

Importing, Exporting and Aggregate Productivity in Large Devaluations*

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Abstract

A standard mechanism linking large real depreciations to declines in aggregate productivity is that firms' access to foreign inputs is restricted. Recent quantitative trade models of importing predict that the economy's aggregate import share should decrease following a real depreciation. I provide evidence that in fact the aggregate import share increases after a large depreciation. Using Mexican micro data, I show that the increase in the overall import intensity is explained by the expansion and entry of new exporters, which are intense importers. I develop a model of joint importing-exporting 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. A model with importing only cannot generate either, and predicts a decrease in aggregate productivity that is twice as large. JEL Codes: F11, F12, F14, F62, D21, D22

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1 Introduction

Large economic crises in emerging markets are associated with sharp contractions in output and aggregate productivity as well as strong depreciations of the exchange rate - e.g. Mexico in 1994, Indonesia in 1998 or Argentina in 2001. A standard channel linking the currency depreciation to the decline in productivity pertains trade in intermediate inputs.^{1,2} As foreign goods become relatively more expensive, the ability of firms to import inputs from abroad is hindered. As long as domestic and foreign inputs are imperfectly substitutable, this tends to increase firms' production costs, as shown in Halpern et al. (2015), and thus lower aggregate productivity and welfare. Indeed, Gopinath and Neiman (2014) have shown that firms stopped importing their inputs from individual countries during the Argentine crisis of 2001.

To determine the effects of the depreciation, two factors are important. First, the degree of substitutability between foreign and domestic inputs determines how the devaluation affects production costs at the firm level. Estimating this particular parameter is the subject of a vast literature in international economics, which typically finds estimates above unity.³ Second, the pattern of reallocation following the crisis affects how the firm level responses are mapped into an aggregate effect. In standard models of firm-level importing, a devaluation disproportionately affects the most intense importers, which are highly exposed to the shock and tend to be more efficient firms. This pattern of reallocation, together with the high elasticity of substitution, imply the following property of standard models of importing: following a real depreciation, the aggregate expenditure share on imported inputs should decrease, as firms strongly substitute their material purchases from foreign towards domestic varieties, and the most import intensive firms contract.

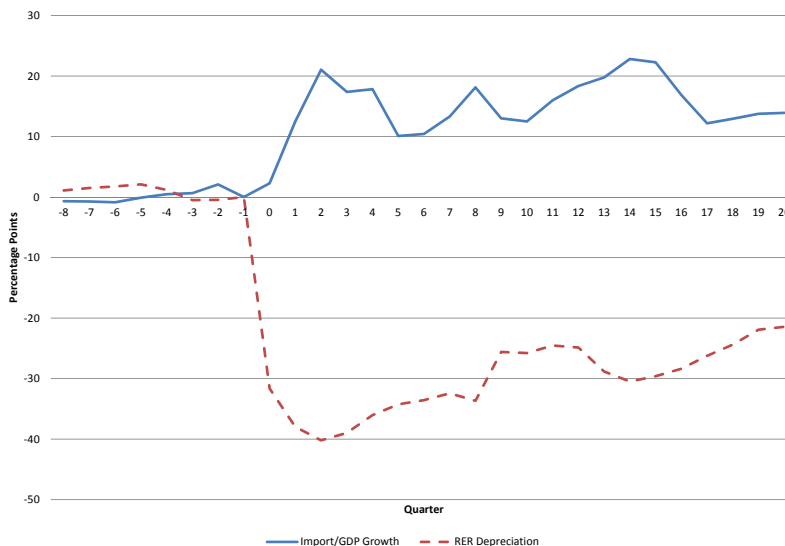
Figure 1 suggests, however, that this prediction is at odds with the data. The figure depicts the dynamics of the aggregate import share, proxied by the ratio of total imports to GDP, in a window of 28 quarters around the devaluation for a sample of 10 emerging market economies. We see that the ratio of imports to GDP increases by as much as 20% within the first year, and remains 10% above its pre-devaluation level 5 years after the devaluation. Since the the ratio of total imports to GDP is an imperfect measure of the aggregate import share, I provide two additional pieces of evidence that confirm the pattern in Figure 1. First, I use data from input output tables to construct country-level imported input shares, defined as the share of total spending in inputs accounted by imported inputs.⁴ Secondly, I use micro data on domestic and imported materials for Mexico and Indonesia. Both pieces of evidence point in the same direction: the overall economy becomes more import intensive after the devaluation.

¹This channel has also been proposed to account for the cost of sovereign defaults - see Mendoza and Yue (2012).

²An extensive literature has linked imports of intermediate inputs to firm productivity - see e.g. Amiti and Konings (2007).

³Estimates of this elasticity based on gravity models yield values in the range of 8 (Eaton and Kortum (2002)) to 4 (Simonovska and Waugh (2014)). Recent estimates based on firm-level data tend to find values closer to 2 - see Blaum et al. (2016) or Antràs et al. (2014). In contrast, Boehm et al. (2015) find evidence of strong complementarities, with values below unity. Their estimates stem from exploiting the 2011 Japanese earthquake and therefore may be more reflective of a short run elasticity. The literature in international macroeconomics, which infers this parameter from the price elasticity of aggregate imports, tends to find lower values, sometimes below unity. Imbs and Mejean (2015) argue, however, that this is due to an aggregation bias.

⁴The input-output tables provide data on total and imported input spending and hence allow to exactly compute the aggregate import share. The disadvantage of this measure, relative to the ratio of imports to GDP, is that it comes in annual frequency.



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 1: Imports-to-GDP ratio After a Large Devaluation

This fact can be rationalized in two ways. One possibility is an elasticity of substitution between domestic and foreign inputs that is less than unity. This, however, is at odds with the body of estimates from the international trade literature mentioned above, and would imply that all firms are importers, contradicting the robust finding that the majority of firms actually do not import - see Bernard et al. (2007). Alternatively, the increase in the aggregate import share could be explained by compositional effects: an expansion of firms that are import intensive. Indeed, exploiting the Mexican and Indonesian micro data, I provide evidence for the latter explanation. A decomposition of the growth in the aggregate import share shows that about three-quarters of this increase can be accounted by a “between” and a “covariance” effect: initially import intensive firms expand, and the firms that increase their import intensity tend to expand. These effects are inconsistent with the type of reallocation predicted by standard models of importing. Additionally, I find that a quarter of the increase in the aggregate import share is explained by net entry, that is by the contribution of new importers net of the firms that stop importing. Importantly, the “within” effect, i.e. the change in the import share holding firm size constant, tends to *decrease* the aggregate import share, consistent with an elasticity of substitution above unity as assumed by quantitative firm-based models of importing.

What explains this expansion of intense importers? A natural explanation follows from the combination of (i) increased incentives to export after the currency depreciation and (ii) a complementarity between exporting and importing. Alessandria et al. (2015) provide evidence of (i) for the sample of countries in Figure 1 above.⁵ The fact that large exporters tend to be large importers is a robust feature of trade data - 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.⁶ Indeed, using Mexican firm-level data, I provide evidence that the compositional effects that account for the increased aggregate import share are driven by the expansion of

⁵The 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.

⁶Albornoz 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.

exporters.

To rationalize these findings, I propose a model of importing-exporting 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. 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 pre-devaluation. 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.⁷

I study a counterfactual depreciation of the real exchange rate in the calibrated model.⁸ 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. Quantitatively, the import share increases by about 8 percent in the model.⁹ 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.¹⁰ 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.¹¹ These findings are consistent with results using Mexican and Indonesian micro data.¹² In terms of normative implications, the model predicts an increase in the consumer price index of about 4 percent.

I compare these results to outcomes from a model with importing-only, which is close to the frameworks in the literature. To do so, I recalibrate a version of the model without exporting to a subset of the moments considered above.¹³ The model with importing-only generates a decrease in the aggregate import intensity of about 15 percent. This large decrease is mostly explained by negative compositional effects, by which firms with high import intensity contract. These findings are at odds with the evidence from Mexico and Indonesia. Finally, the model with importing-only predicts an increase in the consumer price index of about 8 percent,

⁷The draws of the 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.

⁸The real exchange rate is exogenous because the model is static.

⁹In Mexico, the aggregate import share increased by about 18 percent between 1994 and 1999. However, a sectoral decomposition shows that about half of this increase is accounted by changes between sectors. The within-sector increase in the aggregate import share was about 9 percent.

¹⁰The 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.

¹¹The 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.

¹²The model predicts a positive contribution of net entry, although quantitatively very small.

¹³I target the aggregate import share, the fraction of importers, as well as the dispersions in value added, import intensity and their correlation.

which is twice as large as the effect in the model with importing-exporting. Intuitively, in the model with importing-only, the devaluation disproportionately affects the most efficient firms, which are initially intense importers. 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 several strands of the literature. First, it is related to the literature that studies trade liberalizations and provides evidence on the connection between imported inputs and firm productivity - 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 also related to a recent literature that studies input trade in quantitative models of importing with firm heterogeneity - see Halpern et al. (2015), Antràs et al. (2014), Gopinath and Neiman (2014) and Blaum et al. (2016).¹⁴ These papers feature estimates of the elasticity of substitution between domestic and foreign inputs which exceed unity. Thus, while they differ in their focus, these frameworks feature the prediction that the economy should become less import-intensive following a real depreciation that makes foreign inputs more expensive. I provide evidence that the aggregate import share in fact increases after a large devaluation and link this fact to the expansion of exporters. I show that a model of joint importing-exporting can rationalize this finding. My model is therefore related to the frameworks in Lapham and Kasahara (2013), Amiti et al. (2014) and Eslava et al. (2015), who also emphasize the importing-exporting connection, although with a different focus.¹⁵

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 Analysis

2.1 Data Sources

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 Statistics (IFS) database.^{16,17}

I rely on input output tables from two sources. First, the OECD national input-output tables, which provide information on domestic and imported flows by sector for all OECD countries as well as 27 non-member economies between 1995 and 2011.¹⁸ 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 also provides input-output tables for 40 of countries.¹⁹ The empirical results of Section 2.2 below are robust to using either

¹⁴Gopinath and Neiman (2014) is closely related as they also focus on a large currency devaluation. Using customs-level data for Argentina, they document how firms stop 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. This mechanism plays a central role in my analysis too. I document how the aggregate volume of imports collapses after the devaluation and remains below trend for as long as 20 quarters in a sample of 10 episodes.

¹⁵Amiti et al. (2014) focus on the exchange rate pass-through, while Eslava et al. (2015) study quality upgrading and the skill premium after trade liberalizations.

¹⁶The 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 indexes in the respective country and the US. A decrease of either measure of the real exchange rate represents a depreciation of the local currency.

¹⁷The 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.

¹⁸See Table 12 in the Appendix for a list of countries in the OECD input output sample.

¹⁹Table 12 in the Appendix provides a list of countries in the WIOD.

source for the input output tables.²⁰

I measure tariffs with an average (simple or weighted) of effectively applied tariffs across all products, taken from World Development Indicators.²¹

Finally, 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 Estadística, Geografía e Informática (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.

2.2 The Aggregate Import Intensity in Large Devaluations

In this section, I document the behavior of the aggregate import share in a sample of emerging markets that experienced large depreciations of their real exchange rates in recent times. The aggregate import share is defined as the ratio of total imported intermediate inputs to total intermediate inputs. The list of episodes is contained in Table 1.²²

Imports-to-GDP ratio. I start by proxying 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 1 contains the evolution of M/Y and the real exchange rate, RER, 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 the RER falls by up to 40% on impact and then gradually increases, although it remains 20% below its original level even 5 years after the devaluation. Importantly, M/Y grows by about 20% within 3 quarters and remains 10% above its pre-devaluation level after 5 years. This medium-term increase in the aggregate import share, in a context where foreign inputs are relatively more expensive, is grossly at odds with recent quantitative models of importing - see Halpern et al. (2015), Gopinath and Neiman (2014) or Blaum et al. (2016).

Country	Date	Country	Date
Argentina	2001	Malaysia	1997
Brazil	1998	Mexico	1994
Colombia	1998	Russia	1998
Indonesia	1997	Thailand	1997
Korea	1997	Turkey	2001

Table 1: Episodes of Large Devaluations

²⁰The OECD database provides a larger sample of countries, covering all ten episodes of large devaluations. The WIOD covers only the episodes of Brazil, Indonesia, Korea, Russia and Turkey. An advantage of the WIOD is that it provides data on foreign sales and hence allows to compute export shares by sector.

²¹World Bank estimates are based on data from the UNCTAD's TRAINS database as well as the WTO's IDB and CTS databases.

²²The sample of episodes is taken from Alessandria et al. (2015), who focus on small open economies that experienced a recent real exchange depreciation for which data is available for at least 20 quarters after the event. I do not consider Uruguay 2002 because its data is available only at the yearly frequency. The yearly data for Uruguay depicts a pattern which is qualitatively in line with the findings of this section - see Figure 10 in the Appendix.

Figures 8-9 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, we see a strong tendency for the country import intensity to increase, both in the short and medium run.²³

The above findings are confirmed by regression analysis which controls for 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. Figure 15 in the Appendix documents the evolution of tariffs in a window of seven years around the devaluation for the sample of countries considered above. We see that indeed tariffs tended to decrease in the sample period when the devaluations occurred.²⁴ To address this concern, I assess the effect of the devaluation on the imports-to-GDP ratio in a regression specification that controls for the effect of tariffs, as well as country and time fixed effects. More specifically, I run the following specification:

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

where $m_{ct} \equiv M_{ct}/Y_{ct}$ is the imports-to-GDP ratio of country c in quarter-year t , α_c, α_t are country and quarter-year fixed effects, τ_{ct} are average applied tariffs and $deva_{ct}$ is an indicator of whether the devaluation has occurred (it takes a value of unity for 20 quarters after the devaluation). Table 2 contains the results. Column 1 shows that the devaluation 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 2.²⁵ Similar results are obtained when including a measure of the real exchange rate instead of the devaluation indicator - see column 3. Quantitatively, a 30 percent real depreciation implies a 5 increase in the imports-to-GDP ratio.

While the aggregate import intensity tends to increase after the large devaluations considered above, we note that the total volume of imports tends to decrease. Figure 11 in the Appendix shows the behavior of an index of import volume, as well as real GDP, in a window of 28 quarters around the devaluation, averaged over the episodes considered above. 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.²⁶ 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.²⁷

Import Share from Input Output Tables. A natural caveat to the above findings is that the imports to GDP ratio is an imperfect measure of the aggregate import share. 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

²³An exception is Colombia, which displays a clear decrease in its aggregate import intensity following the devaluation.

²⁴We note, however, that the overall decrease was moderate: tariffs fell from 12 to 10 percent on average in the seven year period. A decline in tariffs of this magnitude is small relative to the large currency depreciation seen in Figure 1 above. To see this, consider the following back of the envelope calculation. Suppose that the real effective price of foreign inputs is given by $(1 + \tau)e$, where τ denotes the ad valorem tariff and e the real exchange rate (in units of local per foreign currency). Then a decrease in tariffs from 12 to 10 percent, together with a real depreciation of 20 percent, results in an increase in the real price of inputs of about 18 percent.

Moreover, most of the decrease tended to happen two years after the increase in the import share. That is, the import share tends to increase between years -1 and 0, while tariffs decrease between years 1 and 2.

²⁵The 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.

²⁶Note that the series depicted in Figure 11 were detrended, and hence these statements should be interpreted as relative to trend.

²⁷These patterns for total imports and real GDP are consistent with the findings of Gopinath and Neiman (2014) for Argentina.

Dep. var. $\log(m_{ct})$	(1)	(2)	(3)
$deva_{ct}$	0.09*** (0.03)	0.09*** (0.04)	
τ_{ct}		-0.37 (0.43)	-0.03 (0.40)
$\log(RER_{ct})$			-0.17*** (0.03)
Country FE	Yes	Yes	Yes
Quarter-Year FE	Yes	Yes	Yes
Obs	290	223	223
R^2	0.50	0.58	0.65

Table 2: 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 1 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.

accounted by inputs, even when the share of imported inputs in total inputs is constant. To better measure the aggregate import share, I use data from input output tables which provide data on imports of intermediate goods and domestic input spending. In particular, I use data from the World Input-Output Database (WIOD)²⁸ and the OECD.²⁹ A shortcoming, relative to the M/Y measure, is that the data is available in yearly frequency. Figure 2 contains the growth rate in the aggregate import share, defined as the ratio of imported inputs over total spending in inputs by all sectors in the economy, between each year and the year before the devaluation. The graph depicts the average over the country experiences in the sample.³⁰ We see that, following a large devaluation, the aggregate import share features a similar behavior to the one of M/Y documented in Figure 1 above. The import share increases by more than 15% within the first two years and remains 20% higher than its pre-devaluation level after six years.³¹

²⁸See Timmer et al. (2015) for a description of this dataset.

²⁹In particular, the data for Brazil, Indonesia, Korea, Russia and Turkey is taken from WIOD, while data for Argentina, Malaysia, Colombia and Thailand is from OECD. Mexico is excluded from the analysis as data for 1994 is not available.

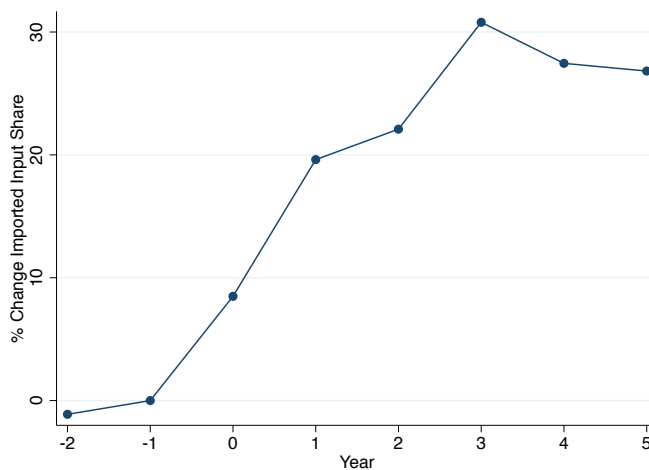
³⁰Figure 12 in the Appendix contains the dynamics of the import share for each of these countries.

³¹A similar pattern is found when restricting the analysis to the Manufacturing sector. Figure 14 in the Appendix depicts the evolution of the import share for the Manufacturing sector following large devaluations.

Dep. var. $\log(m_{ct})$	(1)	(2)	(3)
$deva_{ct}$	0.08*** (0.02)	0.08*** (0.02)	
τ_{ct}		-0.12** (0.06)	-0.07** (0.03)
$\log(RER_{ct})$			-0.23*** (0.04)
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Obs	1,054	927	743
R^2	0.94	0.95	0.96

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 1. 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.



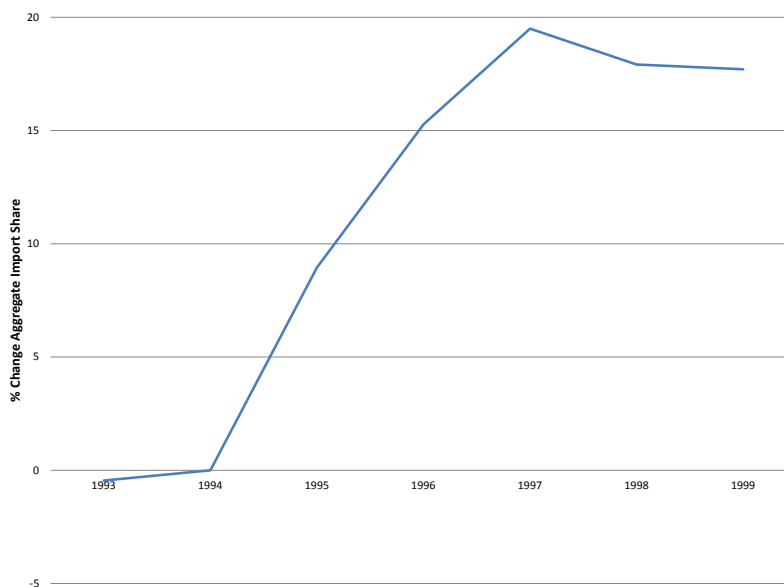
Notes: The Figure depicts the rate of growth in the ratio of imported inputs to total (imported plus domestic) inputs between a given year and the year before the devaluation (labeled -1). The year of the devaluation is labeled 0. The line in the Figure is an average of the experiences of the episodes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

Figure 2: The Aggregate Import Share After a Large Devaluation

The increase in the import share following the devaluation can also be seen through regression analysis. Table 3 contains the results of estimating (1) using the OECD input output tables, which give data for 62 countries over 1995-2011, where m_{ct} is now the aggregate import share of country c in year t . We see that, after controlling for the effect of tariffs and year fixed effects, the devaluation is associated with an 8 percent increase in the aggregate import share. 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. These estimates are broadly consistent with the results in Table 2 above.

Table 14 in the Appendix shows that the results of Table 3 are not driven by cross-sector reallocation. Exploiting the sectoral information in the input output tables, I estimate (1) at the country-sector level and obtain similar estimates of the coefficient on the devaluation indicator or the real exchange rate.

A Measure with Micro Data. As a third piece of 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 3 contains the growth in the aggregate share of imported materials (in total materials) after the Mexican devaluation of 1994. We see that the import share increases by about 20% in the first three years and remains above 15% after five years. For Indonesia, Figure 18 in the Appendix shows that the import share is 10% above its pre-devaluation value.



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 1994 for the Manufacturing sector in Mexico. Source: Survey of Manufacturing, EIA.

Figure 3: The Aggregate Import Share in Manufacturing after the Mexican Devaluation

In the case of Mexico, the devaluation happened soon after the introduction of NAFTA.³² 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 3 is driven by NAFTA. First, import tariffs were eliminated gradually over a period of 15 years. In fact, between 1994 and 1999, which is the post-devaluation period considered above, average tariffs did not decrease - see Figure 19 in the Appendix.³³ 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 Accounting for the Increase in Aggregate Import Intensity

In this section, I exploit the Mexican 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

³²In particular, the trade agreement came into effect in January of 1993 and the devaluation happened at the end of 1994.

³³We also note that the Maquiladora sector is not included in the the Survey of Manufacturing used to construct Figure 3.

Year	Within	Between	Covariance	Entry	Exit	All
1995	2.91	6.71	0.32	1.75	2.75	8.95
1996	1.55	5.36	2.87	9.17	3.69	15.27
1997	-0.98	10.89	2.93	11.17	4.61	19.41
1998	-1.91	9.58	4.32	12.62	6.69	17.91
1999	-2.79	9.99	4.27	13.53	7.30	17.70

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 4: Accounting for the Change in the Aggregate Import Intensity

share into the contribution of continuing importers (CI), new importers (E) and firms that stop importing (X). 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:

$$\frac{\Delta s_{AGG}}{s_{AGG1}} = \underbrace{\left\{ \sum_{CI} m_{i1} (s_{i2} - s_{i1}) \right\}}_{Within} + \underbrace{\left\{ \sum_{CI} (m_{i2} - m_{i1}) s_{i1} \right\}}_{Between} + \underbrace{\left\{ \sum_{CI} (m_{i2} - m_{i1}) (s_{i2} - s_{i1}) \right\}}_{Covariance} \quad (2)$$

$$+ \underbrace{\left\{ \sum_E m_{i2} s_{i2} \right\}}_{Entry} - \underbrace{\left\{ \sum_X m_{i1} s_{i1} \right\}}_{Exit} \frac{1}{s_{AGG1}},$$

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 4 contains the results of the decomposition. Three features stand out. First, the within component 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. Second, the between and covariance terms are positive and grow in magnitude with the time horizon. By 1999, they jointly account for three-quarters of the total increase in the aggregate import share. 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 a quarter of the total effect by 1999.³⁴

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.

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

³⁴Similar results are obtained when performing the decomposition in (2) on the Indonesian micro data between 1996 and 2000. Table 15 in the Appendix contains the results. As in the Mexican case, we find a negative within term, a positive between + covariance term, and a positive net entry term.

with the expansion of import intensive sectors. More precisely, we consider the following decomposition:

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

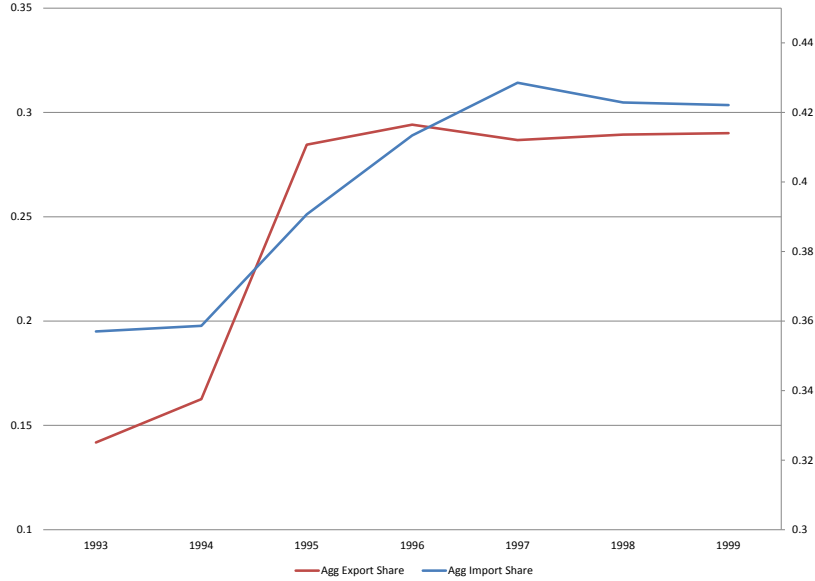
where m_{jt} denotes the share of total materials accounted by sector j in period t , s_{AGGjt} denotes the aggregate import intensity of sector j in period t , and J is the total number of sectors in Manufacturing. I define sectors at the two digit level and perform the decomposition taking 1994 as initial year, and each of 1995-1999 as final year. Table 16 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 17 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.

2.4 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 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 4 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 20 in the Appendix.

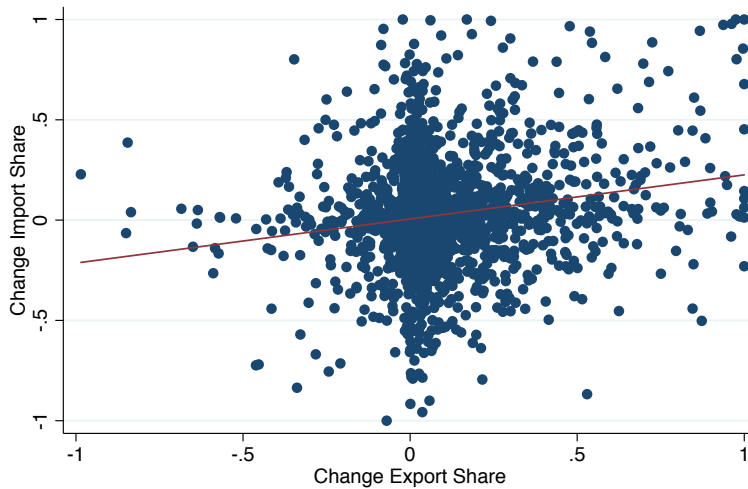
³⁵Wood and wood products shows a large decline in its import intensity, but accounts for a small share of total Manufacturing materials.



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 foreign). The aggregate import share is the ratio of total imported materials to total materials (domestic plus foreign). Source: Survey of Manufacturing, EIA.

Figure 4: 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 5 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



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

Figure 5: Expanding Exporters and Importers After Mexican Devaluation

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

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 5: The Change in the Aggregate Import Intensity and Expanding Exporters

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 5 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 theory of importing in Gopinath and Neiman (2014) and Halpern et al. (2015), which is the standard framework to evaluate the effects of large 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.

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

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

³⁸For 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.

cannot affect world input prices or demand for their products in Foreign countries. The model is static.

Technology. There is a mass of local firms, indexed by i , with technology given by

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

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:

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

where β_i is an idiosyncratic 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

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

where q_c and z_c are the quality and quantity of the input from country c , and Σ denotes the sourcing strategy, that is 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. When selling to the Home market, the firm faces an aggregate demand given by:

$$y_i = p_i^{-\sigma} P^{\sigma-1} S, \tag{5}$$

where $p_i, P \equiv \left(\int p_i^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}$ and S are the price charged, the price index, and total consumer and intermediate spending at Home. In terms of revenue,

$$p_i y_i = p_i^{1-\sigma} P^{\sigma-1} S_D.$$

This demand stems from (i) consumer preferences that are CES with elasticity of substitution σ , and (ii) a structure of roundabout production by which the domestic variety is a CES aggregator (with elasticity σ) of the output of all domestic firms. More specifically, consumer utility is given by

$$U = \left(\int_i c_i^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}. \tag{6}$$

Additionally, the domestic variety z_D is produced according to

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

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

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

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

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_X per destination and a variable cost τ , which are assumed to be common across destinations for simplicity. There is also a fixed cost to being an exporter, F_X . Importing from any origin has a fixed costs of f , assumed to be common across origins for tractability.⁴⁰ Variable input costs are included in the (exogenously given) prices p_c^* . There is also a fixed cost to being an importer, F_M .

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 needs to jointly decide 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. The cost minimization problem consists of choosing $\{l, z_D, \{z_c\}\}$ to minimize

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

For now, let's assume that the set Σ_i is given. It can be shown that the expenditure on foreign inputs m_I is:

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

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

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

where Q is given by

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

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

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

⁴⁰Allowing 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 Antràs et al. (2014), who provide a solution algorithm to tackle this problem.

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:

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

The domestic share can be linked to the sourcing strategy n by

$$s_D = \left(1 + \left(\frac{1-\beta}{\beta} \right)^\varepsilon e^{1-\varepsilon} (p_D/q_D)^{\varepsilon-1} z^{1-\varepsilon} n^{\eta(\varepsilon-1)} \right)^{-1}. \quad (7)$$

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

$$u_i = \varphi^{-1} \left(\frac{1}{1-\gamma} \right)^{1-\gamma} \left(\frac{p_D}{\gamma \beta^{\frac{\varepsilon}{\varepsilon-1}} q_D} \right)^\gamma s_{Di}^{\frac{\gamma}{\varepsilon-1}} \quad (8)$$

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:

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

Standard calculations imply the usual constant markup pricing rule:

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

and domestic revenue and variable profits:

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

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

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

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

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

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

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 $\pi_{ij}^v > f_X$, which reduces to:

$$b_j > \underbrace{e^{-\sigma} \sigma^\sigma (\sigma - 1)^{1-\sigma} (1 + \tau)^{\sigma-1} u_i^{\sigma-1} f_X}_{\equiv b^*(u_i)} \quad (9)$$

We see that the optimal export strategy is to export to destinations where demand is sufficiently high. Importantly, the demand threshold is a function of the unit cost: firms with lower unit cost feature lower thresholds and export to more countries. Hence, the benefits from exporting to a given destination are larger for intense importers.

Export/Import Status and Sourcing Strategy. The choice of the optimal sourcing strategy, given by s_D , determines the countries to which the firm will export, as per (9), and hence total export revenue and profits. In what follows, I characterize the optimal sourcing strategy s_D conditional on import/export status. Then I characterize the optimal choice of import/export status.

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

$$R_{Xi} = e^\sigma \left(\frac{\sigma}{\sigma - 1} \right)^{1-\sigma} (1 + \tau)^{1-\sigma} u_i^{1-\sigma} \underline{b}^\theta \frac{\theta}{\theta - 1} b^{*1-\theta}, \quad (10)$$

where b^* depends on u_i according to (9) and u_i depends on s_D according to (8). Similarly, the profits from exporting, net of fixed costs f_X but excluding F_X, F_M or input-sourcing fixed costs, are:

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

The total profits from being an importer-exporter are:

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

where n is the input sourcing strategy and be linked to s_D via (7). The profits of the importer-exporter can

be written as:

$$\begin{aligned} \tilde{\Pi}_{XM} &= \beta^{\frac{\varepsilon}{\varepsilon-1}\gamma(\sigma-1)} \varphi^{\sigma-1} s_{Di}^{-\frac{\gamma}{\varepsilon-1}(\sigma-1)} + \tilde{f}_X^{1-\theta} \frac{1}{\theta} \beta^{\frac{\varepsilon}{\varepsilon-1}\theta(\sigma-1)\gamma} \varphi^{\theta(\sigma-1)} s_{Di}^{-\frac{\theta(\sigma-1)}{\varepsilon-1}} \\ &\quad - \tilde{f}\gamma\eta(\sigma-1) \left(\frac{\beta}{1-\beta} \right)^{\frac{\varepsilon}{\eta(\varepsilon-1)}} (s_D^{-1} - 1)^{\frac{1}{\eta(\varepsilon-1)}} - \tilde{F}_X - \tilde{F}_M, \end{aligned} \quad (11)$$

where the variables with tilde have been re-scaled by general equilibrium prices and parameters.⁴¹ The firm chooses its optimal sourcing strategy s_D to maximize the expression in (11). It can be shown that the optimal domestic share conditional on exporting-importing, denoted by s_D^{XM} , is given by:

$$\begin{aligned} &(1-\beta)^{\frac{1}{\eta}\frac{\varepsilon}{\varepsilon-1}} \beta^{\frac{1}{\eta}\frac{\varepsilon}{\varepsilon-1}(\eta\gamma(\sigma-1)-1)} \varphi^{\sigma-1} s_D^{\frac{1}{\eta}\frac{1}{\varepsilon-1}(1-\eta\gamma(\sigma-1))} (1-s_D)^{1-\frac{1}{\eta(\varepsilon-1)}} \\ &+ (1-\beta)^{\frac{1}{\eta}\frac{\varepsilon}{\varepsilon-1}} \beta^{\frac{1}{\eta}\frac{\varepsilon}{\varepsilon-1}(\theta\eta\gamma(\sigma-1)-1)} \varphi^{\theta(\sigma-1)} s_D^{\frac{1}{\eta(\varepsilon-1)}(1-\theta\eta\gamma(\sigma-1))} (1-s_D)^{1-\frac{1}{\eta(\varepsilon-1)}} \tilde{f}_X^{1-\theta} \\ &= \tilde{f}_M, \end{aligned} \quad (12)$$

The remaining import-export strategies can be studied as special cases of (11)-(12). For example, the profits of a firm that only imports are given by (11) when $f_X \rightarrow +\infty$ and \tilde{F}_X is omitted:

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

The profits when the firm only exports are given by (11) 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:

$$\tilde{\Pi} = \max \{ \tilde{\Pi}_D, \tilde{\Pi}_X, \tilde{\Pi}_M, \tilde{\Pi}_{XM} \}.$$

⁴¹In particular:

$$\begin{aligned} \tilde{\Pi}_{XM} &\equiv \frac{\Pi_{XM}}{\sigma^{-\sigma} (\sigma-1)^{\sigma-1} \left(\frac{1}{1-\gamma} \right)^{-(1-\gamma)(\sigma-1)} \left(\frac{p_D}{\gamma q_D} \right)^{-\gamma(\sigma-1)} P^{\sigma-1} S_D} \\ \tilde{f} &\equiv \frac{1}{\gamma} \frac{1}{\eta} \left(\frac{1}{1-\gamma} \right)^{(1-\gamma)(\sigma-1)} \left(\frac{p_D}{\gamma q_D} \right)^{\gamma(\sigma-1)} \frac{\sigma^\sigma}{(\sigma-1)^\sigma} \left(\frac{q_D}{p_D} \right)^{\frac{1}{\eta}} z^{\frac{1}{\eta}} e^{\frac{1}{\eta}} P^{1-\sigma} S_D^{-1} f \\ \tilde{f}_X^{1-\theta} &\equiv P^{(1-\sigma)} S_D^{-1} \frac{\tilde{\theta}}{\tilde{\theta}-1} b^{\tilde{\theta}} e^{\tilde{\theta}\sigma} \sigma^{-\sigma(\tilde{\theta}-1)} (\sigma-1)^{(\tilde{\theta}-1)(\sigma-1)} \times \\ &\quad \times \left(\frac{1}{1-\gamma} \right)^{(\sigma-1)(1-\gamma)(1-\tilde{\theta})} \left(\frac{p_D}{\gamma q_D} \right)^{(\sigma-1)\gamma(1-\tilde{\theta})} (1+\tau)^{-\tilde{\theta}(\sigma-1)} f_X^{1-\tilde{\theta}} \\ \tilde{F}_X + \tilde{F}_M &\equiv \frac{F_X + F_M}{\sigma^{-\sigma} (\sigma-1)^{\sigma-1} \left(\frac{1}{1-\gamma} \right)^{-(1-\gamma)(\sigma-1)} \left(\frac{p_D}{\gamma q_D} \right)^{-\gamma(\sigma-1)} P^{\sigma-1} S_D} \end{aligned}$$

General Equilibrium. To close the model, we assume that (i) the supply of foreign inputs is perfectly elastic at price p_c^* , (ii) all fixed costs are in unit of labor, and (iii) an exogenous level of the trade deficit, D . The trade balance condition is given by:

$$\int_i R_{X_i} di + D = \int_i (1 - s_{D_i}) m_i di,$$

where R_{X_i} is firm i 's export revenue, given by (10). The labor market clearing condition is

$$\begin{aligned} L = & \int_i l_i di + \int_{i \in M} (f_i n_i + F_M) di + \int_{i \in X} (f_{X_i} n_{X_i} + F_X) di \\ & + \int_{i \in XM} (f_i n_i + f_{X_i} n_{X_i} + F_X + F_M) di, \end{aligned}$$

where M , X and XM are the set of importers only, exporters only, and importer-exporters, l_i is labor demand by firm i , n_{X_i} is the mass of countries to which firm i exports, and L is the inelastic labor supply. An equilibrium is attained when firms maximize profits, consumer maximize utility, and the trade and labor market clearing conditions are satisfied. Section 6.2 in the Appendix contains a detailed characterization of the equilibrium.

4 Quantitative Exercise (Preliminary)

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_{X_i} . 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 $\rho_{f_c f_x}$.⁴² I choose these parameters 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 $\sigma, \varepsilon, \gamma$, and η are taken from Blaum et al. (2016) and summarized in Table 18 in the Appendix. I set $\theta = 1.05$ to match the growth in total exports of 110% between 1994-1999 in Mexico. Table 6 below contains the results of the calibration.

⁴²These 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 $\rho_{\varphi f_c} \equiv \text{Corr}(\log(f_c), \log(\varphi))$. I normalize mean efficiency to unity, so that $\mu_\varphi = \sigma_\varphi^2/2$.

Description	Parameter	Targeted Moment			
	Value	Description	Model	Data	
Average importing fixed cost (μ_{f_c})	1.7	Aggregate Import Share	0.39	0.36	
Average exporting fixed cost (μ_{f_x})	40.18	Aggregate Export Share	0.18	0.16	
Fixed cost import status (F_M)	0.05	Fraction Importers	0.31	0.25	
Fixed cost export status (F_M)	0.7	Fraction Exporters	0.01	0.07	
Fixed cost import-export (F_{XM})	0.72	Fraction Importer-Exporters	0.11	0.17	
Dispersion in efficiency (σ_φ)	0.61	Dispersion va	1.82	1.71	
Dispersion in importing fixed costs (σ_{f_c})	2.83	Dispersion s_i	0.23	0.27	
Dispersion in exporting fixed costs (σ_{f_x})	26.7	Dispersion s_x	0.12	0.18	
Correlation efficiency - importing fixed cost ($\rho_{\varphi f_c}$)	0.86	Correlation $va - s_i$	0.32	0.27	
Correlation efficiency - exporting fixed cost ($\rho_{\varphi f_x}$)	0.57	Correlation $va - s_x$	0.33	0.15	
Correlation importing - exporting fixed costs ($\rho_{f_c f_x}$)	0.49	Correlation $s_i - s_x$	0.21	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 6: 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.⁴³ 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 7 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.⁴⁴ We see that the calibrated model generates an increase in the aggregate import share of about 7.7 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 16.

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 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.⁴⁵

In terms of normative implications, the model predicts an increase in the ideal consumer price index of about 3.7 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 1.27 percentage points.

⁴³This can be seen formally from the definition of the re-scaled fixed costs, which depend on e :

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

⁴⁴I 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 19 in the Appendix.

⁴⁵The overprediction in the growth of the fraction of exporters is large. This is possibly related to the fact that the initial fraction of exporters was severely below target in the calibration.

Increase in RER of ...	Within	Between	Covariance	Entry	Exit	Total
... 5%	-0.87	2.2	0.09	0.07	0.07	1.43
... 10%	-1.69	4.49	0.25	0.14	0.11	3.08
... 20%	-3.27	10.09	0.76	0.29	0.2	7.67
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, for the model with importing and exporting as calibrated in Table 6. All entries are in percentage points.

Table 8: Accounting for the Increase in Aggregate Import Intensity: Counterfactual Data

Rate of growth in ...	Increase in RER of ...			Mexico
	5%	10%	20%	94-99
Aggregate Import Share	1.43	3.08	7.67	17.7
Aggregate Export Share	15.18	30.94	64.15	78.36
Fraction Importers	-7.04	-13.33	-25.22	-37.42
Fraction Exporters	18.39	52.87	133.00	27.25
Fraction Importer-Exporters	15.06	32.14	66.80	35.45
Price Index	1.15	2.15	3.74	-
Welfare	-0.04	0.16	1.27	-

Table 7: Effects of a Devaluation

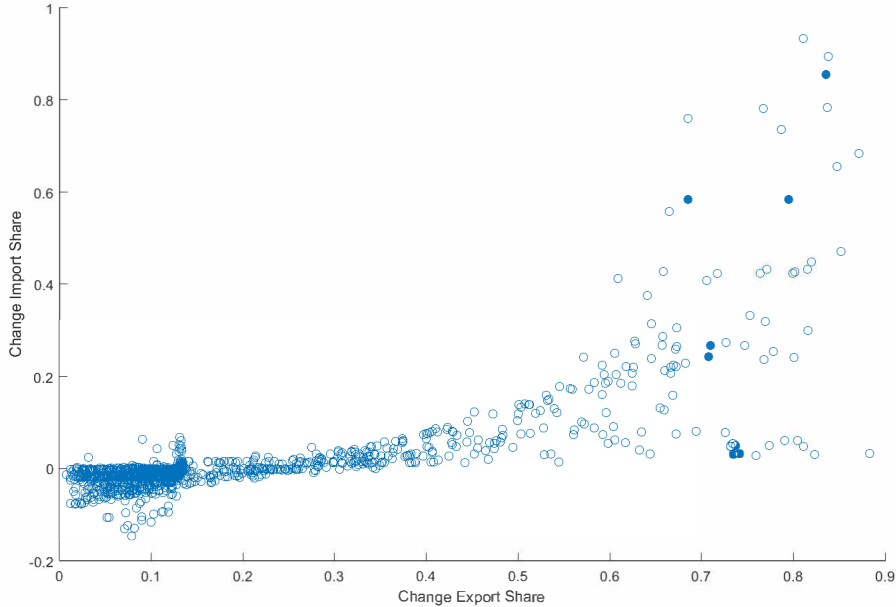
To better understand the mechanics of the model, I decompose the increase in the aggregate import share using the methodology in (2). Table 8 contains the results. The third and fourth rows correspond to the 20 percent model devaluation and the Mexican experience between 1994-1999, respectively. The model generates a within component that is negative and of similar magnitude that in the data.⁴⁶ 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 11 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.⁴⁷

Figure 6 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 in Figure 5.

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, $F_X \rightarrow +\infty$. I recalibrate the model with importing only to a subset of

⁴⁶This 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.

⁴⁷Recall 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 7. Only firms with non-zero changes are included.

Figure 6: Expanding Importers and Exporters in Counterfactual Devaluation

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 9 contains the results of the calibration. Table 11 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 a factor of about two.

To uncover the mechanics of the importing-only model, I decompose the change in the aggregate import share following the methodology in (2). Table 11 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.⁴⁸

The pattern of reallocation of the model can also be seen graphically. To illustrate the importance of the between effect, Figure 7 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 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

⁴⁸Finally, we note that, like the model with importing-exporting, the model of importing-only predicts a role of net entry that is much smaller than in the data.

Parameter		Targeted Moment		
Description	Value	Description	Model	Data
Average importing fixed cost (μ_{fc})	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_{fc})	3.678	Dispersion s_i	0.27	0.27
Correlation efficiency - importing fixed cost ($\rho_{\varphi fc}$)	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 9: Model with Importing-Only: Calibration to Mexican Data

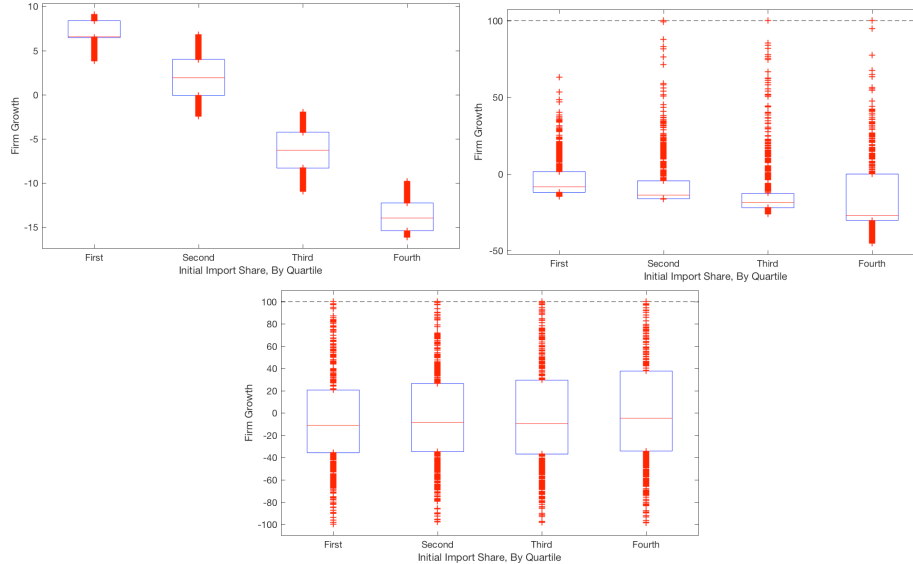
Rate of growth in ...	Increase in RER of ...			Mexico 94-99
	5%	10%	20%	
Aggregate Import Share	-3.98	-7.79	-14.97	17.7
Aggregate Export Share	-	-	-	78.36
Fraction Importers	-0.37	-0.68	-1.53	-37.42
Fraction Exporters	-	-	-	27.25
Fraction Importer-Exporters	-	-	-	35.45
Price Index	2.10	4.11	7.89	-
Welfare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

Table 10: 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 11: 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 7: Pattern of reallocation: Models vs Data

the upper right panel of Figure 7. 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.⁴⁹ Finally, the bottom panel of Figure 7 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 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

⁴⁹In fact, note that, within the highest quartile of initial import intensity, the 75th percentile of firm growth is positive.

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 which is twice as large as 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.

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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 12: 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 13: Countries in WIOD

6 Appendix

6.1 Additional Figures and Tables

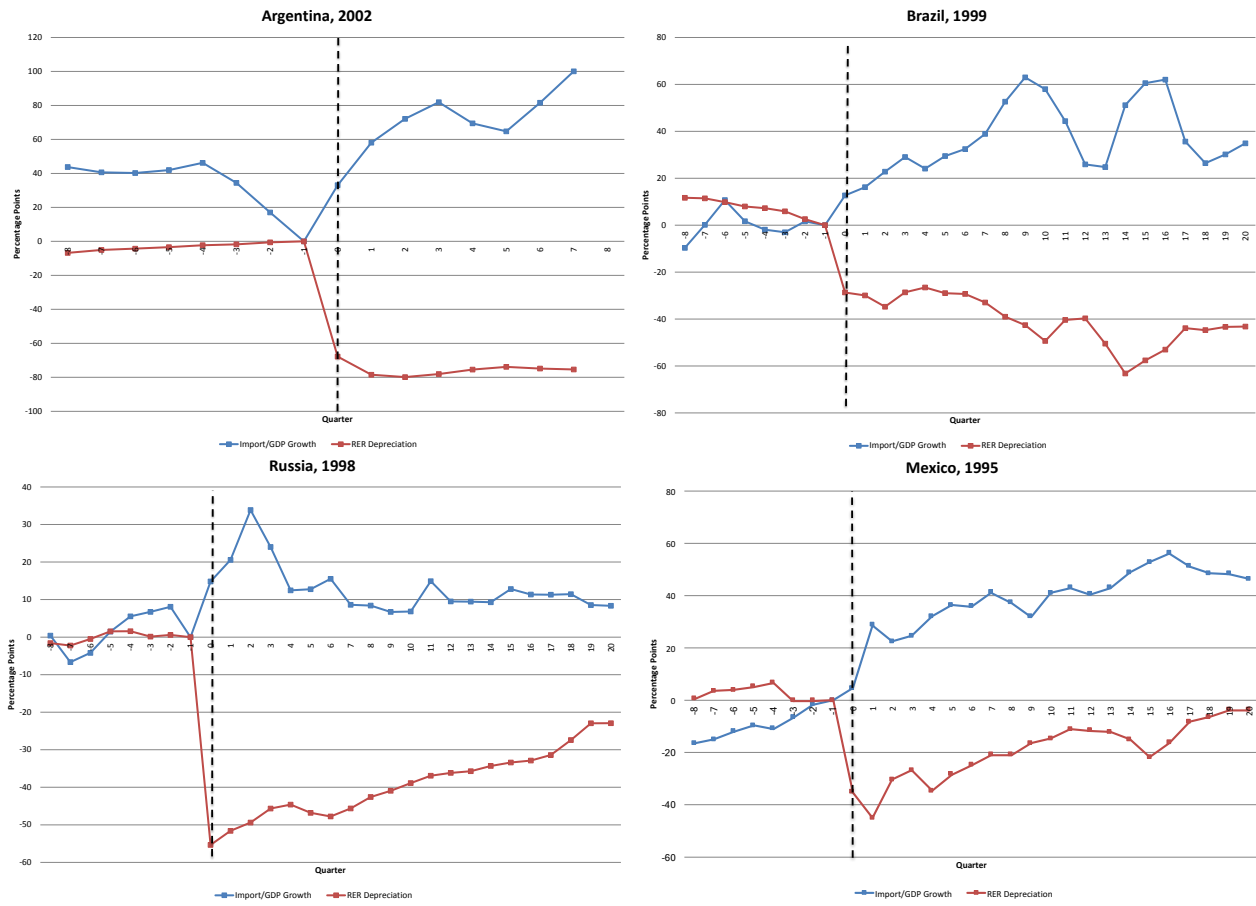


Figure 8: Imports to GDP Ratio After Large Devaluations, By Country

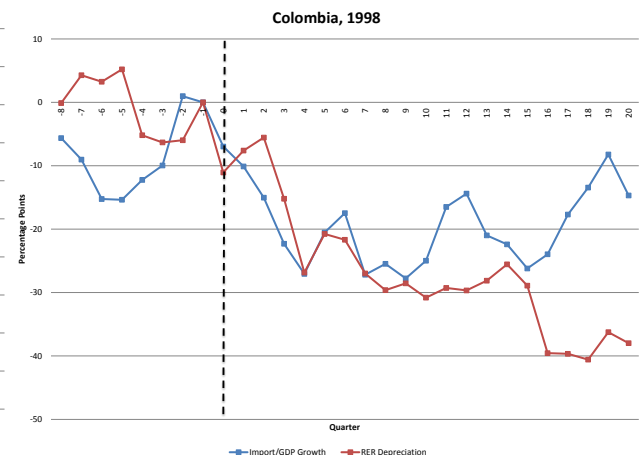
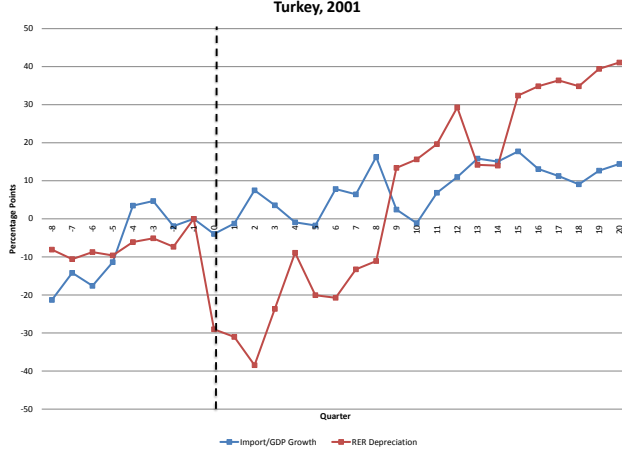
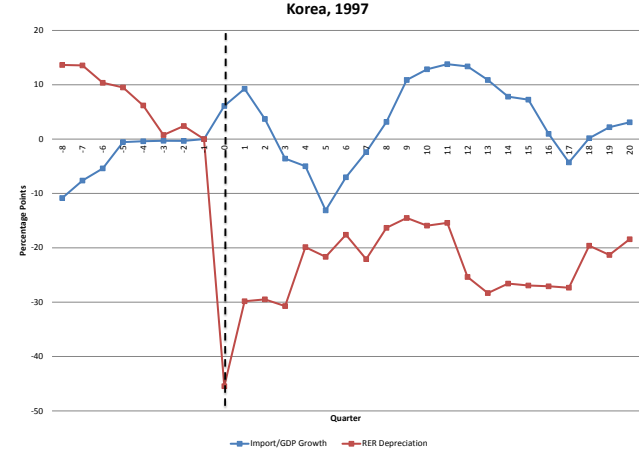
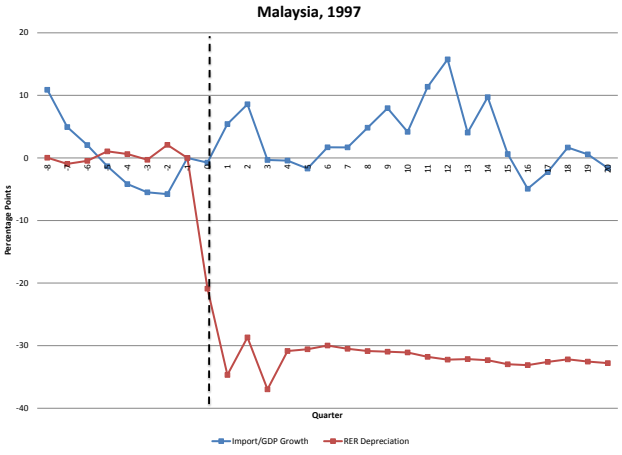
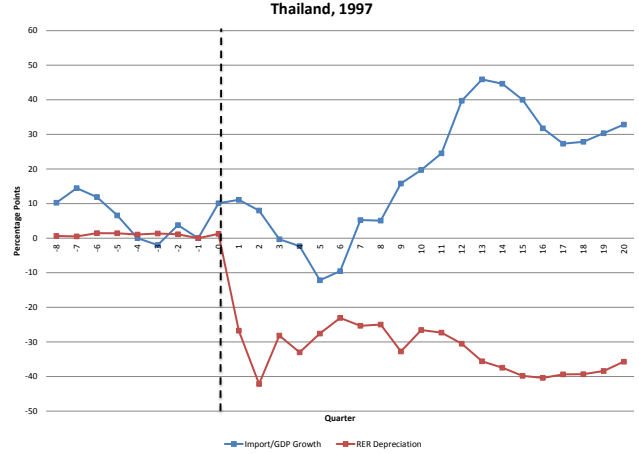
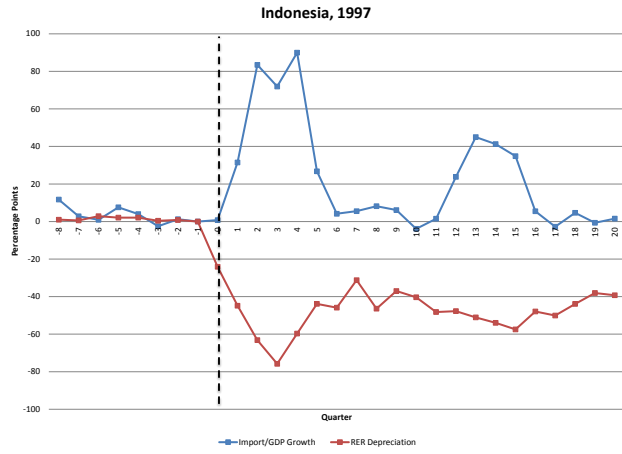


Figure 9: Imports to GDP Ratio After Large Devaluations, By Country

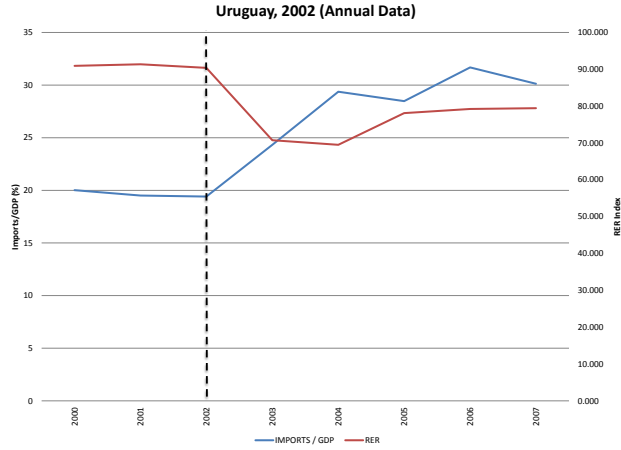
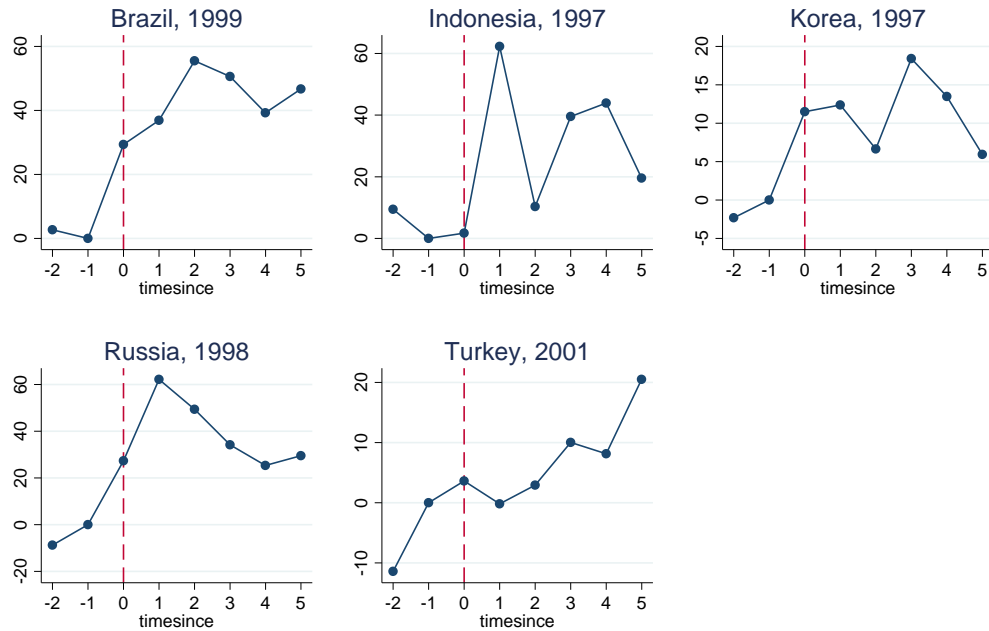


Figure 10: Imports to GDP Ratio, Uruguay



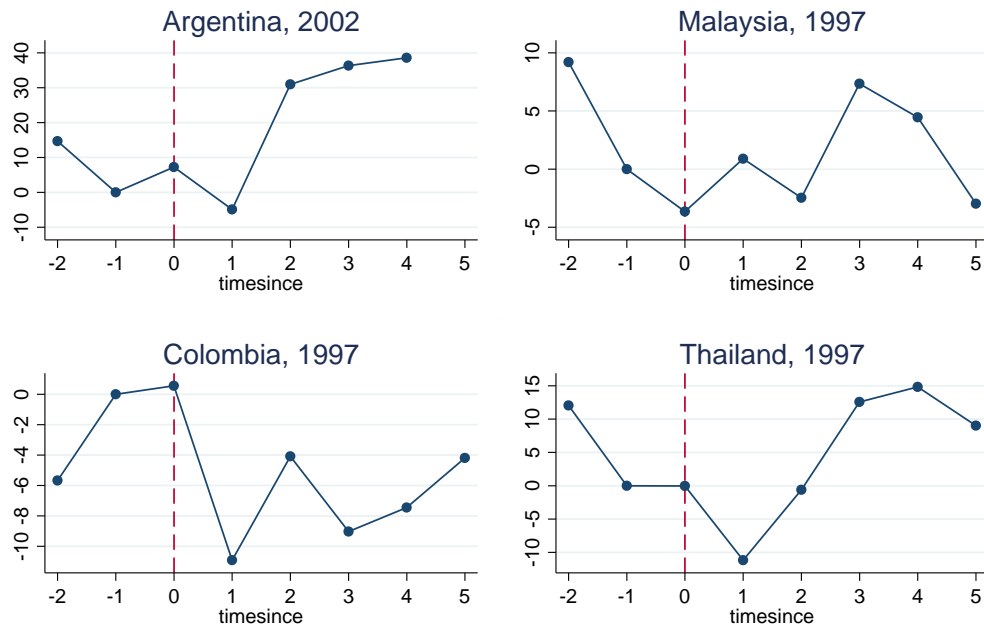
Notes: The Figure depicts the rate of growth of an index of import volume (left axis) and of real GDP (right axis) between a given quarter and the quarter before the devaluation (labeled -1). The quarter of the devaluation is labeled 0. Data for the volume of imports is available only for Argentina, 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 11: Import Volume and Real GDP after a Large Devaluation



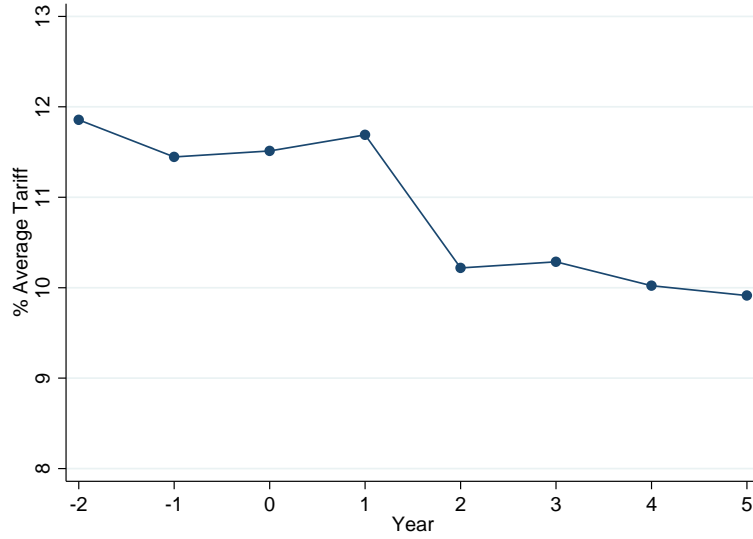
Notes: The Figure depicts the rate of growth in the ratio of imported inputs to total (imported plus domestic) inputs between a given year and the year before the devaluation (labeled -1). The year of the devaluation is labeled 0. Source: WIOD.

Figure 12: Aggregate Import Share After Devaluations, By Country



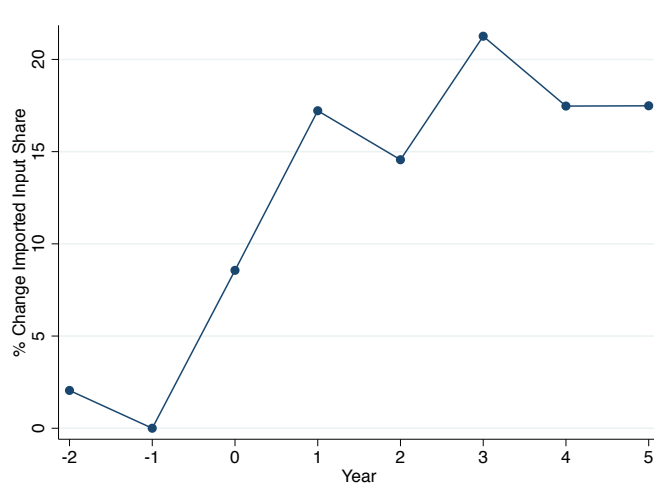
Notes: The Figure depicts the rate of growth in the ratio of imported inputs to total (imported plus domestic) inputs between a given year and the year before the devaluation (labeled -1). The year of the devaluation is labeled 0. Source: OECD.

Figure 13: Aggregate Import Share After Devaluations, By Country (ctd)



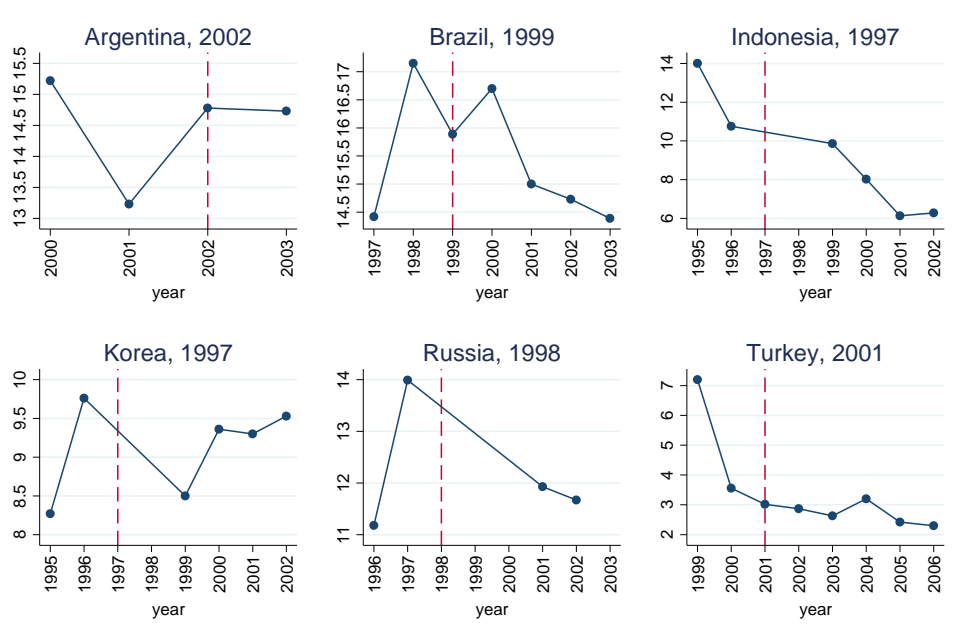
Notes: The Figure depicts the average ad valorem tariff rate (in percentage points) in the sample of countries of Table 1. For each country, the tariff rates is a simple average of the effectively applied rates for all products. The year of the devaluation is labeled 0. Source: World Development Indicators.

Figure 15: Tariffs After Devaluations



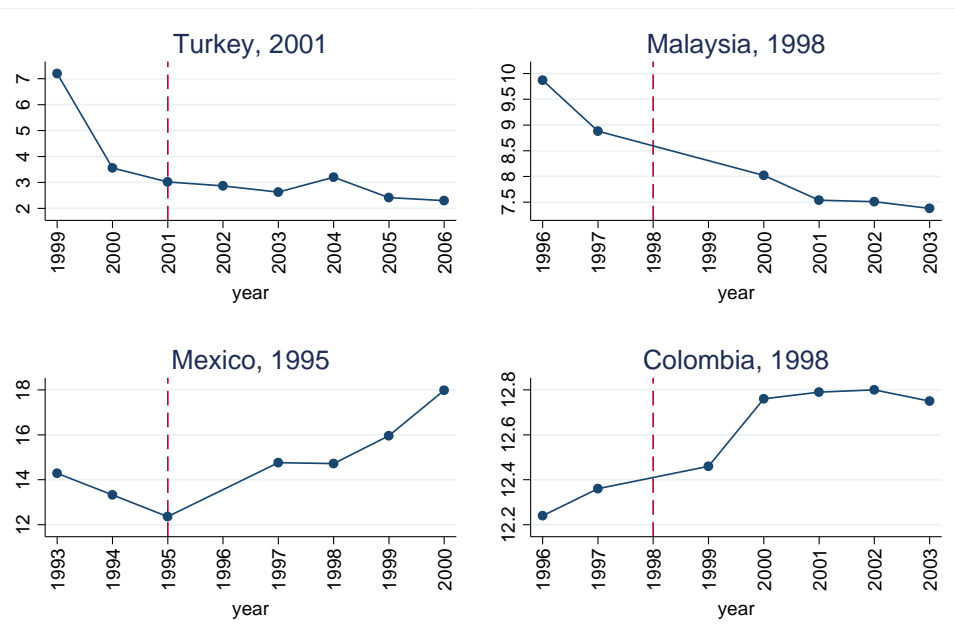
Notes: The Figure depicts the rate of growth in the ratio of imported inputs to total (imported plus domestic) inputs in the Manufacturing sector between a given year and the year before the devaluation (labeled -1). The year of the devaluation is labeled 0. The lines in the Figure is an average of the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

Figure 14: 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 1. 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 16: 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 1. 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 17: Tariffs After Devaluations, By Country (ctd)

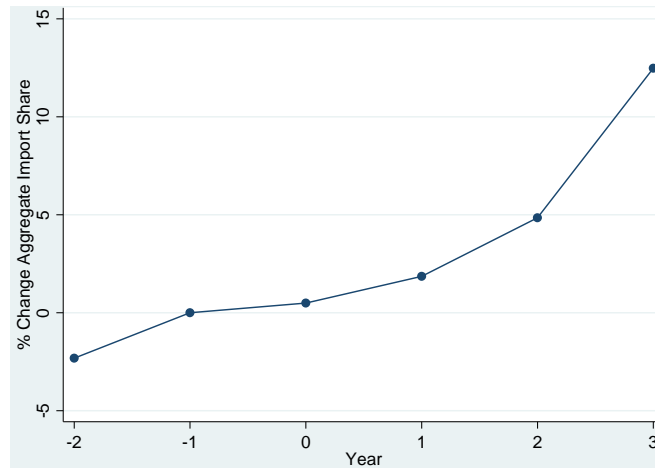
Dep. var. $\log(m_{jct})$	(1)	(2)	(3)	(4)
$deva_{ct}$	0.10*** (0.01)	0.10*** (0.01)	0.10*** (0.01)	
τ_{ct}		-0.09*** (0.03)	-0.09*** (0.01)	-0.03*** (0.01)
$\log(RER_{ct})$				-0.23*** (0.01)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes
Country x Sector FE	No	No	Yes	Yes
Obs	34,765	30,579	30,579	24,519
R^2	0.72	0.74	0.93	0.94

Table 14: Aggregate Import Share: Sector-level Analysis

Year	Within	Between	Covariance	Entry	Exit	All
2000	-1.383	-2.676	6.867	25.95	16.29	12.48

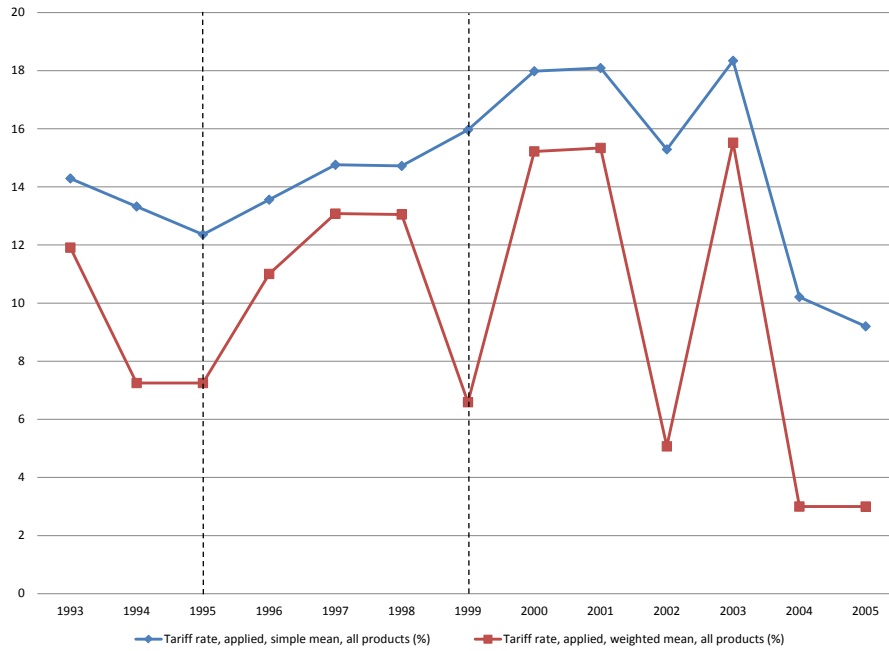
Notes: The Table contains the decomposition of the aggregate import share given in (2) for Indonesia between 1996 and 2000. The column “All” reports the total increase in the aggregate import share ($\Delta s_{AGG}/s_{AGG1}$). All values are in percentage points. Source: Survey of Manufacturing, SI.

Table 15: Accounting for the Change in the Aggregate Import Intensity: Indonesia



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 18: The Aggregate Import Share in Manufacturing after the Indonesian Devaluation



Notes: The Figure depicts the average ad valorem tariff rate (in percentage points) in the sample of countries of Table 1. 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 19: Tariffs After Mexican Devaluation

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 16: 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

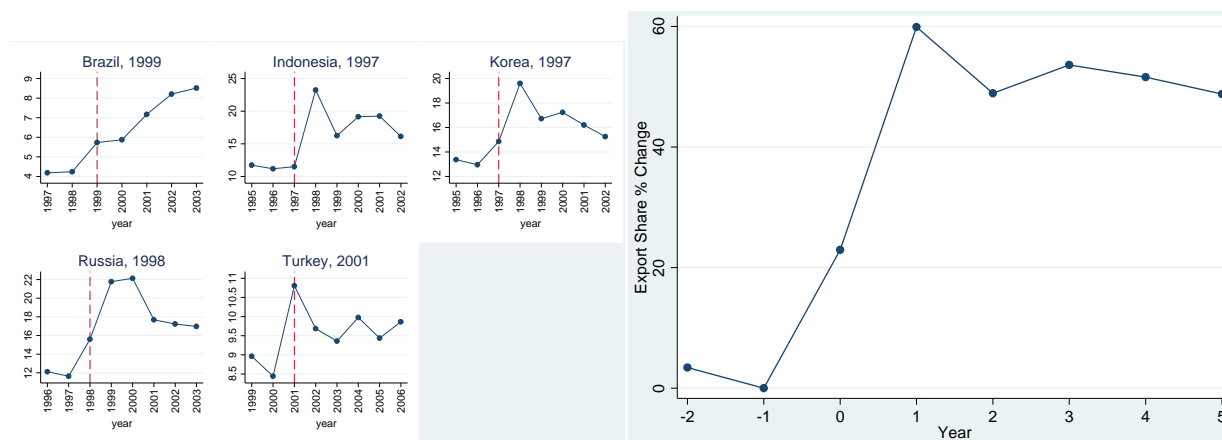
Table 17: Sector Level Decomposition, Within and Between Component

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

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 19: Trade Deficit: Models vs Data



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 20: 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 18: Other Parameters

6.2 General Equilibrium

To be added.