilde{f} \equiv \frac{1}{\gamma}\frac{1}{\eta}\left(\frac{1}{1-\gamma}\right)^{(1-\gamma)(\sigma-1)}\left(\frac{p_D}{\gamma q_D}\right)^{\gamma(\sigma-1)}\frac{\sigma^\sigma}{(\sigma-1)^\sigma}\left(\frac{q_D}{p_D}\right)^{\frac{1}{\eta}} z^{\frac{1}{\eta}} e^{\frac{1}{\eta}} P^{1-\sigma} S^{-1} f \tag{22}$$

$$\begin{aligned}\tilde{f}_X^{1-\theta} \equiv\ & P^{(1-\sigma)} S^{-1} \frac{\theta}{\theta-1} \underline{b}^\theta e^{\theta\sigma} \sigma^{-\sigma(\theta-1)} (\sigma-1)^{(\theta-1)(\sigma-1)} \times \\ & \times \left(\frac{1}{1-\gamma}\right)^{(\sigma-1)(1-\gamma)(1-\theta)} \left(\frac{p_D}{\gamma q_D}\right)^{(\sigma-1)\gamma(1-\theta)} (1+\tau)^{-\tilde{\theta}(\sigma-1)} f_X^{1-\theta}\end{aligned} \tag{23}$$

$$\tilde{F}_s \equiv \sigma^\sigma (\sigma-1)^{1-\sigma}\left(\frac{1}{1-\gamma}\right)^{(1-\gamma)(\sigma-1)}\left(\frac{p_D}{\gamma q_D}\right)^{\gamma(\sigma-1)} P^{1-\sigma} S^{-1} F_s \text{ for } s \in \{M, X, XM\}. \tag{24}$$

Re-scaled profits associated with strategy $s \in \{D, M, X, XM\}$ are given by

$$\tilde{\Pi}_s \equiv \frac{\Pi_s}{\sigma^{-\sigma}(\sigma-1)^{\sigma-1}\left(\frac{1}{1-\gamma}\right)^{-(1-\gamma)(\sigma-1)}\left(\frac{p_D}{\gamma q_D}\right)^{-\gamma(\sigma-1)} P^{\sigma-1} S_D},$$

where Π_s are firm profits associated with strategy s. I now show how the problem of the firm can be solved as a function of the re-scaled fixed costs in (22)-(24).

Consider the strategy of importing-exporting. Firm profits are given by the sum of domestic and export profits net of all fixed costs:

$$\begin{aligned}\Pi_{XM} &= \pi_D^v + \pi_X - fn - F_{XM} \\ &= \sigma^{-\sigma}(\sigma-1)^{\sigma-1} u_i^{1-\sigma} P^{\sigma-1} S + \frac{1}{\tilde{\theta}-1}\underline{b}^\theta e^{\theta\sigma}\sigma^{-\theta\sigma}(\sigma-1)^{\theta(\sigma-1)}(1+\tau)^{-\theta(\sigma-1)} u_i^{-\theta(\sigma-1)} f_X^{1-\theta} - fn - F_{XM}\end{aligned}$$

Since the unit cost u_i and the mass of import countries n are both linked to the domestic share via (12) and (11), profits can be expressed as

$$\Pi_{XM} = \sigma^{-\sigma}(\sigma-1)^{\sigma-1}\left(\frac{1}{1-\gamma}\right)^{-(1-\gamma)(\sigma-1)}\left(\frac{p_D}{\gamma\beta^{\frac{\varepsilon}{\varepsilon-1}} q_D}\right)^{-\gamma(\sigma-1)} \varphi^{\sigma-1} s_{Di}^{-\frac{\gamma}{\varepsilon-1}(\sigma-1)} P^{\sigma-1} S$$

$$+\frac{1}{\theta-1}\underline{b}^{\theta}e^{\theta\sigma}\sigma^{-\theta\sigma}(\sigma-1)^{\theta(\sigma-1)}\left(\frac{1}{1-\gamma}\right)^{-\theta(\sigma-1)(1-\gamma)}\left(\frac{p_D}{\gamma\beta^{\frac{\varepsilon}{\varepsilon-1}}q_D}\right)^{-\theta(\sigma-1)\gamma}(1+\tau)^{-\theta(\sigma-1)}\varphi^{\theta(\sigma-1)}s_{Di}^{-\theta(\sigma-1)\frac{\gamma}{\varepsilon-1}}f_X^{1-\theta}$$

$$-f\left(\frac{\beta}{1-\beta}\right)^{\frac{\varepsilon}{\eta(\varepsilon-1)}}(q_D/p_D)^{\frac{1}{\eta}}z^{\frac{1}{\eta}}e^{\frac{1}{\eta}}\left(s_D^{-1}-1\right)^{\frac{1}{\eta(\varepsilon-1)}}-F_{XM}.$$

It is easy to show that profits can be expressed as

$$\begin{aligned}\tilde{\Pi}_{XM} \equiv & \frac{\Pi_{XM}}{\sigma^{-\sigma}(\sigma-1)^{\sigma-1}\left(\frac{1}{1-\gamma}\right)^{-(1-\gamma)(\sigma-1)}\left(\frac{p_D}{\gamma q_D}\right)^{-\gamma(\sigma-1)}P^{\sigma-1}S_D}=\beta^{\frac{\varepsilon}{\varepsilon-1}\gamma(\sigma-1)}\varphi^{\sigma-1}s_{Di}^{-\frac{\gamma}{\varepsilon-1}(\sigma-1)} \\ & +\tilde{f}_X^{1-\theta}\frac{1}{\theta}\beta^{\frac{\varepsilon}{\varepsilon-1}\theta(\sigma-1)\gamma}\varphi^{\theta(\sigma-1)}s_{Di}^{-\theta(\sigma-1)\frac{\gamma}{\varepsilon-1}} \\ & -\tilde{f}\gamma\eta(\sigma-1)\left(\frac{\beta}{1-\beta}\right)^{\frac{\varepsilon}{\eta(\varepsilon-1)}}\left(s_D^{-1}-1\right)^{\frac{1}{\eta(\varepsilon-1)}}-\tilde{F}_{XM},\end{aligned}\tag{25}$$

where $\tilde{f},\tilde{f}_X$ and $\tilde{F}_{XM}$ are given by (22)-(24). Because re-scaled profits $\tilde{\Pi}_{XM}$ are monotone in profits Π_{XM}, it follows that the optimal domestic share s_D^{XM} that maximizes re-scaled profits also maximizes profits. This share is characterized by the first order condition in (18) in the main text.

Profits of an importer-only are given by

$$\begin{aligned}\Pi_M = & \sigma^{-\sigma}(\sigma-1)^{\sigma-1}\left(\frac{1}{1-\gamma}\right)^{-(1-\gamma)(\sigma-1)}\left(\frac{p_D}{\gamma\beta^{\frac{\varepsilon}{\varepsilon-1}}q_D}\right)^{-\gamma(\sigma-1)}\varphi^{\sigma-1}s_{Di}^{-\frac{\gamma}{\varepsilon-1}(\sigma-1)}P^{\sigma-1}S \\ & -f\left(\frac{\beta}{1-\beta}\right)^{\frac{\varepsilon}{\eta(\varepsilon-1)}}(q_D/p_D)^{\frac{1}{\eta}}z^{\frac{1}{\eta}}e^{\frac{1}{\eta}}\left(s_D^{-1}-1\right)^{\frac{1}{\eta(\varepsilon-1)}}-F_M\end{aligned}$$

and can be rescaled as follows:

$$\begin{aligned}\tilde{\Pi}_M \equiv & \frac{\Pi_M}{\sigma^{-\sigma}(\sigma-1)^{\sigma-1}\left(\frac{1}{1-\gamma}\right)^{-(1-\gamma)(\sigma-1)}\left(\frac{p_D}{\gamma q_D}\right)^{-\gamma(\sigma-1)}P^{\sigma-1}S}=\beta^{\frac{\varepsilon}{\varepsilon-1}\gamma(\sigma-1)}\varphi^{\sigma-1}s_{Di}^{-\frac{\gamma}{\varepsilon-1}(\sigma-1)} \\ & -\tilde{f}\gamma\eta(\sigma-1)\left(\frac{\beta}{1-\beta}\right)^{\frac{\varepsilon}{\eta(\varepsilon-1)}}\left(s_D^{-1}-1\right)^{\frac{1}{\eta(\varepsilon-1)}}-\tilde{F}_M\end{aligned}$$

Maximizing this expression over the domestic share gives rise to the optimal value of being an importer-only - and the associated optimal domestic share s_D^M. Finally, the profits of an exporter-only are given by (25) with $s_D=1$:

$$\begin{aligned}\tilde{\Pi}_X \equiv & \frac{\Pi_X}{\sigma^{-\sigma}(\sigma-1)^{\sigma-1}\left(\frac{1}{1-\gamma}\right)^{-(1-\gamma)(\sigma-1)}\left(\frac{p_D}{\gamma q_D}\right)^{-\gamma(\sigma-1)}P^{\sigma-1}S_D}=\beta^{\frac{\varepsilon}{\varepsilon-1}\gamma(\sigma-1)}\varphi^{\sigma-1} \\ & +\tilde{f}_X^{1-\tilde{\theta}}\frac{1}{\tilde{\theta}}\beta^{\frac{\varepsilon}{\varepsilon-1}\tilde{\theta}(\sigma-1)\gamma}\varphi^{\tilde{\theta}(\sigma-1)}-\tilde{F}_X\end{aligned}$$

Profits of a purely domestic firm are:

$$\tilde{\Pi}_D\equiv\frac{\Pi_D}{\sigma^{-\sigma}(\sigma-1)^{\sigma-1}\left(\frac{1}{1-\gamma}\right)^{-(1-\gamma)(\sigma-1)}\left(\frac{p_D}{\gamma q_D}\right)^{-\gamma(\sigma-1)}P^{\sigma-1}S_D}=\beta^{\frac{\varepsilon}{\varepsilon-1}\gamma(\sigma-1)}\varphi^{\sigma-1}$$

6.4 Calibration Strategy

I follow Blaum et al. (2016) and adopt a strategy to bypass the computation of the general equilibrium variables within the calibration. First, given the normalized fixed costs $\tilde{f}, \tilde{f}_X, \tilde{F}_{XM}, \tilde{F}_M, \tilde{F}_X$ defined in (22)-(24), I can solve for optimal firm behavior without knowledge of the general equilibrium variables, S, P. In this way, I can choose a joint distribution of re-scaled fixed costs to generate a distribution of import shares, export shares and value added, as well as fractions of importers, exporters and importers-exporters as in the data.[53] After calibrating the model, I can compute the consumer price index P which is given by a value-added weighted average of firms' domestic shares - as shown in Blaum et al. (2016). Section 6.5 below shows how to compute total spending S and consumer welfare given firms' optimal import and export shares and the re-scaled fixed costs.

6.5 Proof of Proposition 2

Consumer welfare is given by real income $W = I/P$. Normalizing the wage to unity, consumer income is given by

$$I = L + +T + \int_i \pi_i di.$$

To derive π_i, recall that firms have a markup of $\sigma/(\sigma-1)$ so that variable domestic profits, gross of any fixed costs, are

$$\pi_{Di}^v = (p_i - u_i)\, y_i = p_i y_i / \sigma.$$

Total domestic revenue for firm i is given by

$$p_i y_i = \left(\frac{p_i}{P}\right)^{1-\sigma} S,$$

Variable profits from exporting to market j are:

$$\pi_{ij}^v = \frac{e}{1+\tau} p_{ij} y_{ij} / \sigma,$$

where export revenue from market j is:

$$R_{Xij} \equiv p_{ij} y_{ij} = p_{ij}^{1-\sigma} P_j^{\sigma-1} X_j = p_{ij}^{1-\sigma} b_j.$$

Total profits of firm i are therefore given by:

$$\pi_i \quad = \quad (p_i/P)^{1-\sigma} S/\sigma + R_{Xi}/\sigma - l_{F_i},$$

where l_{Fi} is the total fixed cost bill of importing and exporting of firm i and $R_{Xi} = \int R_{Xij} dj$ are total exports of firm i. Aggregating across firms, we get consumer income:

$$I \quad = \quad L + T + S/\sigma + R_X/\sigma - L_F, \tag{26}$$

where $R_X \equiv \int R_{Xi} di$ and $L_F \equiv \int_i l_{Fi} di$ are the economy-wide exports and fixed cost bill. In turn, total domestic spending, S, is given by

$$S = I + S_X,$$

[53] While S, P affect the level of firm value added, I target moments of the distribution of value added in logs, which do not depend on such general equilibrium variables. Because S, P enter firm value added multiplicatively, they drop after taking logs and computing the standard deviation or their correlation with import/export shares.

where S_X denotes spending by local producers, respectively. Letting m_i be total material spending by firm i and s_i be total input spending by firm i, we know that

$$\begin{aligned} S_X &= \int_i s_{Di} m_i di = \int_i s_{Di} \gamma s_i di = \int_i s_{Di} \gamma \frac{\sigma-1}{\sigma} R_i di \\ &= \gamma \frac{\sigma-1}{\sigma} S \int_i s_{Di} \left(\frac{p_i}{P}\right)^{1-\sigma} di + \gamma \frac{\sigma-1}{\sigma} \int_i s_{Di} R_{Xi} di, \end{aligned} \tag{27}$$

where we used that firms spend a fraction γ of their total input spending s_i on materials and that total spending s_i accounts for a fraction $(\sigma-1)/\sigma$ of revenue R_i. Hence

$$S = I + S_X = I + \gamma \frac{\sigma-1}{\sigma} S \int_i s_{Di} \left(\frac{p_i}{P}\right)^{1-\sigma} di + \gamma \frac{\sigma-1}{\sigma} \int_i s_{Di} R_{Xi} di$$

Using (26), we get that

$$S = L + T + \frac{1}{\sigma} S + \frac{1}{\sigma} R_X - L_F + \gamma \frac{\sigma-1}{\sigma} S \int_i s_{Di} \left(\frac{p_i}{P}\right)^{1-\sigma} di + \gamma \frac{\sigma-1}{\sigma} \int_i s_{Di} R_{Xi} di$$

Note that

$$\left(\frac{p_i}{P}\right)^{1-\sigma} = \frac{\varphi_i^{\sigma-1} s_{Di}^{\frac{\gamma}{\varepsilon-1}(1-\sigma)}}{\int_i \varphi_i^{\sigma-1} s_{Di}^{\frac{\gamma}{\varepsilon-1}(1-\sigma)} di} \equiv \omega_{Di},$$

where ω_{Di} is the share of domestic sales accounted by firm i. Hence,

$$S = L + T - L_F + \frac{1}{\sigma} S \left(1 + \gamma(\sigma-1) \int_i s_{Di} \omega_{Di} di\right) + \frac{1}{\sigma} R_X + \gamma \frac{\sigma-1}{\sigma} \int_i s_{Di} R_{Xi} di. \tag{28}$$

We now work out expressions for export revenue R_X and the fixed costs L_F. It can be shown that firm-level exports are given by:

$$\begin{aligned} R_{Xi} &= \varphi_i^{\sigma-1} \frac{s_{Xi}}{1-s_{Xi}} s_{Di}^{\frac{\gamma}{\varepsilon-1}(1-\sigma)} P^{(1-\gamma)(\sigma-1)} S \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} (1-\gamma)^{(1-\gamma)(\sigma-1)} \left(\gamma \beta^{\frac{\varepsilon}{\varepsilon-1}} q_D\right)^{\gamma(\sigma-1)} \\ &= \kappa_1 \varphi_i^{\sigma-1} \frac{s_{Xi}}{1-s_{Xi}} s_{Di}^{\frac{\gamma}{\varepsilon-1}(1-\sigma)} P^{(1-\gamma)(\sigma-1)} S \end{aligned} \tag{29}$$

where

$$\kappa_1 \equiv \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma} (1-\gamma)^{(1-\gamma)(\sigma-1)} \left(\gamma \beta^{\frac{\varepsilon}{\varepsilon-1}} q_D\right)^{\gamma(\sigma-1)} \tag{30}$$

Aggregate exports are therefore:

$$R_X = \kappa_1 \left(\int_i \varphi_i^{\sigma-1} \frac{s_{Xi}}{1-s_{Xi}} s_{Di}^{\frac{\gamma}{\varepsilon-1}(1-\sigma)} di\right) P^{(1-\gamma)(\sigma-1)} S \equiv \kappa_1 \Upsilon P^{(1-\gamma)(\sigma-1)} S. \tag{31}$$

Note that the last term in (28) can be expressed as:

$$\int_i s_{Di} R_{Xi} di = \kappa_1 \left(\int_i \varphi_i^{\sigma-1} \frac{s_{Xi}}{1-s_{Xi}} s_{Di}^{1+\frac{\gamma}{\varepsilon-1}(1-\sigma)} di\right) P^{(1-\gamma)(\sigma-1)} S \equiv \kappa_1 \mathit{\Gamma} P^{(1-\gamma)(\sigma-1)} S \tag{32}$$

The total bill of fixed costs is given by:

$$L_F = \int_i \left(f_i n_i + f_{Xi} n_{Xi} + \mathbb{I}_{Mi} F_M + \mathbb{I}_{Xi} F_X + \mathbb{I}_{XMi} F_{XM}\right) di,$$

where n_i (n_{Xi}) is the mass of countries from (to) which the firm imports (exports), and $\mathbb{I}_{Mi}, \mathbb{I}_{Xi}$ and $\mathbb{I}_{XMi}$ are indicators of whether the firm is an importer-only, exporter-only or importer-exporter, respectively. Recall that

$$n_{Xi} = \left(s_{Xi}^{-1} - 1\right)^{-\frac{\theta}{\theta-1}} e^{-\sigma\frac{\theta}{\theta-1}} (1+\tau)^{\frac{\theta}{\theta-1}(\sigma-1)} \left(\frac{\theta-1}{\theta}\right)^{\frac{\theta}{\theta-1}} \underline{b}^{-\frac{\theta}{\theta-1}} P^{\frac{\theta}{\theta-1}(\sigma-1)} S^{\frac{\theta}{\theta-1}}$$

$$n_i = \left(\frac{\beta}{1-\beta}\right)^{\frac{\varepsilon}{\eta(\varepsilon-1)}} (q_D/P)^{\frac{1}{\eta}} z^{\frac{1}{\eta}} e^{\frac{1}{\eta}} \left(s_{Di}^{-1} - 1\right)^{\frac{1}{\eta(\varepsilon-1)}}$$

Using the relation between the fixed cost of importing and its re-scaled version, given by (22), it follows that:

$$f_i n_i = \kappa_2 P^{(\sigma-1)(1-\gamma)} S \left(s_{Di}^{-1} - 1\right)^{\frac{1}{\eta(\varepsilon-1)}} \tilde{f}_i$$

where

$$\kappa_2 \equiv \left(\frac{\beta}{1-\beta}\right)^{\frac{\varepsilon}{\eta(\varepsilon-1)}} \frac{(\sigma-1)^{\sigma}}{\sigma^{\sigma}} q_D^{\gamma(\sigma-1)} \gamma^{1+\gamma(\sigma-1)} (1-\gamma)^{(1-\gamma)(\sigma-1)} \eta. \tag{33}$$

Similarly, using the relation between the fixed cost of exporting and its re-scaled version, given by 23, we have that:

$$n_{Xi} f_{Xi} = \left(\frac{\theta-1}{\theta}\right) \kappa_3 P^{(\sigma-1)(1-\gamma)} S \left(s_{Xi}^{-1} - 1\right)^{-\frac{\theta}{\theta-1}} \tilde{f}_{Xi},$$

where

$$\kappa_3 \equiv \sigma^{-\sigma} (\sigma-1)^{\sigma-1} (1-\gamma)^{(1-\gamma)(\sigma-1)} (\gamma q_D)^{\gamma(\sigma-1)} \tag{34}$$

The relation between the fixed costs to the firms' international status and its re-scaled versions, given in 24, can be expressed as:

$$\begin{aligned} F_M &= \kappa_3 P^{(1-\gamma)(\sigma-1)} S \hat{F}_M \\ F_X &= \kappa_3 P^{(\sigma-1)(1-\gamma)} S \hat{F}_X \\ F_{XM} &= \kappa_3 P^{(\sigma-1)(1-\gamma)} S \hat{F}_{XM} \end{aligned}$$

It follows that:

$$\begin{aligned} L_F &= S P^{(\sigma-1)(1-\gamma)} \int_i \left(\kappa_2 \left(s_{Di}^{-1} - 1\right)^{\frac{1}{\eta(\varepsilon-1)}} \tilde{f}_i + \left(\frac{\theta-1}{\theta}\right) \kappa_3 \left(\frac{s_{Xi}}{1-s_{Xi}}\right)^{\frac{\theta}{\theta-1}} \tilde{f}_{Xi} + \mathbb{I}_{Mi}\kappa_3 \hat{F}_M + \mathbb{I}_{Xi}\kappa_3 \hat{F}_X + \mathbb{I}_{XMi}\kappa_3 \hat{F}_{XM} \right) di \\ &= \Psi S P^{(\sigma-1)(1-\gamma)} \end{aligned} \tag{35}$$

where

$$\Psi \equiv \int_i \left(\kappa_2 \left(s_{Di}^{-1} - 1\right)^{\frac{1}{\eta(\varepsilon-1)}} \tilde{f}_i + \kappa_3 \left(\frac{\theta-1}{\theta}\right) \left(\frac{s_{Xi}}{1-s_{Xi}}\right)^{\frac{\theta}{\theta-1}} \tilde{f}_{Xi} + \kappa_3 \mathbb{I}_{Mi} \hat{F}_M + \kappa_3 \mathbb{I}_{Xi} \hat{F}_X + \kappa_3 \mathbb{I}_{XMi} \hat{F}_{XM} \right) di$$

We now solve for spending and welfare. Plugging (32), (31), and (35) and into (28), we obtain an expression for total spending:

$$S = \frac{L+T}{1 - \frac{1}{\sigma} - \gamma\frac{(\sigma-1)}{\sigma} \int_i s_{Di}\omega_{Di} di - \frac{1}{\sigma}\kappa_1 \Upsilon P^{(\sigma-1)(1-\gamma)} - \gamma\frac{(\sigma-1)}{\sigma}\kappa_1 \mathit{\Gamma} P^{(\sigma-1)(1-\gamma)} + \Psi P^{(\sigma-1)(1-\gamma)}} \tag{36}$$

Combining (26), (31), (35) and (36) yields the desired expression for I.