International Trade, Volatility, and Income Differences

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Abstract Developing countries trade less than rich countries. I show that this lack of involvement in trade arises because high domestic volatility discourages exporters' investments in foreign market access. At the cross-country level, I find that country's TFP volatility explains 40% of the relationship between trade and GDP per capita. Using Colombian micro-level data, I document that exporters facing higher domestic sales volatility export less. In industries with more domestic sales volatility, new exporters expand relatively less over their life cycle. This dampening of the firm-level export expansion path is more severe in products with more variable markups. Motivated by these novel firm-level findings, I develop an international trade model with new exporter dynamics and non-CES demand that can account for the novel facts at the firm and the cross-country levels. These findings suggest that trade frictions calculated using static trade models reflect the interactions of domestic volatility and exporters' investment decisions to grow into foreign markets. Indeed my quantitative findings show that the volatility differences across countries are equivalent to a 30% higher trade cost in developing economies. These volatility differences account for 40% of the differential trade cost estimated by static models.

JEL Classifications: F10, F12, F14, F23, F63, O19, O24

Keywords: Income differences · Exporters Dynamics · International Trade · Volatility · Firms Dynamics · Uncertainty

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1 Introduction

Living standards vary significantly across the globe and with them the patterns of international trade. Countries with a higher level of development have more exporters per capita that are larger and more likely to continue exporting. [1] Consequently, developed countries export more than less developed ones. These facts have been attributed to less developed countries facing relatively high export costs. Furthermore, these costs have been estimated to have large impacts on the level of development.[2] But how can we unleash the benefits of eliminating these trade costs? To answer this question, we need to understand the source of these relatively high trade costs.

This paper shows that developing countries export less mainly because they are more volatile. The domestic volatility that firms face affects their incentives to invest in growing into foreign markets, depressing exporters' growth and total trade. Domestic volatility has a relatively large effect on trade because the costs of investing in foreign market access are relatively high. [3] I show that the interaction between the domestic volatility and the trade frictions that affect firm growth into foreign markets, explains most of the relationship between development and international trade.

In sections 3 and 4, I document new facts about domestic volatility and trade. Firstly, I present cross-country evidence on the relevance of domestic volatility to explain export differences. Three salient features stand out in the cross-country data: (1) developing countries have higher TFP volatility; (2) more volatile countries export less conditional on the level of development and standard gravity variables; and (3) the role of development on trade is substantially reduced after controlling for macro or microeconomic volatility. Indeed, volatility seems to have a much stronger effect on trade than the level of GDP per capita.

Secondly, I show that industry volatility shapes the pattern of expansion of individual firms. Specifically, I use Colombian firm-level data on domestic and international transac-

[1] See A. Fernandes et al. (2015) for a study of the relationship between exporter characteristics and development.
[2] See recent work by Waugh (2010), Blum et al. (2019), Fieler (2011) and de Sousa et al. (2012).
[3] See recent work by Das et al. (2007), Alessandria et al. (2021a)

tions to document three novel features of firm dynamics[4]. First, exporter growth is driven by increases in the relative demand of the market, similar to the findings of Fitzgerald et al. (2021) and Steinberg (2021). Second, exporters more exposed to domestic volatility grow slower in their export markets than in their domestic market. Third, the negative relationship between export growth and volatility is stronger for products with more responsive markups to exchange rate shocks. The second fact implies that higher domestic volatility reduces exporter incentive to invest in foreign markets. The third fact shows that variable markups can be important to explain the negative relationship between exporter expansion and domestic volatility.

I build a dynamic model with firm heterogeneity and new exporter dynamics to quantify the role of volatility for trade. The model extends the new exporting dynamic model to allow for a variable price elasticity and thus variable markup. Two main reasons motivate this model: (1) the firm-level data suggest that variable markups are relevant to understand the negative relationship between volatility and exports, and (2) this allows me to test the relevance of this microeconomic mechanism. [5] I show that the standard models with CES-demand cannot match the documented micro-level facts.

Section 6 turns to the quantitative analysis. I use the model to test to what extent the micro-level mechanism can explain the novel aggregate and micro-level findings. I estimate the parameters of the model to match Colombian aggregate average trade openness, the evolution of exporters over their life cycle in firm-level fact 1, and my causal estimates on heterogeneous markup response to changes on firms' marginal cost. The model can account for firm-level fact 2 regarding the adverse effects of higher domestic sales volatility on exporters' growth.

Next, I proceed to test the ability of the model to replicate the cross-country relation between total exports and volatility. I simulate economies with different levels of volatility on their aggregate and firm-level productivity. I compute the ergodic distribution of the model

[4] A key advantage of the data is that it allows me to separate domestic from international shocks

[5] I refer to standard models of new exporter dynamics as those that have: (1) monopolistic competition, (2) constant price elasticity, (3) fixed export costs, and (4) a market-specific investment decision that increases future sales conditional on firm's prices.

and observe how their total export responds to different levels of volatility in four different versions of the model. The four models are (1) a standard static model with firm heterogeneity, (2) a static model with variable markups, (3) a dynamic model assuming constant price elasticity, and (4) the my dynamic model with variable markups. All but my model predict a positive or null relationship between domestic volatility and total exports, at odds with the empirical findings. These results show the macroeconomic relevance of the micro-level findings documented in the data. Assuming that exporters make a static decision or that they face demand with constant price elasticity comes at the cost of missing the relationship between aggregate export and the level of volatility.

The quantitative predictions of the model are striking. Keeping macroeconomic volatility unchanged, if developing countries were to reduce their microeconomic volatility to the level of developed ones, their exports would increase on average 97%. When I perform a similar exercise for the macroeconomic volatility, I find that exports in developing economies will grow by 26%. To put these results in context, they imply that the average volatility difference between developing and developed countries is equivalent to developing countries facing on average 30% higher iceberg costs. In this sense, the proposed mechanisms can account for 40% of the differential trade cost that developing countries face as estimated by de Sousa et al. (2012). These results highlight the importance of domestic volatility as a determinant of endogenous trade barriers. The interaction between the domestic volatility and the investment cost that firms face to grow into foreign markets significantly affects exports.

Literature. The paper relates to several strands of literature at the intersection of macroeconomics, international trade, and development.

The main contribution of this paper is to understand why developing economies engage in less international trade than developed ones. To the best of my knowledge this is the first paper showing that domestic volatility explains most of the differences in the estimated export costs in developing economies. The literature goes back to the findings of Rodrik (1998) suggesting the low export performance in Sub-Saharan countries was mainly due to trade costs, similarly Limao et al. (2001) shows the relevance of the lack of infrastructure to explain part of the relatively low levels of trade in these countries. On the other hand, Waugh (2010) shows that to match the data on trade and prices, export costs in developing economies need to be higher than in developed ones, de Sousa et al. (2012) find similar empirical results using the border effects methodology. In contrast, Fieler (2011) argues that the existence non-homothetic preferences in demand for goods may be important to understand this relationship. These findings follow from models in which firms face static decisions where volatility cannot play an important role by construction. Blum et al. (2019) departs from the static frameworks with the insights of inventory models to understand this relationship. They argue that the shipment data suggest higher per-shipment costs to export in developing economies explaining part of the export cost. My approach differs to those in the literature in two ways: (1) I rely on the insights of the predictions of dynamics models, and (2) I show that the estimated trade costs are an equilibrium outcome of the interaction between domestic volatility and the dynamic nature of exporter decisions.

This paper is the first one to estimate how domestic sales volatility affects a firm market-specific growth over their life-cycle. There is an extensive literature on investment under uncertainty that followed the seminal work of Lucas et al. (1971), Hartman (1972), Andrew (1983) and Pindyck (1982). I focus on a particular type of investment, the market-specific investment that firms make to grow into each market, so far ignored in this literature. [6]

In this sense, the present work proposes a new mechanism through which volatility discourages investment — the existence of variable price elasticity — contributing to the literature that studies how economic frictions interact with uncertainty affecting firm investment decisions. Until now the literature has focused on the three main frictions: (1) investments frictions that generate the real option effect (e.g. Pindyck (1982), Bloom (2007), Bloom (2009), Novy et al. (2020), Alessandria et al. (2021c), Martin et al. (2020),Handley et al. (2017)); (2) financial frictions to explain why uncertainty reduces firms investment (e.g. Arellano et al. (2019) and Merga (2020)); and (3) the existence of sticky prices e.g. (Basu

[6] Recent work has found that this investment that work as a demand shifter is essential to explain firms' growth in both their domestic and foreign markets as in Ruhl et al. (2017), Fitzgerald et al. (2021), Steinberg (2021), Alessandria et al. (2021a), Fitzgerald et al. (2018), Einav et al. (2021).

et al. (2017), and Fernández-Villaverde et al. (2015)). My empirical findings show the existence and relevance of variable price elasticity as a novel mechanism complementary to the literature.

The third contribution of this paper is to develop a framework that nest the insights Fitzgerald et al. (2021) to explain how exporters grow and how their growth is affected by domestic volatility. By relaxing the assumption of constant price elasticity the extended model can account for the patterns regarding (1) exporter dynamics over their life-cycle, (2) the heterogeneous markup response to exchange rate shocks, and (3) the negative relationship between exporters growth and domestic volatility. I do this within the framework of a small open economy, allowing me to show the aggregate relevance of my micro-level findings to explain the behavior of total exports.

The fourth contribution of this paper is to the literature on the relationship between prices and exchange rates. The literature has struggled to separate the effects of exchange rates on prices as it is not clear whether the price response is driven by markup or changes in costs. I solve this problem by proposing an estimation procedure to compute the pure markup response to exchange rate shocks without having to estimate the level of markup. In this sense, my results complement Berman et al. (2012) finding that larger firms adjust their prices less than smaller ones due to exchange rate changes, and Amiti et al. (2014) finding that larger exporters also import more, showing that exchange rate changes affect the marginal cost of production. I also propose a new instrumental variable approach to solve the endogeneity problems that may arise due to the use of exchange rates movements.

Layout. The rest of the paper is structured as follows. Section 2 presents the data sources. Section 3 presents the estimation strategy and results for the three aggregate facts. Section 4, documents the micro-level facts using firm-level administrative data from Colombia. Section 5 presents the model, and section 6 its estimation and quantitative results. Section 7 concludes.

2 Data

To document the three aggregate facts I use several data sources: Penn World table database, the Dynamic Exporter Database from World Bank, the Enterprise Survey from the World Bank, and CEPII database.

For the micro-level data and model estimation I use three primary data sources: (1) Administrative data from Colombian customs (2) Administrative data from ”Superintendencia de Sociedades” of Colombia with firm’s balance sheet information, and (3) Colombian manufacturer survey.

2.1 Cross country Data

Penn World Tables. This data cover 183 countries between 1950 and 2019. I use this data for country’s total factor productivity and other aggregate variables such as GDP, and export and import prices. [7]

Dynamic Exporter Database. This data source provides data on the number of exporters, average exports per exporter, entry and exit rates, and new exporter growth. The data is at the origin-destination-year level. This new data has been used by A. M. Fernandes et al. (2019) and A. Fernandes et al. (2015). It provides data to compute the relevance of the intensive and extensive margin of trade to account for the relationship between total exports and volatility. Its disadvantage is the limited coverage of countries. It covers 70 countries from 1990 to 2012, but for most countries only covers from 2005 to 2012.

CEPII. I use two datasets from the CEPII foundation, the ”Gravity” data set and the ”Trade-Prod” data set. [8] The first data provides information on variables relevant to explain bilateral trade across countries, such as the existence of trade agreements, geographical characteristics, variables measuring cultural proximity, and the existence of a common currency. The data set covers the years 1948 to 2019.

[7] See Feenstra et al. (2015) for more details.

[8] see K. Head et al. (2010) and De Sousa et al. (2012) at CEPII foundation webpage for more detailed about these data sets

The "TradeProd" data set provides information on bilateral trade, production, and protection in compatible industry classifications for developed and developing countries. This data runs from 1980 to 2006 for 26 industrial sectors within manufacturing—this data set yields bilateral product level exports across countries. The advantage of this data source over the Dynamic exporter database is the extended period and the number of countries. The disadvantage is the lack of data on the margins of trade for different exporters. The data on manufactures serves as a robustness check to show that the results are not driven by differences in sectoral composition across development levels.

Enterprise Survey from the World Bank. This data set provides comparable data across countries on sales, labor, and capital for firms in each country. I use labor and labor productivity changes to construct comparable measures of the microeconomic volatility in each country.

2.2 Firm-level Data

I use two administrative data sets from Colombia to measure variables at the firm level. The first data set reports exports of each firm at the 8-digit product level for each destination and period. The data is monthly and provides information on the quantities shipped and the value of the shipment in Colombian pesos and U.S. dollars over the period 2006-2019. I aggregate export flows for each firm product destination yearly to avoid the usual problems with lumpiness in trade.[9]

I merge this data with firm-level data from "Superintendencia de Sociedades" which reports the variables firms declared in their balance sheet information. This dataset provides information on firms' total income, operational income, operational cost, total costs, profits, and operational profits, among other variables. These variables are in nominal Colombian Pesos, and I deflate these variables with the production price index. The data sets cover a sub-sample of 20,000, the largest firms representing around 90% of total value-added. The

[9] see Alessandria et al. (2021c) as an example of the lumpiness in trade and its relevance for exporter behavior at high frequency.

sample is skewed towards larger firms generating a concern due to possible bias for firm-level empirical facts. The focus on exporters alleviates this concern, generally the largest firms in the economy, and given the concentration of total exports on larger firms. Furthermore, I show that the firm-level facts are robust to including or not this data in the appendix.

3 International Trade and Volatility Around the World

This section focuses on the cross-country evidence. I document three novel facts. First, I document those countries with higher volatility also have lower GDP per capita.[10] Second, I reexamine the relationship between exports and the level of development. I find that unconditional on the level of volatility, there exists a positive relationship between aggregate exports and level of development as in Waugh (2010), Fieler (2011), Blum et al. (2019), A. Fernandes et al. (2015) and de Sousa et al. (2012). Third, I show that conditional on the level of micro or macroeconomic volatility, the relationship between aggregate exports and GDP per capita reduces almost by half, becoming negligible in some cases. In other words, aggregate fact 1 can explain aggregate fact 2, and I refer to this connection as aggregate fact 3.

I focus on two sources of volatility, the macroeconomic and microeconomic volatility of each country. Macroeconomic volatility refers to the time series volatility of the cyclical component of the aggregate total factor productivity (TFP). Microeconomic volatility is the average cross-section standard deviation of changes in firm's labor productivity at the firm level. The aggregate facts that I document in the following section show the relevance of different sources of volatility to explain the estimated trade frictions that prevent developing economies from engaging in international trade with the rest of the world.

[10] This first result is consistent with a body of literature showing that more volatile countries growth less such as Ramey et al. (1995),Aghion et al. (2010),Badinger (2010), Imbs (2007), Koren et al. (2007)

3.1 Cross-country Volatility Measure

In this subsection I present the measures of macro and microeconomic volatility. In the appendix A, I use different measures to show that the findings are independent of the measure of domestic volatility.

Macroeconomic volatility measure. I measure the macroeconomic volatility of each country as the time-series standard deviation of the detrended estimated TFP. I proceed in several steps. First, I define $t\hat{f}p_{it}$ as the detrended value of the log of the TFP of each country i at time t.[11]. The measure of TFP comes from the estimates of Penn World Tables. I then proceed to estimate equation (1):

$$\ln \widehat{tfp}_{i,t} = \alpha_{0,i} + \rho_i \ln \widehat{tfp}_{t-1} + e_{i,t} \tag{1}$$

stating that the detrended series of estimated aggregate TFP follows an AR(1) process where t denotes a year. Equation (1) is estimated separately for each of the N countries, generating a vectors of $\{\rho_i\}_{i\,\in N}$ and a time series of the estimated residuals for each country $\{e_{i,t}\}_{i\,\in N}$. I then compute the macroeconomic volatility as the standard deviation of of $e_{i,t}$

Microeconomic volatility measure. To compute the firm-level shocks without the macroeconomic common component that affects firms within a country-industry-year, I follow Yeh (2021) and di Giovanni et al. (2021). For a firm f, in country i, industry j, at time t, I first estimate:

$$\Delta \text{labor prod}_{f,i,j,t} = \gamma_{i,j,t} + e_{f,i,j,t} \tag{2}$$

Where Δlabor prod is the log yearly change in the labor productivity, defined as total sales over total workers, for a firm f in year t [12]. The $\gamma_{i,j,t}$ denotes country-industry-year fixed effects, so that $e_{f,i,j,t}$ can be interpreted as the pure firm-level shocks.

[11] I detrend the series by using an H-P filter with a smooth parameter equal to 100 since I am using annual frequency data

[12] I restrict my sample to those firms that do not declare any direct or indirect export. I do this to avoid computing the direct effects that foreign shocks may have on the volatility of firms.

I compute the microeconomic volatility as the average observed standard deviation across time for each country i as follow:

$$\sigma_i^{\omega} := \sum_{t=1}^{T} \frac{\sqrt{\sum_{f \in F_{i,t}} \frac{\left(\hat{e}_{f,t} - \mu_t^{e_f}\right)^2}{|F_{i,t}|-1}}}{T}$$

where $\mu_{i,t}^{e_f}$ denotes the average of $\hat{e}_{f,i,j,t}$ across firms at year t, and $|F_{i,t}|$ is the total number of firms in country i.[13]

3.2 The Aggregate Facts

In this subsection, I document the three aggregate facts. The three facts together show the empirical relevance of countries' volatility to explain the export differences across levels of development.

Aggregate Fact 1: Negative relationship between per capita GDP and volatility. Figure 1 shows a negative relationship between the average level of GDP per Capita (Y-axis) and each measure of volatility (X-axis). Each variable is presented in logs, and the standard deviations for each measure are in percentage points. When I compare the average level of microeconomic volatility, I find that developing countries are 59% more volatile than developed countries for the sub-sample of countries I have data. When I focus on the macroeconomic volatility, developing countries are on average 74% more volatile than developed ones. [14]

Exports, volatility and income differences: Conceptual framework. I now focus on the relationship between trade, development level, and volatility. Following Keith Head et al. (2014) , and Redding et al. (2004) we can postulate that conditional on a given moment on time, bilateral exports are given equation by (3). It states that conditional on exporting, the logarithm of country i's exports to country j denoted by $\ln(x_{ijt})$ can be decomposed in

[13] I follow the guideline of the World bank to weight each firm by the weights they provide so that the estimates of using the sample are representative for the economy.

[14] I define developed economies as those with a GDP per capita (PPP at 2011 us dollar) above 30,000.

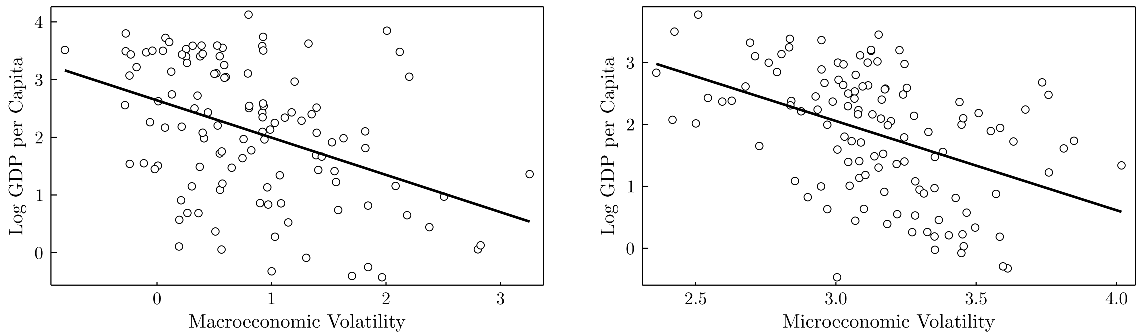


Figure 1: Volatility and GDP per Capita

an origin country fixed effect α_i, a destination time fixed effect γ_{jt} and a vector of bilateral variables captured by $\boldsymbol{y}_{ijt}$, [15]

$$\ln(x_{ij}) = \alpha_i + \gamma_j + \boldsymbol{\beta y}_{ij} + \epsilon_{ij} \tag{3}$$

I follow Keith Head et al. (2014) and Eaton et al. (2002) by using a two-step procedure, to understand the variables that relates with the origin component of a country, α_i. First, I estimate a gravity equation to back up the origin fixed effects, $\hat{\alpha}_i$

After estimating α_i from (4) (denoted by $\hat{\alpha}_i$) I estimate:

$$\hat{\alpha}_i = \beta_0^\alpha + \beta_1^\alpha \ln \sigma_i + \beta_2^\alpha \ln \frac{GDP}{L} + \boldsymbol{\alpha_3} \bar{\boldsymbol{y}}_{ij} + \boldsymbol{\alpha_4} \bar{\boldsymbol{h}}_i + \boldsymbol{\alpha_5} \bar{\boldsymbol{Q}}_i + e_i \tag{4}$$

the equation shows that countries origin fixed are related to country i level of volatility, its GDP per capita, the average of the bilateral-time variables, the average of the origin time-varying variables denoted by σ_i, $\frac{GDP}{L}$, $\bar{\boldsymbol{y}}_{ij}$, and $\bar{\boldsymbol{h}}_i$ respectively. I also control for countries' quality institution, it level of financial development, and direct measures of exporting costs denoted by the vector $\bar{\boldsymbol{Q}}_i$. In particular, I use the three indexes developed by the World Bank that captures the quality of the contract enforcement, the financial development of a country i, and the declared export costs that exporters face.[16] The two main coefficient of

[15] See Keith Head et al. (2014) for a descriptions of models and the history of gravity equations in international trade.

[16] I include these three indexes obeys because they are correlated with the level of development and the volatility of a country and are also relevant for international trade Manova (2008), Manova (2013), Kohn et al. (2020), and Blum et al. (2019).

interest are β_1^α and β_2^α. The former captures the relationship between the average exports of a country and its volatility. The latter captures the relationship between the average exports and its level of development.

Aggregate Fact 2: Positive relationship between exports and income per capita. Table 1 presents the results for both the macro and the microeconomic volatility measures. Each of the 4 four columns presents a different specification. Column (1) estimates (4) without controlling for the volatility of a country. In columns (1) and (2) the only controls are for the declared export cost in the Doing Business survey, besides the standard gravity controls. Columns (3) and (4) add controls for the level of financial and contractual enforcement index for each country reported in the same data set. Both results show significant and relevant relations between the level of development and the average export to each market, even after controlling by country size (proxied by the average level of GDP and population).

Aggregate Fact 3: Negative relationship between volatility and exports. In Table 1, columns (2) and (3) are homologous to column (1) and column (2) but add the variable of interest, the macro or microeconomic volatility measures. The results in columns (2) and (3) of panel 1 show that the estimated relationship between exports and the level of GDP per capita drops between around 45% controlling for the level of macroeconomic volatility of each country and that it becomes non-significantly different from zero.

Panel 2 of Table 1 shows that after controlling for microeconomic volatility the relationship between average exports and the level of GDP per capita reduces by around 35%. There is one difference worth mentioning among these panels, as mentioned before there is only data on labor productivity changes for a subset of countries restricting the number of countries in Panel 2 of 1.

The previous results show that macroeconomic and microeconomic volatility are essential variables to predict average exports to each market. They not only predict considerable variations of average exports across countries but also capture a significant share of the variations that had been attributed to the level of development studies such as in Waugh (2010),

Table 1: Volatility and Exports Around the World

Panel 1: Macro-Economic Volatility and Average Exports

	Av. Exports	Av. Exports	Av. Exports	Av. Exports
$log(\frac{GDP}{L})$	0.50**	0.30	0.40*	0.19
	[0.19]	[0.18]	[0.20]	[0.20]
log(Macro-Volatility$_i$)		-0.64**		-0.64**
		[0.23]		[0.23]
First-stage Observations	174,025	174,025	174,025	174,025
Numb. Countries	109	109	109	109
R^2	0.55	0.59	0.56	0.60
Year × Destination × Product FE	✓	✓	✓	✓
Gravity Controls	✓	✓	✓	✓
Doing Business	Exp.	Exp.	Exp/Cred/Cont	Exp/Cred/Cont

Panel 2: Micro-Economic Volatility and Average Exports

	Av. Exports	Av. Exports	Av. Exports	Av. Exports
$log(\frac{GDP}{L})$	0.77***	0.50**	0.63***	0.43**
	[0.19]	[0.22]	[0.17]	[0.20]
log(Micro-Volatility$_i$)		-1.46**		-1.45**
		[0.68]		[0.66]
First-stage Observations	39,439	39,439	39,439	39,439
Numb. Countries	38	38	38	38
R^2	0.83	0.85	0.84	0.86
Year × Destination × Product FE	✓	✓	✓	✓
Gravity Controls	✓	✓	✓	✓
Doing Business	Exp.	Exp.	Exp/Cred/Cont	Exp/Cred/Cont

Standard errors in brackets. Error cluster at country level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Fieler (2011), and Blum et al. (2019). The three aggregate facts provide an important explanation of why exports costs and exports values seem to be empirically associated with variations in the level of development even after controlling for the standard determinants of international trade.

More importantly, these results challenge our understanding of the determinants of international trade. This is because, in standard models that allow for exporters dynamics, higher volatility will increase exports because of the presence of the "Oi-Hartman-Abel" effect[17]. I will show later that this result depends on the assumption of the demand that firms face. In particular, I will show that once we allow for a demand that generates variable price elasticity similar to what we observe in the data the "Oi-Hartman-Abel" effect disappears.

3.3 Volatility and The Margins of Export

To understand how differences in volatility translate to smaller total exports I examine how the different margins od trade reacts to these differences in levels of volatility. This allows us to obtain the observed relevance of each margin.

The three margins of exports: Conceptual framework. Let N_{ijt}^{exp} be the number of exporters, z_{ijt}^{*} be the productivity threshold at which exports decide to exit exporting, and $x(z_{f,t})_{ij}$ be the exports of a firm with productivity $z_{f,t}$. The total exports from country i to j, ,$X_{ij,t}$, can be expressed as the number of exporters available on the economy multiplied by the average export per active exporter from i to j, denoted by $\bar{x}_{ij,t}$:

$$X_{ij,t} = N_{i,t}^{exp} \underbrace{\int_{z_t^*}^{\infty} x_{ij}(z_{f,t}) dG(z_{f,t})}_{=\bar{x}_{ij,t}} \tag{5}$$

Assuming these variable are a function of the micro or macro volatility of country i, we can decompose the relevance of each margin. Equation (6) follows after applying logs to

[17] I refer to "Oi-Hartman-Abel" effect to the effect in which higher volatility increases the expected return on investment. Increasing firm's investment and size.

(6) and taking the derivative with respect to the volatility measure $\ln \sigma^x$, making use of the Leibniz integral rule:

$$
\begin{aligned}
\frac{\ln X}{\ln \sigma^x} = & \underbrace{\frac{\ln N^{exp}}{\ln \sigma^x}}_{\textit{Ext. margin}} \\
& + \frac{1}{\bar{x}} \underbrace{\left(\int_{z_t^*}^{\infty} \overbrace{\frac{\partial \ln x(z_f)}{\partial \ln \sigma^x}}^{\textit{Unc. adjustment}} x(z_f) dG(z_f) + \int_{z_t^*}^{\infty} \overbrace{\frac{\partial \ln g(z)}{\partial \ln \sigma^x}}^{\textit{Distr. adjustment}} x(z_f) dG(z_f) \right)}_{\textit{Int. Margin}} \\
& + \frac{1}{\bar{x}} \underbrace{\frac{\partial z^*}{\partial \ln \sigma^x} \frac{g(z^*)}{1 - G(z^*)} x(z^*)}_{\textit{Comp. margin}}
\end{aligned}
\tag{6}
$$

In equation (6) I have dropped the sub-index denoting the pair of countries (ij) and time (t) to simplify notation. It states that the response of total exports to changes in volatility can be decomposed into three margins: (1) the extensive margin, (2) the intensive margin, and (3) the compositional margin.

The extensive margin response states how the number of exporters responds to changes in volatility. The intensive margin captures how the incumbent exporters change their exports in response to changes in volatility. The compositional margin states how much exports of the marginal exporters change as a response to changes in the measure of volatility.

Equation (6) shows that the intensive margin can be decomposed as the sum of two sub-margins. The first sub-margins denote the effects of higher volatility on firms conditional on their productivity level, and I call this the uncertainty adjustment. The second sub-margin captures changes in the distribution of productivity conditional on the export level of each exporter, and I call it the distributional channel.

Suppose that conditional on firm productivity, the effect of volatility on a firm's export is zero. The only impact that changes in volatility will have on the intensive margin will be changing the relative weights of firms' productivity. It will only affect the intensive margin through changes in the distribution of realized productivity. This is the case in any static type of model where all decisions are the statics. If more volatility generates an increase in the share of the relatively more productive firms, the average productivity of the incumbent exporters will increase. But firms' exports will be the same conditional on the level of productivity. In this example, the effect of the uncertainty adjustment is zero. In contrast, the impact of the distributional adjustment is positive.

Empirical relevance of the margins of exports. Given the data availability, I can only compute two components, the extensive margin and the intensive. Following Keith Head et al. (2014) I treat the compositional effect as the unexplained component once we account by the intensive and extensive margin in the total relationship between total exports and volatility:

$$\textit{Comp. margin} = \textit{Total elasticity} - \textit{Int. Margin elasticity} - \textit{Ext. Margin elasticity}$$

To measure the relative importance of each margin, I follow the two-step strategy described before. I change the dependent variable to be the log number of the exporter and the average exports per incumbent exporter. Panel 1 of Table 2 shows the result with macroeconomic volatility measure as the independent variable. Column 1 shows the relationship between total exports without controlling for volatility. In column 2, I control for the macroeconomic volatility. Columns 3 and 4 show the relationship between the number of the exporter, the extensive margin, and the average exports per incumbent, the intensive margin. I find that controlling for the macroeconomic volatility captures around 35% of the relationship between GDP per capita and average exports per destination. Columns 3 and 4 proceed to decompose the margins of trade. The results show that 85% of the relationship between exports and aggregate volatility is due to the extensive margin, 30% to the intensive margin, and -15% to the compositional margin.

Table 2: Margins of Trade and the macroeconomic Volatility

Panel 1: Macro-Economic Volatility and Average Exports

	Total exports	Total exports	Exporters	$\text{Exports}_{\text{Inc. firm}}$
$\frac{\text{GDP}}{\text{L}}$	0.78***	0.45**	0.81**	-0.36
	[0.21]	[0.17]	[0.09]	[0.21]
ln Macro-Volatility$_i$		-0.88***	-0.76**	-0.24
		[0.30]	[0.12]	[0.30]
First-stage Observations	36229	36229	36229	36229
R^2	0.89	0.92	0.94	0.86
Numb. Countries	29	29	29	29
Year × Destination × Product FE	✓	✓	✓	✓
Gravity Controls	✓	✓	✓	✓
Doing Business	Exp/Cred/Cont	Exp/Cred/Cont	Exp/Cred/Cont	Exp/Cred/Cont

Panel 2: Micro-Economic Volatility and Average Exports

	Total exports	Total exports	Exporters	$\text{Exports}_{\text{Inc. firm}}$
$\frac{\text{GDP}}{\text{L}}$	0.74***	0.53**	0.96***	-0.39*
	[0.20]	[0.24]	[0.14]	[0.20]
ln Micro-Volatility$_i$		-1.42**	-0.78**	-0.97**
		[0.61]	[0.38]	[0.43]
First-stage Observations	36229	36229	36229	36229
R^2	0.85	0.87	0.94	0.86
Numb. Countries	38	38	38	38
Year × Destination × Product FE	✓	✓	✓	✓
Gravity Controls	✓	✓	✓	✓
Doing Business	Exp/Cred/Cont	Exp/Cred/Cont	Exp/Cred/Cont	Exp/Cred/Cont

Standard errors in brackets. Error cluster at country level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Panel 2 of Table 2 shows the result when I use the microeconomic volatility measure, with 68% of the reduction in exports due to the intensive margin, 55% is because of the extensive margin, and -23% is associated with the compositional margin. This finding suggests that volatility generates higher sorting into the export market and that the uncertainty channel is big enough to counteract the possible positive effect that higher volatility has through the distributional margin.

3.4 Robustness

While aggregate facts 1 and 2 are well known and documented in the literature, aggregate fact 3 is new. In this subsection I present different robustness tests to test the validity and robustness of the aggregate fact 3. The result of the robustness are presented in the appendix A.

Measurement of macroeconomic volatility. One concern of the present estimation strategy is the extent to which results are robust to other measures of the origin country volatility. I compute the aggregate volatility of the standard deviation of log changes of GDP instead of the estimated TF. I also check if the results are invariant to the use of different filter methods to detrend the TFP series. I find that leads to similar results.

Global factors in the measurement of macroeconomic volatility. Another concern is that the volatility measures may reflect both global and domestic components. If foreign demand volatility discourages exports, and that is also making some countries more volatile this will generate similar predictions to the ones I have documented. To deal with this concern, I regress the cyclical component of the TFP against a year fixed effect. Then I use the residuals of this estimation to construct the volatility of each country. This step allows purging out the effect that is common across countries. Results hold regardless of these approaches.

Measurement of microeconomic volatility. The main concern using this measure of microeconomic volatility is that in some models, the labor productivity may reflect the average markups of the firm. To solve this problem, I also use labor changes as another measure of firms' domestic volatility. Results hold regardless of using labor changes within the firm to compute the volatility.

Trade composition and volatility. If the country's structure of production affects both its volatility and its total exports, this may generate similar results as the one I find. For example, a country may specialize in producing an industry whose product is particularly difficult to export but with more volatile production. In this case, volatility is not behind the country's low export performance but rather its structure of production. To test for this possibility, I focus only on the manufacturing sector and proceed in the same way as before. Performing these exercises does not change the findings documenting in aggregate fact 3.

Reverse causality problem. Another concern of the relationship is the fact that low trade generates more volatility. A possible reason behind this relationship is that as countries find it harder to increase exports or decrease imports, they are less able to smooth the domestic shocks through international borrowing and lending. This lack of ability to smooth the shocks may increase volatility in the estimated TFP or in GDP. This conjecture was tested by Razin et al. (1992), and they did not find significant changes volatility after episodes of trade or capital flow liberalization. To test if this may be a concern, I use the variation of the pre-sample period in TFP from 1950 to 1975. This allows me to construct the measure of volatility during a period in which trade was low for most countries relative to the observed levels of trade openness observed after 1980. Proceeding this way presents a volatility measure potentially unrelated to the shocks that may have affected its level of estimated volatility. Focusing on a period of a relatively small level of trade across the globe allows me to reduce the relative difference in volatility due to the differences in trade across countries. I find that those results are stronger when using this out-of-sample measure of volatility.

4 Volatility and Exporters Growth

In the previous section, I have documented three facts that show the relevance of domestic volatility to explain why developing economies engage in less trade. This empirical relationship is important since standard models are not able to reproduce it, as will show later. In this section, I focus on the exporter micro-level data from Colombia to show that those exporters that face higher domestic volatility grow less over their life cycle. I show that given the way exporters grow into foreign markets, volatility discourages the market-specific investment exporters make to grow into foreign markets.

Micro-level fact 1: New exporters grow through increases in their demand. I revisit the facts documented in Fitzgerald et al. (2021) and Steinberg (2021) to understand how Colombian exporters grow over their life cycle. I focus on two main variables and their evolution over the exporters' life cycle, the quantities and the prices of the product an exporter is selling. By doing this, I show that while, on average, exporters increase the exports over their life cycle, this is not true for observed prices. The result of this subsection show that new exporters grow by increasing their relative demand in each of the markets they serve.

I pin down the evolution of quantities in a particular market, which is defined as six-digit product and destination pair. I estimate the following equation:

$$\ln \text{export}_{i,d,l,t} = \sum_{h=0}^{5} \beta_h \mathbb{I}^h_{\{age=h\}} + \ln p_{i,d,l,t} + \gamma^a_{i,l,t} + \gamma^b_{d,l,t} + \epsilon_{i,d,l,t}$$

where $\text{export}_{i,d,l,t}$ represents the total exports value that firm i is selling of product l to destination d in year t. I project total markets against a dummy variable $\mathbb{I}^h_{\{age=h\}}$ that equals one when the exporters spent h years continuously selling product l to destination d. I controls for the prices of the product, $p_{i,d,l,t}$, and I include firm-product-time fixed effects, $\gamma^a_{i,l,t}$, and product-destination-time fixed effects $\gamma^b_{d,l,t}$. The addition of this fixed effects allows me to purge out the common variation in sales for firm i of product l at time t, while the second set of fixed effects allows to purge out the common variation across exporters within a destination product time.

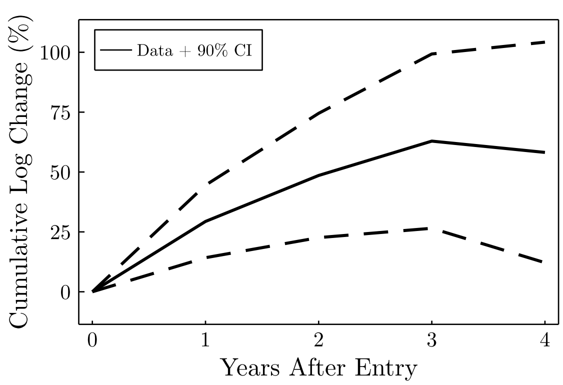
To pin down the price dynamics over the exporter life cycle, I proceed in a similar but without controlling for prices:

$$\ln p_{i,d,l,t} = \sum_{h=0}^{5} \beta_h^p \mathbb{I}^h_{\{age=h\}} + \gamma^a_{p\,i,l,t} + \gamma^b_{p\,d,l,t} + \gamma^c_{p\,\text{cohorts}} + \epsilon_{i,d,l,t}$$

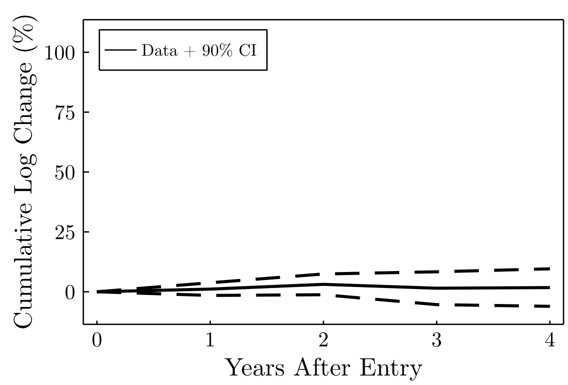
In this case, β_h^p captures the differential changes in prices over the life cycle of the exporter relative to the common variation in prices for that product l at time t.

By construction β_0^p and β_0 are set to zero, so that each estimate of $\{\beta_h\}_{h=1}^H$ or $\{\beta_h^p\}_{h=1}^H$ captures the relative change of the dependent variable to its entry value. I define a new exporter as an exporter that did not export any positive amount to that product-destination market in the last three years[18].

Figure 2 presents the results of the estimation by plotting the estimates of β_h and β_h^p over exporter life cycle. Consistent with the findings by Fitzgerald et al. (2021) and Steinberg (2021) I find that while export sales grow over the life cycle, the prices are basically constant. Exporters grow into markets by facing higher demand conditional on prices.



(a) Sales Dynamics



(b) Price Dynamics

Figure 2: New Exporter Dynamics

[18] This implies that I lose the first three of my sample since I cannot observe if the exporters did any export before.

4.1 Firm's Exposure to Volatility

Having established the way exporters grow over their life cycle, I proceed to show how exporters' growth is negatively related to the domestic volatility they face. Since I can't observe the number of workers, I will use domestic sales changes to construct a measure of how firms are exposed to domestic volatility.

I focus on the domestic sales of the other firms in the same industry to avoid the volatility measure being directly related to firms level shocks or foreign demand shocks. I proceed in three steps to compute firms' exposure to domestic volatility. First, I compute the log change of domestic sales (denoted by $\Delta s^D_{f,t}$). I purged out the aggregate and industry shocks that are common to the firms in the same industry at the same time t, by regressing the change of the log change of domestic sales against industry-year fixed effects to compute the firm-level shocks to domestic sales; this is a similar approach to the one in Yeh (2021), and di Giovanni et al. (2021). I obtain the residual change in the domestic sales, which I interpret as the firm-level shock to domestic sales for firm f at time t. I denote it as $\Delta\hat{s}^D_{f,t}$, as shown in the following equation:

$$\Delta s^D_{f,t} = \gamma_{j,t} + \Delta\hat{s}^D_{f,t}$$

Second I define the set of those exporters whose main product at the six-digit (within the 4-digit category J) level is h^6_J as $F_{h^6_J}$. I compute the average across all periods of the cross-sectional standard deviation of firm-level shocks $\Delta\hat{s}^D_{f,t}$ for all the firms, besides the firm f, for which whose main export product is h^6_J as :

$$\sigma_{f,t,h^6_J} = \sqrt{\frac{1}{|F_{h^6_J}| - 1} \sum_{j \neq f \in F_{h^6_J}} (\Delta\hat{s}^D_{j,t}) - \bar{\Delta} s^D_{j,t})^2}$$

σ_{f,h^6_J} can be interpreted as the average volatility of the firm-level domestic shocks for those firms whose main export product is within the six-digit category h^6_J, leaving out the firm f. Third, I define the set of all firms whose main exported product lies within the HS-4 digit J as F_{h^J}. I then compute firm f exposure to volatility as follows:

$$\sigma_{f,t} = \sum_{h_J^6 \in h^J} \frac{\textit{tot. export}_{2006}^{h_J^6}}{\textit{tot. export}_{2006}^{h^4}} \sigma_{f,t,h_J^6} \tag{7}$$

Equation (7) states that firm f exposure to volatility is the weighted sum of the cross-sectional standard deviation of firm-level domestic shocks, σ_{f,h^6} for those products that belong to the same set F_{h^J}. I compute the weighted sum of this volatility measure by using the industry shares of how much the total exports of the products in category h_J^6 represented of the total exports J at the year 2006.

To clarify how this measure is constructed, let's see an example. Imagine the product tea, a 4-digit category. Within this group, we have green tea and black tea as two potential 6-digits products within the four digit product tea. The measure σ_{f,h^6} computes the volatility of firm-level domestic shocks of those firms whose main product of export is green tea or black tea. While σ_f, is the weighted average of σ_{f,h^6}. σ_f is the weighted sum for the domestic volatility in the sales of green tea and black tea, weighted by how much the exports of green or black tea accounted for over the total exports of tea in the year 2006.

The objective of this construction as a measure of the firms' exposure to volatility is to alleviate some potential concerns. First, by using domestic sales of others firms' firm-level shocks, I alleviate the concerns that the volatility measure may be affected by the shocks affecting that particular firm. Second, by using domestic sales, I do not allow the foreign demand shocks to have a direct effect on the measure of volatility. Second, by fixing the export shares and the main products of the firm in the year 2006, I alleviate the concern that future shocks for some particular products the relevance of that product in total exports.

Micro-level fact 2: New exporters grow less as they are more exposed to volatility. I estimate equation (8) to test if exporters' growth over foreign markets is a function of the sales domestic volatility they face. I estimate the following equation to asses this question empirically:

$$\ln\left(\frac{\text{exp share}_{i,l,d,t+h}}{\text{Init. exp share}_{i,l,d}}\right) = \sum_{j=1}^{5}\beta_j^1 \ln \sigma_{i,t}^{\omega}\mathbb{I}_{\{\text{age}=j\}} + \sum_{j=1}^{5}\beta_h^2\mathbb{I}_{\{\text{age}=j\}} \\ + \gamma_{l,t}^a + \gamma_{d,t}^b + \gamma_{i,t} + controls_{i,m,t} + e_{i,m,t} \tag{8}$$

where exp share$_{i,l,d,t}$ denotes the share of export of exports that firm i, at time t of product l sells to destination d divided by the total sales of the firm. Init. exp share$_{i,l,d}$ is the value of exp share$_{i,l,d,t}$ over the first year of exports to that product-destination market. $\mathbb{I}_{h=j}$ is, as before, the dummy variable that is equal to one if the age of the firm in that particular market is h. I add product-time and destination-time fixed effects denoted by $\gamma_{l,t}^a$ and $\gamma_{d,t}^b$, to capture those variations in the relative growth of the export share that are common to the destination or product for each period of time, and firm fixed effects, γ_i, is to capture the average growth of the export share that is common within the firm. The estimation of $\{\beta_\sigma^j\}_j$ comes different sources of variations: (1) the differences in firms' exposure to domestic sales volatility across time and markets, and (2) by the differential exposure to domestic volatility of those exporters that have different product mixes but that sell to the same market.

Figure 3 shows the estimated differences in the cumulative change of exports over the exporters' life cycle with a tenure of at least five years for each market. It compares the difference of the median exporter in terms of the volatility relative to one exporter facing a standard deviation smaller volatility. The estimates show the relevance of this result, the firm facing one standard deviation smaller level of uncertainty is almost 80% larger after five years. The estimated coefficients are presented in column (3) of Table A.6.

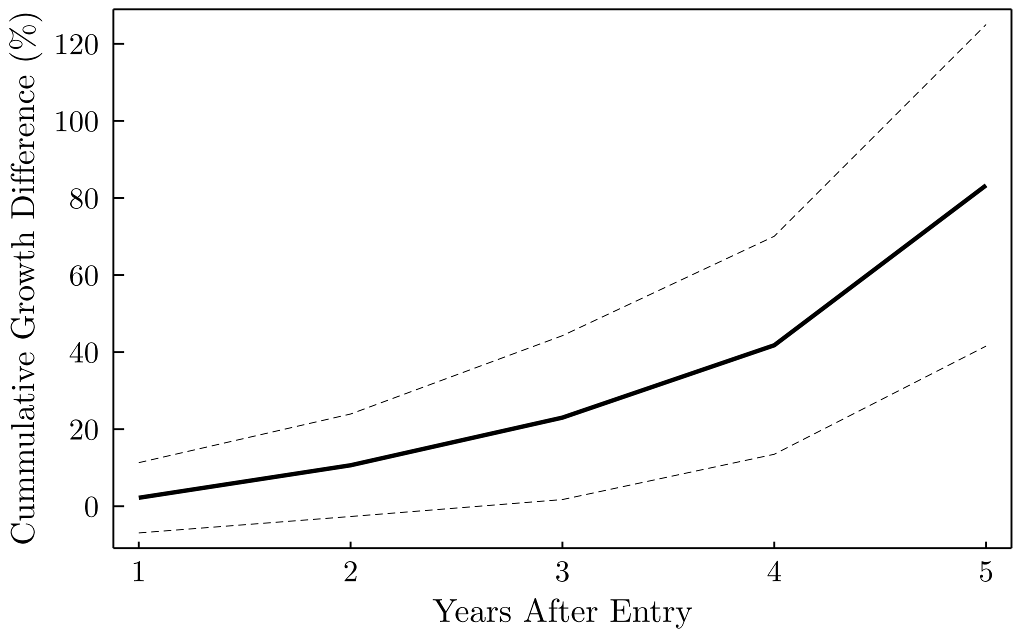


Figure 3: New Exporter Growth and Volatility

5 Volatility and Exporters Dynamic under CES Structure

In this section, I show that standard models cannot generate the observed relationship in the data. I show that when profits are convex in their productivity, this generates a prediction that is contrary to the empirical patterns I have documented. The relevance of these results is given because standard models that assume monopolistic competition, CES demand function, and linear production in labor lies within this category. I show that the Oi–Hartman–Abel effect is present in standard models of international trade[19].

Let $z \in \mathbb{R}_+$ be the realization of a random variable Z and $A \in \mathbb{R}_+$ denote the productivity and the customer capital for a firm. I present two main proposition showing that as A capture how new exporters grow into the foreign markets, standard models assuming monopolistic competition, CES demand function, and linear production in labor cannot math the empirical relationship relating exporters' growth and volatility.

[19] See Bloom (2013) for a description of the Oi–Hartman–Abel effect.

Definition 1: Demand Shifter. *$A \in \mathbb{R}_+$ is a demand shifter if there exist a continuous function $f : A \rightarrow \mathbb{R}_+$, $f' > 0$ and $f'' < 0$ such that the following two conditions holds, (1) $q^d(p, A) = f(A)^d(p, 1)$ and (2) optimal prices do not depend on A. Where $q^d(p, A)$ denotes the demand charging price p, with customer capital A.*

The definition of the demand shifter follows from the empirical pattern I have documented in the previous section. In what follows I assume this to hold, as an assumption that is sufficient to capture the observed pattern in the data regarding exporters' growth. Let $c(A', A)$ denote the investment cost for a firm in changing the customer capital it has from A to A'. Assumption 1 states the usual assumptions about investment under convex adjustment costs.

Assumption 1: Investment cost. *$c(A', A)$ is a continuous differentiable function such that $C_A(.) < 0$, $C_{A'}(.) > 0$, $C_{A,A'}(.) > 0$, $C_{A',A'}(.) > 0$*

Assumption 2: Profits function. *$\pi(z, A)$ is a continuous differentiable function in both arguments.*

Assumption 3: Convex profit function. *The profit function $\pi : (z, A) \rightarrow \mathbb{R}_+$ is convex in z.*

Proposition 1: *For all $A > 0$ and $z > 0$, under assumption A1-A3, the firm's growth rate on its demand shifter, A' is non-decreasing with a mean preserving spread over Z.*

Proof. See appendix C.1

Proposition 1 shows that if the profit function of the firm presents risk-loving in its productivity and the investment has the usual convex adjustment costs, when the firm face a mean preserving spread process (higher risk), the market-specific investment in customer capital will weakly increase conditional on a productivity level and customer level of the firm.

Assumption 4: Demand and market structure. *The market structure of the economy is given by monopolistic competition. The demand the firm,*q^d *is given by* $q^d(p) = Dp^{-\theta}$*, where* $D \in \mathbb{R}_+$ *and* $\theta > 1$.

Assumption 5: Production. *The firm with productivity* z *use a linear technology in labor,* l*, to produce its output. The production* q^s*, is given by* $q^s = zl$

Assumption 4 and 5, describe the usual assumption that are used in the literature of international trade and in the literature studying the dynamic behavior of exporters as in for example Fitzgerald et al. (2021) and Steinberg (2021).

Proposition 2: *Under assumption 4 and 5 the firm's profit functions is convex in z.*

Proof. See appendix C.1

Corollary 1: *Assumption 1 to 5 implies that a mean preserving spread over the productivity of the firm will increase the growth rate of* A *in standard models.*

In the next section, I propose a solution to these counterfactual results just by relaxing one assumption. If we relax the assumption of constant price elasticity, the profits function does can become concave in the firms' productivity. I do this by building a model that nests the standard model in the literature, and I find that once the model is estimated, it can replicate the macro and micro-level facts documented in the empirical section. In this sense the model providing an explanation for the underlying mechanism that generates why developing countries trade less. And it also show the relevance of the existence of variable markups to shutdown the Oi–Hartman–Abel effect.

6 The Model

Motivated by my novel empirical findings, I nest a standard Melitz type of model by adding two features. I first allow firms to build customer in the foreign market as in Fitzgerald et al. (2021), in which firms makes marketing expenditure to shift up the demand they face conditional on prices. This addition allows me to capture the micro-level fact 1 in a simple way. Second, I allow the model to present demand functions with variable prices elasticity by using Kimball (1995) preferences. I parametrize the indirect utility function following the work of Klenow et al. (2016) and Gopinath et al. (2010), as it will be clear in the following sections. I find that allowing for variable price elasticity is enough to generate the aggregate fact three and the micro-level fact on the negative relationship between exporters and volatility. The existence of variable markups shuts down the Oi–Hartman–Abel effect.

In the model, a firm is a tuple of productivity (ω_i) and customer capital (A_i). The firm makes two static decisions, it has to decide to export or not, and the prices that will charge to each of the destinations. Firms produce output using a technology that is linear in labor, denoted by l. In case the firm decides to export today, it collects the profits of selling abroad and pays a fixed cost of exporting f_{exp}. The firm can invest in marketing, i_d, to increase the customer capital it has. The investment in marketing realized in the following year as an increase in demand conditional on the price firm will charge. In case the firm decides not to export, it will not be able to initiate a marketing campaign in the foreign market, and the customer capital it has will depreciate more rapidly.

6.1 Foreign Consumer's Problem

In this subsection, I described the consumer indirect utility function, and I show how it generates variable price elasticity as a function of firms' relative prices.

The foreign consumer takes aggregate quantities, Q^*, and prices, P^*, as given and solve the following problem:

$$\min_{q(\omega)} \int_{\omega \in \Omega} p(\omega) q(\omega) d\omega \tag{9}$$

s.t.

$$\int_{\omega \in \Omega} A(\omega)^{\alpha} \Upsilon \left(\frac{q(\omega)}{A(\omega)^{\alpha} Q} \right) d\omega = 1 \tag{10}$$

where $\Upsilon(x)$ denotes the indirect utility function of the representative consumer[20]. In (10) $A(\omega)^{\alpha}$ represents the customer capital that firm ω has when selling to this particular market.

If we defined $\psi = \Upsilon(.)^{-1}$, the demand for a variety $q(\omega)$ is given by:

$$q(p, A) = \psi(\frac{\tilde{Q}p(\omega)}{P})A(\omega)^{\alpha}Q \tag{11}$$

where P is the price index of the market, defined as $P = \int_{\Omega} \frac{q(\omega)}{A(\omega)^{\alpha}Q}p(\omega)$, and $\tilde{Q}$ is defined by $\tilde{Q} = \int_{\Omega} \Upsilon'(\frac{q(\omega)}{A(\omega)^{\alpha}Q})\frac{q(\omega)}{A(\omega)^{\alpha}Q}$. For what follows I follow Klenow et al. (2016) by assuming that:

$$\Upsilon(x) = 1 + (\theta - 1)e^{\frac{1}{\eta}}\eta^{\frac{\theta}{\eta}-1}\left(\Gamma(\frac{\theta}{\eta}, \frac{1}{\eta}) - \Gamma(\frac{\theta}{\eta}, \frac{x^{\frac{\eta}{\theta}}}{\eta})\right), \; \theta > 1; \; \eta > 0 \tag{12}$$

where θ determines the markup elasticity for a firm selling to the whole market, the parameter η determines the super-elasticity parameter -how sensitive is the price elasticity to the firm's relative prices. Conditional on θ, η is a key parameter that affects how a firm's markups will vary with the firm relative prices. I proceed now to define the choke price, p^c, and to show its existence for this case.

Definition 2 (Choke price): The choke price, $p^c \in \mathbb{R}_+$, is defined as the price such that for all $p \geq p^c$, $q(p) = 0$

Under this definition, together with equation (12), we can characterized the choke price as follows:

$$p^c = e^{\frac{1}{\eta}}\frac{\theta - 1}{\theta}\frac{P}{\tilde{Q}} \tag{13}$$

which together with equation (11) and (12) generates the following demand:

$$\log q(\omega) = \frac{\theta}{\eta}\log(\eta\log(\frac{p(\omega)}{p^c})) + \log A^{\alpha} + \log Q \tag{14}$$

The first thing to note is that $A(\omega)$ is a demand shifter. The second important result is that the demand elasticity to prices, defined as $\epsilon(\omega)$, can be written as a function of the

[20] I assume following Kimball (1995) that $\Upsilon(1) = 1, \Upsilon'(x) > 0\Upsilon''(x) < 0$.

choke price p^c, the price of the firm, and the parameters θ and η:

$$\xi(\omega) = -\frac{\theta}{\eta \log(\frac{p(\omega)}{p^c}))} \tag{15}$$

equation (15) implies that as $\eta \ \to 0$, $\xi(\omega) = \to \theta$ which is the standard CES case. Under this case the model will resemble the standard model of new exporter dynamics as in Ruhl et al. (2017), Alessandria et al. (2021b), Fitzgerald et al. (2021) and Steinberg (2021) . I will show later that the CES case is rejected by the data since the markups respond to changes in the firms' costs. Furthermore, we already saw that under the case of $\eta = 0$, these models would generate counterfactual predictions in terms of the relationship between total exports and domestic volatility.

6.2 Firms Problem

Firm's demand and variable markups. Under standard arguments the optimal price that a firm with marginal cost of production, $\nu(\omega)$, will decide to charge will be given by:

$$p(\omega) = \mu(\omega)\nu(\omega) \tag{16}$$

$\mu(\omega)$ denotes the markup that the firm producing the variety ω charge to the market that is selling to. Equation (15) implies that the firm' optimal will be given by:

$$\mu(\omega) = \frac{\theta}{\theta + \eta \log(\frac{p}{p^c})} \tag{17}$$

Note that equation (17) implies that the markup is decreasing in the price that firms decide to charge. Put it differently, more productive firms will charge higher markups, while less productive firms will charge smaller markups. A result consistent with the findings by De Loecker et al. (2016).

The above result is important to understand why under variable markups, the standard "Oi-Hartman-Abel" effect shutdowns under this setup. On the one hand, when a good shock hits the firm, it will not increase production that much. This is because as the firm reduces prices, the demand becomes less responsive. On the other hand, bad shocks become more costly. This is because as firms translate their shocks to prices, their sales will reduce more rapidly due to the relatively higher prices they face. The existence of variable markup elasticity reduces the profits increases for firms in good time and amplify the reduction in bad times. This effect will dominate over the "Oi-Hartman-Abel" effect if η is large enough. This implies that under these preferences, the existence or not of the "Oi-Hartman-Abel" effect depends on how sensible markup is to the shock firms face.

Firm's operational profits. Since each firm i produces a variety, $z_{i,t}$ and the level of customer capital $A_{i,t}$ are enough to characterize firm's decision. For what follows I drop the index for variety ω, and I refer to a firm by the productivity and customer capital it has.

In this case, the operational profits the firm will collect are given by equation (18) where $\mu(z_i)$ denotes the firm's optimal markups. Since customer capital here works as a demand shifter conditional on prices, I define $\tilde{q}_i^d(p_i) = q_i^d(p_i, 1)$ and re-write profits as:

$$\pi(z_i, A_i) = A_i^{\alpha} p_i \tilde{q}_i^d(p_i) \left(1 - \frac{1}{\mu(z_i)}\right) \tag{18}$$

Law of motion for customer capital. In the model, firms invest in increasing the demand they face conditional on prices. This investment translates into new customers every period after the firm loses a share δ of customers in the process. I follow Fitzgerald et al. (2021) and assume that the law of motion of customer is given by equation (19). Conditional on exporting today, $m = 1$, firms will have a customer capital leve of A_i' tomorrow. If firms do not to export today, $m = 0$, they will not be able to invest in accumulating customer capital, and they will face higher loses of customer at the depreciation δ^{nexp}. I assume that $\delta^{nexp} \geq \delta$ [21].

$$A_i' = m\left(i_d + A_i(1-\delta)\right) + (1-m)A_i(1-\delta^{nexp}) \tag{19}$$

[21] The higher depreciation rate depending on the firms' presence or not in the market that firm generates the hysteresis in the exporters' behavior as having been widely documented by the literature e.g. Giovannetti et al. (1996). The intuition of this behavior is due to the fact that exporters will have an option value to wait as they have higher customer capital

Firm's dynamic problem. In the model, firms take two decisions that will have an impact on their future expected profits and, by so doing, on the expected value of the firm. These decisions are the exporting decision, denoted by m, and the investment to accumulate more customers denoted by i_d. The cost of investing is given by $c(i_d, A_i) = i_d - \frac{\phi}{2}\left(\frac{i_d}{A_i}\right)^2$. Equation (20) shows the problem of the firm conditional on the aggregate productivity $a_{i,t}$, the idiosyncratic productivity level $\omega_{i,t}$ and the customer base the of the firm A_i. I denote with an apostrophe the value of the state variable at t+1, and by Θ the vector of aggregate state variables that are necessary to solve the problem.

$$\begin{aligned} V(\omega_i, A_i, a, \Theta) = \max_{m\in\{0;1\};i_d\in[0;\infty)} &\pi^d(z_i, 1) + m(\pi(z_i, A_i) - f_{exp}) - \\ &- c(i_d, A_i) + \mathbb{E}\left[\Lambda_{t,t+1}V(\omega_i', A_i', a', \Theta')\right] \end{aligned} \tag{20}$$

s.t.: (18), (19)

The decision of exporting or not in this model is a discrete decision given by $m \in \{0; 1\}$. If firms decide to export $m = 1$. In this case, they will collect the total profits from exports, which are the operational profits from exporting $\pi(z_i, A_i)$ minus the fixed cost of exporting, f_{exp}. If they decide not to export $(m = 0)$, firms will only collect the profits for selling to the domestic market, $\pi^d(z_i, 1)$ for which I normalize the capital customer base they have to one.

The second decision firms need to make is to decide how much they want to invest in building customer capital, denoted by i_d. Since firms only invest in growing into foreign markets, this investment captures the market-specific type of investment exporters do to grow abroad. I assume the decision of building a customer for the firm is irreversible. Firms can't make a negative investment in their customer capital. The cost of investing customer capital is given by $c(i_d, A_i) = i_d + \frac{\phi}{2}\left(\frac{i_d}{A_i}\right)^2$, where the second term denotes the convex cost of investing. I add this to capture the growth rate of firms over their life cycle.

Firm's optimal dynamic behavior. Firms' exporter behavior is characterized by two main equation. The first equation, equation (21), pins down the optimal capital customer the firm decides to have in next period. The second one, given in equation (22), characterise the optimal decision of firms in terms of exporting, it denotes the minimum level of productivity for which the firm will be willing to export.

$$\frac{\partial i_d(A^*,A)+\frac{\phi}{2}\left(\frac{i_d(A^*,A)}{A_i}\right)^2}{\partial A^*} \geq \mathbb{E}_a \left\{ \Lambda_{t,t+1} \overbrace{(1-Pr(\omega_i'^*))}^{\text{export prob.}} \overbrace{\mathbb{E}_{\omega_i}\left\{\frac{\partial V(A^*,z')}{\partial A^*} | \omega_i' > \omega_i'^*\right\}}^{\text{Expected MR conditional on exp.}} \right\} \tag{21}$$

Equation (21) holds with equality when firms decides to invest on customer capital, $i_d > 0$. In this case, firms decide to equalize the marginal cost of investment, the left-hand side of equation (21), to the expected marginal return on investment, the right-hand side of the same equation. Using the Leibniz rule, we can show that there are two components affecting the total expected marginal return on investment. One is the expected probability that in the next period, the firm will export, where I use ω'^* to define the minimum level of productivity at which the firm will decide to pay the fixed export cost to stay in the export market. The second component of the total expected return on investment is the marginal expected return of investment conditional on exporting. Both of these terms are affected by the uncertainty that firms face with respect to the realization of future shocks.

The second equation that will characterize the exporters' decision is given by equation (22), which characterizes the minimum of productivity at which firms will pay the export cost to stay in the export market, denoted by ω'^*. The marginal firm is indifferent between staying or not in the export market if the operational profits of doing so plus the optional value of not losing the customer capital she has accumulated is equal to the investment cost plus the exporting fixed cost. The equation shows how the past decisions of customer accumulation affect the extensive margin.

$$\hat{\pi}(\omega_i^*, a_t, A) + \overbrace{\mathbb{E}\{\Lambda_{t,t+1}[V(A^*, z') - V((1-\delta^{exp})A, z')]\}}^{\Delta\text{Option value}} = fe + i_d + \frac{\phi}{2}\left(\frac{i_d(A^*, A)}{A}\right) \quad (22)$$

6.3 Volatility in The Model

I assume uncertainty and volatility in the model enter through the changes in the marginal cost of production that firms face. There are two types of components that determine the productivity of the firms. The aggregate productivity, a_t, and a idiosyncratic productivity $\omega_{i,t}$. The total level of productivity that a firm has is given by $z_{i,t} = e^{\omega_{i,t} + a_t}$.

I assume that each component of the firms' productivity level follows an AR(1) process as shown by Equations. In the model, the microeconomic and macroeconomic levels of volatility are be given by σ^ω and σ^a, respectively. Each level of volatility has different implications in terms of how it directly affects the economy. The microeconomic volatility, σ^ω, generates higher dispersion of firms around the particular mean since I assume $\nu^\omega = -\frac{(1-\rho^\omega)\sigma^{\omega 2}}{2(1-\rho^{\omega 2})}$. Higher macroeconomic volatility implies that the mean level of the distribution across time becomes more volatile since I assume that $\nu^a = -\frac{(1-\rho^a)\sigma^{a2}}{2(1-\rho^{a2})}$ [22].

$$\ln \omega_{i,t} = \nu^\omega + \rho^\omega \ln \omega_{i,t-1} + \sigma^\omega \epsilon_{i,t}, \quad \epsilon_{i,t} \sim N(0,1) \quad (23)$$

$$\ln a_t = \nu^a + \rho^a \ln a_{t-1} + \sigma^a e_t, \quad e_t \sim N(0,1) \quad (24)$$

6.4 Domestic Consumers, Final Good Production and The Bond Market

Domestic consumers. The behavior of all the consumers in this economy is captured by a representative consumer that is the owner of the firms, supply labor inelastically L, and also

[22] There are two moments that are affected by the changes in volatility. The second moment, and the third moment, which are given by $E(x^2) = e^{\frac{\sigma^2}{1-\rho}}$ and $E(x^3) = e^{3\frac{\sigma^2}{1-\rho}}$.

hold risk-free bonds. Every period she decides how much to consume of the non-tradable final good, which I denote by C, and how much to save. Her problem is given by:

$$V^c(b, \Theta) = \max_{b', C} u(C) + \beta \mathbb{E} \left\{ V^c(b', \Theta') \right\}$$

s.t.

$$P^C C + b' = wL^s + \Pi^{dom} + \Pi^{exp} + r_t b'$$

I assume that b will be provided in zero net supply at all time. This implies that the trade is balance in this economy, and that the interest rate will adjust for this to be the case. The household problem determines the stochastic discount factor for the firm given by $\Lambda_{t,t+1} = \beta \frac{u_c(C')}{u_c(C)}$.

Final good production. The good consumption bundle is produced by a representative firm that operates in a competitive market. It uses two goods as inputs, a bundle of imported goods, M, and a bundle of domestic goods, D. The price of each of these bundles is given by, P^m and and P^D, respectively. The problem of the final good producer consists in minimizing the expenditure of the inputs necessary to produce the quantity of final good C. The problem is given by:

$$\min_{M,D} P^m M + P^D D$$

s.t.

$$\left(M^{\frac{\gamma-1}{\gamma}} \nu + D^{\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} \geq C$$

where ν represents the home bias preferences as usual. For what follows I normalize the price of the import goods to one. Under this case the demand for the domestic bundle conditional on the amount of imports is given by:

$$D = M \omega^{-\gamma} (P^d)^{-\gamma}$$

This equation, together with the assumption that trade is balanced all the time, implies that given prices P^D exports pin down the demand for domestic bundle.

Domestic bundle. The domestic bundle is produced using the intermediates goods produced by the domestic firms in the economy. The production will be given a similar problem as the one of the foreign consumer. I assume firms are able to reach all the consumers in the domestic economy [23]. As before, the problem for the producer of the domestic bundle, in this case, will be given by:

$$\min_{q(\omega)} \int_{\omega \in \Omega} p^d(\omega) q^d(\omega) d\omega$$

s.t.

$$\int_{\omega \in \Omega^d} \Upsilon \left(\frac{q^d(\omega)}{D} \right) d\omega = 1$$

As before I assume that $\Upsilon(.)$ will be given by equation (12), and that both θ and η will be equal across markets. The price of the domestic bundle P^D is defined as $P^D = \int_\Omega \frac{q^d(\omega)}{D} p^d(\omega)$, and $\tilde{D}$ is defined by $\tilde{D} = \int_\Omega \Upsilon'(\frac{q^d(\omega)}{Q^d}) \frac{q^d(\omega)}{D}$.

As before, in this case, there exists a choke price which I denote by p^d. But there is a difference between the domestic choke prices p^c_d, and the foreign choke price, p^c_f. While the former is an equilibrium object that depends on the state of the domestic economy, I treat the latter as a parameter that I will estimate in the model. This distinction follows from the assumption that the domestic economy is a small open economy that does not affect foreign prices.

6.5 Equilibrium

Lets now define an equilibrium for this economy. Lets first define the tuple of aggregate state variables as $\Theta = \{a, \Omega_{\omega_i}, \Omega_A, B\}$, as a the tuple composed by the aggregate level of productivity, a, the distribution of firms productivity, Ω_{ω_i}, the distribution of customer capital Ω_A and the total bonds holding for this economy B. While individual state variables are given by the bonds holding of the consumer, b, the firm's idiosyncratic productivity, ω_i and its customer capital A.

[23] This assumption obeys two main reasons. First is a simplifying assumption that allows me to avoid keeping track of the distribution of the domestic customer capital firms. Second, the dynamic behavior of the firms in the domestic economy and how this is related to the macro and microeconomic volatility of the country is beyond the scope of this work.

Definition 2: *Equilibrium for the economy.* An equilibrium in this economy is composed by the consumer value function $V^c(\Theta, b)$, the bond holding decision rule $b'(\Theta, b)$ the firm's value function $V(\Theta, \omega_i, A_i)$, the customer capital decision rule $A'(\Theta, \omega_i, A_i)$, the export decision $m^{exp}(\Theta, \omega_i, A_i)$ the quantities exported $q^{exp}(\Theta, \omega_i, A_i)$, and its prices $p^{exp}(\Theta, \omega_i, A_i)$, the quantities and prices for the domestic economy $q^{dom}(\Theta, \omega_i, A_i)$, $p^{dom}(\Theta, \omega_i, A_i)$ and the labor demand for firms $l^d(\Theta, \omega_i, A_i)$. Together with the aggregate prices for the final consumption good $P^c(\Theta)$, $\lambda(\Theta)$ the price of the domestic bundle $P^d(\Theta)$, the wages $w(\Theta)$, the domestic choke price $p^c_d(\Theta)$, the total labor demand $L^d(\Theta)$ the total exports $EXP(\Theta)$, imports $M(\Theta)$, the production of the domestic bundle $D(\Theta)$, the production of the consumption good $C(\Theta)$ and the total profits of firms $\Pi(\Theta)$. Such that given the parameters of the economy $\{\beta, \xi, \theta, \eta, p^c_f, \vartheta, \alpha, \phi, \delta, \gamma, \nu^\omega, \rho^\omega, \sigma^\omega, \nu^a, \rho^a, \sigma^a\}$ the following conditions holds

1. *Consumer's*: The functions solves the problem consumer's problem.
2. *Firm's*: The functions solves the firm's problem.
3. *Production of consumption bundle*: The functions solves the problem of representative firm producing the consumption bundle.
4. *Final good producer*: The functions solves the problem of representative firm producing the final good.
5. *Bond market*: Bond market clear, implying that total export are equal to total imports.
6. *Market clears*: The labor market and the final good consumption clear for all Ω.

6.6 Estimation of The Model

To estimate the model and test to what extent can capture the observed patterns in the data, I proceed by taking some parameters from the literature, another set of parameters I estimate them directly from the data, and the third set of parameters are set within the model to match some moments.

I estimate the parameters that determine the aggregate and firm's productivity shocks directly from the data. For the idiosyncratic productivity, I use the data from the labor productivity in the Colombian survey of the manufacturer, and I estimate an Ar(1), for which I obtained the parameters governing the persistence, ρ^ω and the standard deviation of the shocks σ^{ω}. I proceed in a similar way to estimate the parameters that pindown the aggregate productivity, ρ^{a} σ^{a}, using the H-P filtered aggregate TFP reported by the Penn World Tables for Colombia at the annual frequency. The parameters governing the consumer decision, such as the discount factor,β, the home bias parameters, ω and the relative risk aversion, σ, are set to match an average interest rate of 2%, the average trade openness of Colombia in the last ten years, and the last one is assumed to be one, implying log utility on consumption. I use data from the Colombian Manufacturer Survey to estimate the exporting fixed cost such that it matches the average share of exporting firms in Colombia of 19.5%.

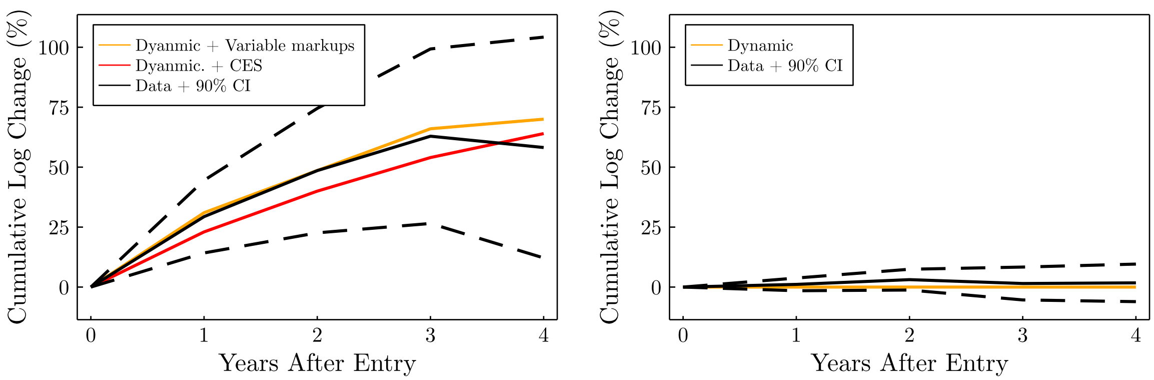
To pin down the parameters related to exporters' growth, I use the equations implied by the model on how new exporters grow over their life cycle. I use these equations to empirically estimate how the growth rate of exporters evolves over their life cycle and to match them in the model. To estimate the parameters related to the variable price elasticity, I set the parameter governing the average price elasticity, θ to 5, as in Klenow et al. (2016), and Gopinath et al. (2010), and I estimate the parameters of the super-elasticity, η and the foreign choke price, p_f^c, to match the relationship between price changes and exchange rate shock I estimate in the data.

Dynamic moments. Let h be the age of an exporter that entered h periods before to the export market, and that had exported every period since then. Let $q^f_{i,t,h}$ be the export quantities of firm i, at time t with age h, to the market f. According to the model, the log growth of the quantities exported to the foreign market f is given by:

$$\log q^f_{i,t,h} - \log q^f_{i,t,0} = \log A^{\alpha}_{i,t,h} - \log A^{\alpha}_{i,t,0} + \underbrace{\log \hat{q}(p^f_{i,t,h}) - \log \hat{q}(p^f_{i,t,0})}_{\gamma_{l,d,t}+\gamma_{i,d,t}+\Delta p^f_{i,t,h}} \tag{25}$$

According to equation (14) $\hat{q}(p,1)$ is composed of three main components. A foreign market component, which is common to all exporters exporting to f, a firm component that is common to all the market the firm serves, and the last component that is an interaction between firms productivity and the choke prices p_f^c for that market. This implies that I can use the estimate of the micro-level fact one to estimate the parameters that govern the growth rate of the exporter due to the customer capital accumulation $A_{i,l,d,t}$.

Panel a of Figure 4, presents the estimates of the data of the micro-level finding 1 and the model predictions in terms of the exporter growth for two different versions. The dynamic model with variable markups and the one with constant variable price elasticity ($\eta \to 0$). Panel b of the Figure 4 shows the same estimate for the relative prices, as described before, both model predict basically non differential changes on prices over the exporters life cycle.



(a) Growth Over Exporter Life Cycle

(b) Price Dynamics

Figure 4: New Exporter Dynamics: Models and Data

Price elasticity: From the empirical estimates to the model. There are three parameters governing firms' optimal pricing strategies. The parameters are, θ, the "average" price elasticity, η, the super-elasticity parameter, and p_f^c the foreign market choke price. As stated before, I set θ to 5, following the work of Klenow et al. (2016), and Gopinath et al. (2010).

The other two parameters, η and p_f^c will be estimated to match the data. According to the model the pass-through to prices of a change in the marginal cost ($\Phi_{i,f}$) for firm i selling to the market f is given by:

$$\Phi_{i,f} = \frac{\theta + \eta \log(\frac{p_i}{p_c^f})}{\theta + \eta \log(\frac{p_i}{p_c^f}) + \eta} \tag{26}$$

According to equation (26), then the pass-through of a shock depends on the price the firm charge to that market relative to the choke price in that market. If $\eta \to 0$ markups are constant, and then firms prices should not change if we control for the marginal cost changes of the firm. In case $\eta > 0$, price changes differ across markets because of the difference in the relative prices of the firm, even after controlling for changes in the firms' marginal costs.

Estimating the markup elasticity in the data. I follow the insights of Arkolakis et al. (2017) and use exchange rate shocks as changes in the marginal cost in foreign currency to estimate how markups respond at firm level. I use the export share of a firm in a particular market as a proxy for ratio of the exporters' price relative to the choke price of the foreign market.

In appendix C.2, I show how we can identify the relative changes in markups across firms as a function of firms' characteristics by using the price responses to exchange-rate shocks. Following this approach, I estimate the following equation:

$$\begin{aligned} \Delta p_{i,d,l,t} =& \beta \Delta e_{i,d,l,t} \times \text{exp. share}_{i,d,l,t-1} + \beta_2 \text{exp. share}_{i,d,l,t-1} \times crtl_{d,t} \\ &+ \theta_{i,l,t} + \theta_{i,l,d} + \gamma_{l,d,t} + e_{i,d,l,t} \end{aligned} \tag{27}$$

Since the change in the bilateral exchange rate variation may reflect relative changes in the foreign markets, I instrument the exchange rate variation with the remittances flows from third countries. In appendix C.2 I described in more detail the exclusion restriction and under what conditions it may be violated. The first stage is given by:

$$\begin{aligned} \Delta e_{i,d,l,t-1} \times \text{exp. share}_{i,d,l,t} =& \Delta remittances_{d,t} \times \text{exp. share}_{i,d,l,2007} + \\ &+ \text{exp. share}_{i,d,l,t-1} \times crtl_{d,t} + \theta_{i,l,t} + \gamma_{l,d,t} + e_{i,d,l,t} \end{aligned}$$

Micro-level fact 3: Markups changes increases with export shares. Table A.8 presents the results of the estimation. In Panel 1, I present the estimates for the First Stage. The first thing to note is that the F-statistic is on the order of 40 alleviating the concerns of the possibility of weak instruments for all of the cases I presented.[24] Second as expected, when we compare the OLS results (column 1), with the IV ones (column 2) we find that our concerned of the possible biased that may reduce our estimates due to the domestic changes that may trigger changes in the exchange rate was correct. Nonetheless, it is worth to mention that both estimates the instrumented one and the OLS one are positive and significant showing that exporters face demand function that present variable price elasticity that are increasing with exporter shares. Furthermore these results are sizeable. A firm with a 1% higher market share, will optimally decide to do and exchange rate pass-though that is between 0.74% and 1.10% lower, as shown by columns (2) and (3) of Panel 2. This results are consistent with the findings of Berman et al. (2012).

Panel 3 also present similar estimate but looking at quantities, which I interpret as a validity test. Two results are important, without the IV the OLS estimate predicts a change in quantities that seems unrelated with the predicted change in prices. After we do the instrument, is not only that quantities respond is negatively, as expected, it is also that the magnitude of the coefficients is much larger for the quantities response than for the prices, as we should expect if its is the case that price elasticity are higher than 1.

Mapping empirical estimates to the model. In appendix C.2 I describe in detail how I target this moment in my model. Briefly what I do is the following. I compute the firm's percentile in terms of its sales distribution. I then target two moments to pin down the value of η and the foreign choke price. I first target the markup change of the 25th percentile exporter relative to those at the median. The second moment I target is the markup change of the median firm close to the 75th percentile.

Estimated parameters. Table 3 shows the parameters of the model. As I have shown before each parameter has its clear empirical moment counterpart, but all of them are set to match the moments together. Table 4 presents the target moments, besides those related to the new exporters behavior.

[24] This is not surprising given the relevance of remittances net flows for Colombian balance of payment

Table 3: Calibrated Parameters

Parameters	Value	Rationale
θ	5.0	Standard in the literature
β	0.96	Yearly frequency
σ^{ω}	0.42	Firms' labor productivity s.d.
ρ^{ω}	0.80	Firms' labor productivity Persistence
σ^{a}	0.02	Aggregate TFP s.d.
ρ^{a}	0.62	Aggregate TFP Persistence
		Parameters to estimate within model
ν	0.33	Home bias
p_f^c	1.15	Foreign choke price
η	3.70	Super elasticity
f_e	2.95	Exporter fixed costs
α	0.95	Endogenous Demand (curvature)
ϕ	5.10	Investment Adjustment Cost
δ	0.08	Depreciation of A_i

Table 4: Additional Target Moments

Moment	Data	Model
Cross sectional markup ($\frac{75^{th}}{50^{th}}$)	0.87	0.86
Cross sectional markup ($\frac{50^{th}}{25^{th}}$)	0.95	0.94
Share of exporters	0.20	0.21
Trade openness	0.32	0.32
Export concentration (top 5%)	0.33	0.30

6.7 Model Implications

Now I proceed to estimate how much the model predicts the empirical relation I observe in the data. The estimation of the model does not target any moment related to how firms respond to volatility at the macro or micro level. In this regard, this section's results can be considered a test for the relevance of the micro-mechanism discussed in the empirical section and its relevance explaining the cross-country results we observed in the data. To achieve this, I proceed by simulating different economies that vary only in their volatility level.

The quantitative exercise I do is as follows. I fixed all the parameters and the series of shocks, $e_{i,t}$ and ϵ_t, and I only change, σ^ω and σ^a. I solve the firm's and consumer decisions every time for each change in σ^a and σ^ω. By doing this, I allow changes in the uncertainty firms face and changes in the actual distribution of shocks.

To understand the relevance of volatility and of the proposed mechanism I simulate 4 different models. Two static models and two dynamics models. For each pair, I compute one with variable markup and another without the variable markups.[25]

The consequences of macroeconomic volatility. Figure 5 presents the estimation for how does macroeconomic volatility affects total exports of a country. In this case I only change σ^a, conditional on simulating the same shocks and fixing the same parameters.

The results of Figure 5 show the relevance of the exporters' dynamics and variable price elasticity to explain why volatility is negatively associated with a country's trade levels. The static models predict a positive relationship between exports and aggregate fluctuations, and a similar prediction follows from the dynamic model without variable markups. The results are not counterfactual when we allow for variable markups and exporters dynamics to coexist in the model.

Furthermore, the predictions of the model are quantitatively important. The model predicts an average elasticity between total exports and macroeconomic volatility of -0.25. Since developing economies are almost two times more volatile than developed ones, this implies that the macroeconomic volatility, keeping constant the micro-level volatility, depresses exports by 25% in developing economies.

The consequences of microeconomic volatility. I now proceed to do a similar experiment to understand the effects of microeconomic volatility predicted by the model, keeping

[25] Each model is estimated to match the exporter share, and total trade openness. Those model with variable markups are estimated to match the markup responses. For the dynamic model with constant markup elasticity, I estimated to match the exporters growth, and I allow $\eta > 0$ but to a value that the the ratio in relative prices is 1. The static models can be generated by setting $\alpha = 0$

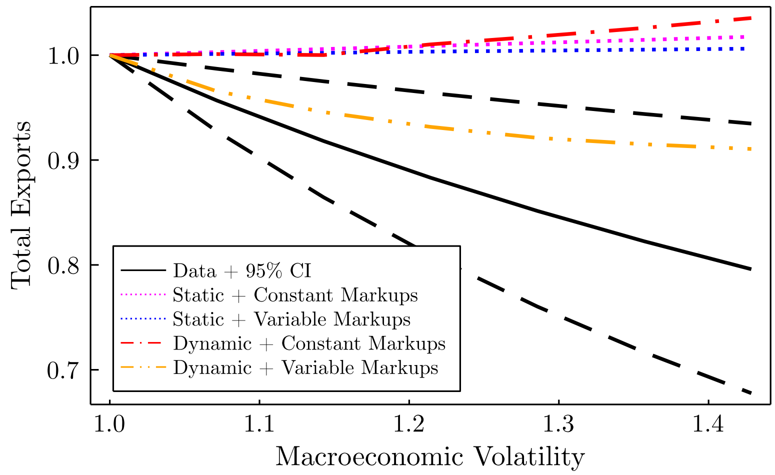


Figure 5: Total Exports and macroeconomic Volatility

the aggregate volatility constant. In this exercise, I only vary σ^{ω}. Figure 6 shows the results for this quantitative exercises for four different type of models.

In this case, model predictions are more striking. As in the previous case, all the models, except the one that allows variable markups and firms dynamic to coexist, predict a positive relationship between exports and volatility. The proposed model predicts an average elasticity between microeconomic volatility and total exports of -1.63. In terms of export differences, this implies that the microeconomics differences translate into developed economies exporting almost double the amount of developing economies.

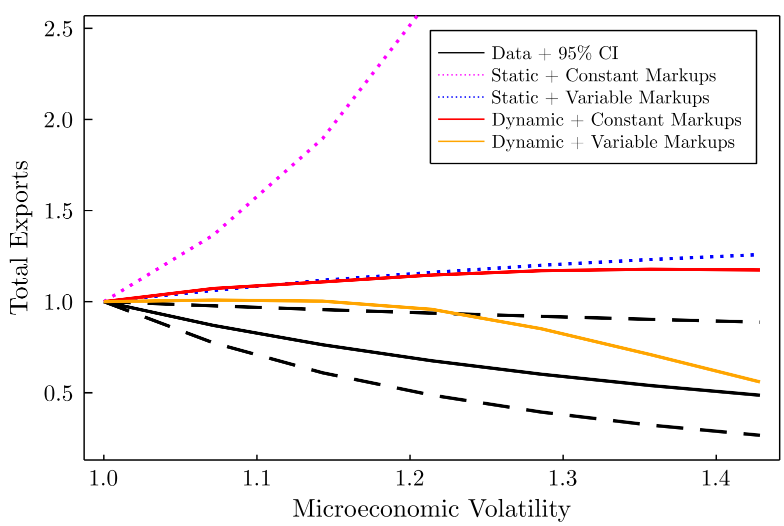


Figure 6: Total Exports and microeconomic Volatility

Analyzing each model's different predictions is insightful to understand the role of each mechanism. When we compare the two static models, we can observe the relevance of variable markup. When firms face variable price elasticity, the reallocation of resources to the more productive firms is smaller. This result is because, relative to the CES case, more productive find it harder to expand through reductions in prices due to the lack of demand sensitivity to prices they face. Under variable price elasticity type of demand, firms find it harder to take advantage in good times.

This cross-sectional intuition is similar to explaining the within-firm responses when exporting exporters invest in growing their demand. As firms face more uncertainty, the profits of good times do not compensate for the bad moments, reducing the average expected return of investment. As a consequence, higher uncertainty reduces firms' investment, depressing total exports. According to the model's prediction, uncertainty's effect on firms' investment is enough to compensate for the positive impact due to the distributional changes that higher volatility generates.

6.8 Testing the micro-level mechanisms

The previous quantitative results and the empirical finding using firm-level show the relevance and importance of the proposed mechanism to explain the documented relationship at the aggregate level. But are the underlying mechanism generating the aggregate responses in the model correct?

I proceed to test the model's ability to generate similar responses in the growth rate of new exporters when firms face higher levels of volatility. I then proceed to test one of the main implications that follow from the quantitative results already presented. I show that when firms face higher variable price elasticity, volatility negatively correlates with exports in the data even more. In appendix C.2 I also test the models' ability to generate the proper responses on the extensive margin.

New exporter growth: Model vs data. I now proceed to test the model's ability to replicate the microlevel data findings in terms of the differential growth of exporters relative to the domestic volatility they Face. To do this, I compare the log differences of the growth rate in the export share against the model with two different calibrations.

To follow the model experiment as close as possible to the one in the data, I proceed. I compare the prediction of the benchmark model to a case in which the domestic volatility decreases a 10%. I adjust the idiosyncratic volatility of firms to match a 10% reduction in the domestic volatility, measured as the average cross-section standard deviation in the log change in the sales of domestic volatility.

Figure 7 presents the results.The model can properly predict the qualitative relation regarding the higher domestic volatility and the differential growth of the new exporter. Quantitatively the model predicts a higher difference relative to the data during the first years of the life of the exporters. These results are successful if we compare them to models without the proposed features. Since, as explained before, these other models will predict null or contrary relationship to the one in the data as shown in previous sections.

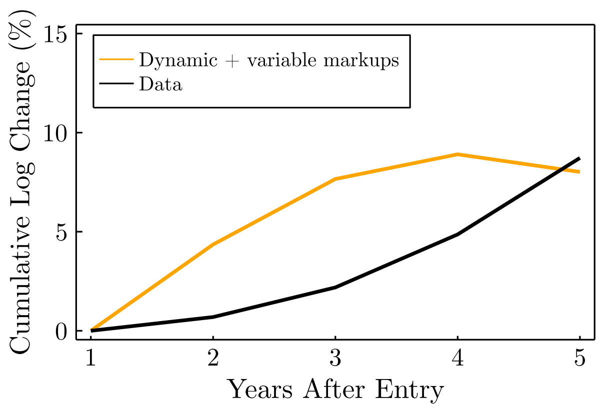


Figure 7: New Exporter Growth and Volatility: Model vs Data

Estimating the markup elasticity across product. The model is successful in replicating the aggregate and micro-level relationship relative to its counterparts. These differences are to the combination of two mechanisms, the new exporting dynamics and the existence of variable price elasticity. The different results between the dynamics model with constant price elasticity and the variable price elasticity show that the relationship between exports and volatility becomes more negative as firms face higher variable price elasticity. A prediction that can be directly tested in the data using industry variation. To achieve this, I estimate the markup elasticity as a function of the export share as described before. The main difference is that now I allow the coefficient that measures the relationship between prices and export share to be heterogeneous for each of the 2-digit products I have in my sample. I denoted the vector of the coefficient measuring the markup-elasticity of each product category as β^{hs-2}.

The purpose of this estimation is to able to group products categories by those that present a high, medium and low markup elasticity. To achieve this, I re-estimate equation (47) and (48) individually for each of the 2-digit products for those product in which I observe more than 500 observations. I then proceed to group industries in three types, low markup elastic industries, medium markup elastic industries, and high markup elastic industries, according to where the estimates of β for each of the industries is below the first third-tile, between the first and third third-tile or above the third third tile.

Micro-level fact 4: More markup elastic products are more responsive to volatility. I estimate how the relationship between domestic volatility and exports depends on the markup-elasticity that characterizes each product. I use the measure of volatility described before, and I interacted with the categorical variable, D_l capturing how markup elastic is product l:

$$\begin{aligned} \ln \mathbf{exp}_{i,l,d,t} = \beta^0 \ln \sigma_i^z + \beta^1 \ln \sigma_i^z D_l + D_l + \gamma^1_{m,t} + \gamma^2_{mth,y_1} \\ + \gamma^3_{age} + controls_{i,l,d,t} + e_{i,l,d,t} \end{aligned} \tag{28}$$

Table 5 presents the results of this estimation. As expected, the results show that regardless of the additional controls at the firm level, when a firm sells products in products categories that are more markup-elastic, the association between exports and the volatility they face drops even more. We cannot reject the hypothesis that as firms face higher variable price elasticity, the relationship between export and volatility increases. For example, column 1 of Table 5 shows that when a firm sells a product that is in on the high markup elasticity group, the negative relationship between exports and volatility becomes almost 62% higher in absolute terms. Similar results hold in columns 2 and 3 when we compare results within-firm across product-destination or within firm-destination across products.

Table 5: Exports, Volatility and markup Elasticity

	$exp_{i,l,d,t}$	$exp_{i,l,d,t}$	$exp_{i,l,d,t}$
Volatility_i	-0.21***		
	[0.03]		
Medium Markup - elastic $\times$ Volatility_i	-0.04	-0.04	-0.07
	[0.59]	[0.04]	[0.05]
High Markup - elastic $\times$ Volatility_i	-0.13**	-0.10**	-0.12**
	[0.06]	[0.05]	[0.06]
Observations	201,665	201,399	197,751
R^2	0.82	0.72	0.80
Year-product-destination FE	✓	✓	✓
Firm-Year FE	-	✓	-
Destination-Firm-Year FE	-	-	✓

Standard errors in brackets. Error cluster at two digit product. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

7 Conclusion

Developing countries trade less than rich countries. This lack of trade integration has often been attributed to relatively high non-policy trade costs. I show these non-policy trade costs reflect the highly volatile environment at home at both the macro and microeconomic levels. Domestic volatility interacts with the relatively high costs of investments that exporters make to grow in foreign markets depressing these investments and lowering trade. Domestic frictions get magnified by the dynamic nature of exporter decisions. This explanation is quantitatively consistent with cross-country and firm-level evidence relating export behavior and volatility. I develop a novel model of new exporter dynamics with variable markup that successfully accounts for the relationship in the data. Abstracting from the proposed firm-level features would lead one to infer much larger trade friction to match the data on aggregate trade flows and development.

The mechanism and findings of this paper may contribute to different issues that have captivated attention, such as the effects of trade policy uncertainty or the differences in firm distribution between developing and developed economies. My findings can be generalized to speak on how firms respond to all the risks arising from both domestic and foreign sources. On the domestic side, domestic investment is likely distorted by the emphasized frictions generating differences in firm distribution across the level of development. On the international front, the model suggests a stronger role for trade policy uncertainty in dampening trade flows.

Furthermore, the relevance of volatility for trade suggests we should re-think macroeconomic stabilization, which includes fiscal, monetary, or commercial policy in developing countries. For example, the extent to which different exchange rate regimes may mitigate or amplify the negative impact of macroeconomic volatility on international trade may provide new insight into the design of optimal exchange rate regimes.

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A Appendix: Cross-Country Estimation

Measurement of macroeconomic volatility. One concern following this estimation strategy is to what extent the results are robust to other measures of the origin country volatility. To check if results holds to different measures of volatility, I also compute the aggregate volatility using the standard deviation of log changes of the estimated TFP (denoted byMacro-Vol.$_i^{\text{Ch}}$), and using the cyclical component of the real GDP (denoted by Macro-Vol.$_i^{\text{GDP}}$). Row 2 and 5 of Table A.1 presents the results of using each measure respectively. I find that results are invariant to using different filter methods to de-trend the TFP series. I also use variations in the real GDP to construct the standard deviation of the country level of volatility and I find similar results.

Global factors in the measurement of macroeconomic volatility. Another concern, is that the volatility measures that I am using may reflect both global and domestic component, to the extent the foreign demand volatility may discourage exports and that is also making some countries more volatile domestically, this may generate similar prediction as the one observed but due to some big foreign partner being more volatile. To deal with this concern I regress the cyclical component of the TFP for all the countries against an year fixed effect, and then I used the residuals of this estimation to construct the volatility of each country. I find that results holds regardless of any of these approaches. The results using this measure of volatility that I denote as Macro-Vol.$_i^{\text{No-global}}$ are presented in the third row of Table A.1.

Reverse causality problem. One of the main concerns of the relationship that I document is the fact that actually is low trade what generates countries to be more volatile. A possible reason behind this relationship is that as countries find it harder to increase or decrease their export or imports, this implies that they will be less able to smooth the domestic shocks through the international borrowing and lending. This lack of ability of smooth the shocks mat increase the level of volatility of a country, in the estimated TFP, or the GDP. While the possibility of this particular story seems natural Razin et al. (1992) did not document this to be the case after observing in the volatility of countries after they went from trade or capital account liberalizations.

But still, even-though this argument is not supported by their findings, there are exist another possible stories given rise to the reverse causality problems. Naturally, properly solving this issue may require causal estimates that are beyond the possibility of the data availability that I have. To test if this may be a big concern I use the variation of the pre-sample period in the TFP, from 1950 to 1975 to construct the measure of volatility, a period in which trade was low for most countries relative the observed levels of trade openness observed after 1980. Proceeding this way allows me to use a volatility measure that is potentially unrelated with the shocks happening to the country that may have affected its level of volatility due to its inability to smooth the domestic shocks. By focusing on a period of relatively small levels of trade across the globe, this allows me to reduce the relevance of shocks to the export that may feed to the domestic economy. Results are actually stronger when using this out of sample measure of volatility. The results using this variable are presented on the fourth row Table A.1, for the variable Macro-Vol.$_i^{\text{pre-sample}}$. The last row of the table presents a similar measure but using the cyclical component of the real GDP Macro-Vol.$_i^{\text{GDP, pre-sample}}$

Trade composition and volatility. It may be that for some reason a particular country structure of production affects both its volatility and its total exports. For example, a country may specialize in the production of an industry for whose product are particular difficult to export, but that also its production is more volatile. Under this case, its not that volatility is the behind the low export performance of the country but it is its structure of production behind this relationship. To test for this possibility I focus only on the manufacturer sector, and I proceed in the same way as described before. I find that performing this exercises does not change the findings documenting in aggregate fact 3. I also run the benchmark estimates but now controlling by the share over total exports of the manufacturer, the agricultural and the mining sector, I find results to be robust to this addition too.

Table A.1: Robustness Measures Macroeconomic Volatility and Trade

	Av. exp.	Av. exp.	Av. exp.	Av. exp.	Av. exp.	Av. exp.	Av. exp.
$\frac{\text{GDP}}{\text{L}}$	0.35**	0.18	0.16	0.15	0.27	0.17	0.20
	[0.16]	[0.18]	[0.18]	[0.18]	[0.17]	[0.17]	[0.16]
$\log(\text{Macro-Volatility}_i)$		-0.54**					
		[0.22]					
$\ln \text{Macro-Vol.}_i^{\text{Ch}}$			-0.56**				
			[0.25]				
$\ln \text{Macro-Vol.}_i^{\text{No-global}}$				-0.60***			
				[0.22]			
$\ln \text{Macro-Vol.}_i^{\text{GDP}}$					-0.53*		
					[0.27]		
$\ln \text{Macro-Vol.}_i^{\text{pre-sample}}$						-0.63***	
						[0.21]	
$\ln \text{Macro-Vol.}_i^{\text{GDP,pre-sample}}$							-0.64***
							[0.20]
Observations	254126	254126	254126	254126	254126	254126	254126
R^2	0.65	0.68	0.67	0.68	0.67	0.69	0.69
Year × Destination × Product FE	✓	✓	✓	✓	✓	✓	✓
Gravity Controls + TOT vol	✓	✓	✓	✓	✓	✓	✓
Doing Business	All	All	All	All	All	All	All

Standard errors in brackets. Error cluster at country level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Measurement of microeconomic volatility. There are some potentials concerns of using the cross sectional standard deviation of the changes in the firm level labor productivity as the volatility measure in the way I described before. The main concern is that in some models, the labor productivity may be just a reflection of the average markups of the firm. While in the model this result would not post any problem, the model should be seen as a

Table A.2: Robustness Measures Macroeconomic Volatility and Trade (Manufactures only)

	Av. exp.	Av. exp.	Av. exp.	Av. exp.	Av. exp.	Av. exp.
$\frac{\text{GDP}}{\text{L}}$	0.53**	-0.01	0.09	0.32	0.09	0.11
	[0.21]	[0.27]	[0.27]	[0.20]	[0.23]	[0.21]
$\ln$ Macro-Vol.$_i^{\text{Ch}}$		-1.12***				
		[0.36]				
$\ln$ Macro-Vol.$_i^{\text{No-global}}$			-1.15**			
			[0.51]			
$\ln$ Macro-Vol.$_i^{\text{pre-sample}}$				-1.11**		
				[0.45]		
$\ln$ Macro-Vol.$_i^{\text{GDP}}$					-1.05*	
					[0.55]	
$\ln$ Macro-Vol.$_i^{\text{GDP,pre-sample}}$						-1.34***
						[0.44]
Observations	138,865	138,865	138,865	138,865	138,865	138,865
R^2	0.62	0.67	0.66	0.65	0.66	0.68
Year $\times$ Destination $\times$ Product FE	✓	✓	✓	✓	✓	✓
Gravity Controls	✓	✓	✓	✓	✓	✓
Term of Trade Volatility	✓	✓	✓	✓	✓	✓
Doing Business	All	All	All	All	All	All

Standard errors in brackets. Error cluster at country level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

simplification of the actual data generating process and to that extent this may be potentially problematic. To solve this problem, I also firm labor changes to compute the domestic volatility. The results are presented in Table A.6.

Table A.3: Margins of Trade and the Micro-Economic Volatility

Panel 1: Micro-Economic Volatility (employment growth) and Average Exports

	Total exports	Total exports	Exporters	$\text{Exports}_{\text{Inc. firm}}$
$\frac{\text{GDP}}{\text{L}}$	0.73***	0.57**	0.92***	-0.31
	[0.22]	[0.22]	[0.14]	[0.20]
ln $\text{Micro-Volatility}_i^{\text{empl}}$		-2.58***	-1.65***	-1.82***
		[0.55]	[0.36]	[0.53]
Observations	39439	39439	39439	36339
R^2	0.85	0.89	0.94	0.88
Numb. Countries	38	38	38	38
Year $\times$ Destination $\times$ Product FE	✓	✓	✓	✓
Gravity Controls	✓	✓	✓	✓
Doing Business	Exp/Cred/Cont	Exp/Cred/Cont	Exp/Cred/Cont	Exp/Cred/Cont

Standard errors in brackets. Error cluster at country level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

B Appendix: Firm-level Estimation

B.1 Price Dynamics Over Exporter Life Cycle

Table A.4: Price dynamics over exporter life cycle.

	(1)	(2)
	Δp_{ildt}	Δp_{ildt}
$\mathbb{I}_{age_{ildt}=1}$	0.01	0.02
	[0.02]	[0.02]
$\mathbb{I}_{age_{ildt}=2}$	0.03	0.02
	[0.02]	[0.04]
$\mathbb{I}_{age_{ildt}=3}$	0.01	0.02
	[0.03]	[0.05]
$\mathbb{I}_{age_{ildt}=4}$	0.02	0.05
	[0.04]	[0.07]
$\mathbb{I}_{age_{ildt}=5}$	0.00	0.05
	[0.05]	[0.08]
$\mathbb{I}_{age_{ildt}=6}$	-0.03	0.11
	[0.06]	[0.10]
$\mathbb{I}_{age_{ildt}=7}$	-0.06	0.07
	[0.07]	[0.12]
Observations	80,776	41,352
R^2	0.87	0.94

Standard errors in brackets. Error cluster at product-destination * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

B.2 Sales Dynamics Over Exporter Life Cycle

Table A.5: Sales dynamics over exporter life cycle.

	(1)	(2)	(3)	(4)	(5)	(6)
	ΔQ_{ildt}	ΔQ_{ildt}	ΔQ_{ildt}	ΔQ_{ildt}	$\Delta \frac{\text{exp}_{ildt}}{\text{tot. sales}}$	$\Delta \frac{\text{exp}_{ildt}}{\text{tot. sales}}$
$\mathbb{I}_{age_{ildt}=1}$	0.25***	0.27***	0.32***	0.20***	0.22**	0.41***
	[0.02]	[0.03]	[0.04]	[0.04]	[0.09]	[0.14]
$\mathbb{I}_{age_{ildt}=2}$	0.50***	0.47***	0.55***	0.37***	0.40***	0.58***
	[0.04]	[0.04]	[0.06]	[0.07]	[0.15]	[0.20]
$\mathbb{I}_{age_{ildt}=3}$	0.67***	0.69***	0.83***	0.50***	0.51**	0.66**
	[0.05]	[0.06]	[0.09]	[0.10]	[0.22]	[0.28]
$\mathbb{I}_{age_{ildt}=4}$	0.88***	0.96***	1.14***	0.61***	0.50*	0.73*
	[0.07]	[0.08]	[0.11]	[0.13]	[0.30]	[0.38]
$\mathbb{I}_{age_{ildt}=5}$	1.01***	1.15***	1.34***	0.71***		
	[0.08]	[0.10]	[0.14]	[0.16]		
$\mathbb{I}_{age_{ildt}=6}$	1.11***	1.32***	1.59***	0.84***		
	[0.10]	[0.12]	[0.17]	[0.19]		
$\mathbb{I}_{age_{ildt}=7}$	1.22***	1.62***	1.93***	1.03***		
	[0.12]	[0.15]	[0.21]	[0.24]		
Observations	110,726	71,337	56,187	57,476	18,333	4,991
R^2	0.90	0.91	0.91	0.96	0.94	0.92

Standard errors in brackets. Error cluster at firm-product-destination. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

B.3 Volatility and Sales Dynamics Over Exporter Life Cycle

Table A.6 presents the estimation of equation (8). Column 1 to column 3 presents the results using the measure of domestic sales volatility as described in (7). Column (1) includes firm fixed effects for those exporters with 2 years or more continuously exporting to the market (product-destination), column (2) includes firm-year fixed effects, and column (3) presents the same estimation of column (2) for those exporters that exported 5 years to each market. Column (4) and (5) presents the estimation results of running the same estimation as in column (2) but using two different measures as described below.

The measure of volatility use in Column (4) is constructed as follows:

1. Compute the log difference on one year of the real domestic sales of each firm i, defined as Δdom. sales
2. Compute the cross-section standard deviation of Δdom. sales, for each year t of those firms with main products of export in the sixth digit belong to the product category J. And take the average over time, for each 6 digit product j. Denote this measure by sd_J^{hs6}
3. Compute the weighted mean by the total of exports of each 6-digit product J on the 4 digit product category K of sd_J^{hs6}. Denoted as sd^{hs4}, which contains a vector for each of 4 digit products of exports.
4. Take the lof of sd^{hs4}

The measure of volatility use in Column (5) is constructed as follows:

1. Restrict the sample to those exporters with at least 2 products and two countries of destination.
2. First compute the common changes in the exports of a firm to all of the products $\gamma_{i,t}$, by estimating:

$$\Delta exp_{i,l,d,t} = \gamma_{i,t} + \theta_{d,l,t} \tag{29}$$

3. Compute the cross-section standard deviation of $\gamma_{i,t}$, for each year t, of those firms other than i with main products of export in the sixth digit belong to the product category J. And take the average over time, for each 6 digit product j. Denote this measure by $sd_J^{hs6,Cexp}$

The similar patterns documenting in column (1) and (3), and in column (4) and (5), suggest that the possible selection because of entry and exit, while may biased the result is not enough to change the patterns. Column (4) show that if we also use the domestic changes in sales for firm i to compute the volatility measures, the patterns observed between the exposure to domestic volatility and their relative growth still hold. Lastly, column (6) use a measure of the variations in sales that are common across the markets exporters served to construct the volatility measure. This measure captures shocks that are common to the firm across the markets it served, alleviating the concerns that demand shocks may be driven these results. The similarity on the estimates and patterns suggest that the changes in demand shocks in the domestic market, or the foreign market, or the entry or exit of exporters, are not important to biased the patterns observed in the data.

Table A.6: Volatility and sales dynamics over exporter life cycle.

	(1)	(2)	(3)	(4)	(5)
	$\Delta \frac{\text{exp}_{ildt}}{\text{tot. sales}}$	$\Delta \frac{\text{exp}_{ildt}}{\text{tot. sales}}$	$\Delta \frac{\text{exp}_{ildt}}{\text{tot. sales}}$	$\Delta \frac{\text{exp}_{ildt}}{\text{tot. sales}}$	$\Delta \frac{\text{exp}_{ildt}}{\text{tot. sales}}$
ln Volatility$_{it}$	0.00	-	-	0.01	-
	[0.02]	-	-	[0.03]	-
$\mathbb{I}_{\{age_{ildt}=1\}} \times$ ln Volatility$_{it}$	-0.01	0.00	0.01	-0.01	0.04
	[0.03]	[0.04]	[0.05]	[0.02]	[0.08]
$\mathbb{I}_{\{age_{ildt}=2\}} \times$ ln Volatility$_{it}$	-0.00	-0.01	-0.04	-0.00	0.02
	[0.04]	[0.05]	[0.07]	[0.02]	[0.12]
$\mathbb{I}_{\{age_{ildt}=3\}} \times$ ln Volatility$_{it}$	-0.08	-0.10	-0.17	-0.06*	-0.15
	[0.05]	[0.07]	[0.10]	[0.03]	[0.16]
$\mathbb{I}_{\{age_{ildt}=4\}} \times$ ln Volatility$_{it}$	-0.22***	-0.26***	-0.41***	-0.13***	-0.62***
	[0.08]	[0.10]	[0.15]	[0.04]	[0.23]
$\mathbb{I}_{\{age_{ildt}=5\}} \times$ ln Volatility$_{it}$	-0.48***	-0.57***	-0.71***	-0.17**	-0.78**
	[0.14]	[0.17]	[0.24]	[0.07]	[0.39]
Observations	23,710	23,121	14,956	23,197	21,174
R-squared	0.26	0.30	0.36	0.29	0.23
Firm FE	✓	-	-	-	-
Firm-year FE	-	✓	✓	✓	✓
Product-year FE	✓	✓	✓	✓	✓
Destination-year FE	✓	✓	✓	✓	✓
First month-year	✓	✓	✓	✓	✓
Age exporting	≥ 2	≥ 2	$= 5$	≥ 2	≥ 2
Volatility measure	Benchmark	Benchmark	Benchmark	No leave out	Common effect

Standard errors in brackets. Error cluster at at firm-product-destination . * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

B.4 Volatility and Incumbent exporters.

Given the measure of volatility I estimate the following equation:

$$\ln \mathbf{exp}_{i,m,t} = \beta^1 \ln \sigma_i^z + \beta^0 \ln \sigma_i^z + \gamma^1_{m,t} + \gamma^2_{mth,y_1} + \gamma^3_{age} + controls_{i,m,t} + e_{i,m,t} \tag{30}$$

Where $\gamma^1_{m,t}$ denotes fixed effects at 2-digit product-destination-year and are fixed effects for cohort γ^2_{mth,y_1}, γ^3_{age} denotes the age of the firm, finally $controls_{i,m,t}$ denotes controls from the firm level, as the total number of products that firm export, and total number of products that the firms export to destination d at time t, and total number of destination, and total number of destination at time t for product l. I also add profits and total fixed assets reported by the sub-set of firms for which I have balance sheet data, which I report separately in table column (3) of Table A.7.

Results in Table A.7 show that a one percent increase in firm's exposure to domestic volatility is associated with 0.60% decrease in average exports. Note that by construction this setting does not allowed the inclusion of firm fixed, because they will absorb all the variation that is relevant for the firm. This implies that the estimates should be interpreted as the relation of volatility with average exports within product, destination and year. In line of (3.3), the point estimates reflects the total relationship between the intensive margin and the exposure of firms' to the volatility on the firm-level shocks.

Table A.7: Exports and Volatility for Continuing Exporters

	(1)	(2)	(3)
	$\text{Exp}_{hs6,d,t}$	$\text{Exp}_{hs6,d,t}$	$\text{Exp}_{hs6,d,t}$
σ_i^{sales}	-0.60***	-0.65***	-0.75***
	[0.04]	[0.04]	[0.04]
Observations	288,389	81,916	55,426
R^2	0.45	0.49	0.55
HS2 X Destination X year	✓	✓	✓
Cohorts and total Age FE	-	✓	✓
Controls: Assets and profits	-	-	✓

Standard errors in brackets. Error cluster at firm level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

C Model

C.1 Proofs

To probe proposition 1 and 2 I prove a set of lemmas that allows me to characterize the firm's value function and its decisions. I then split the proof in two different type of models. The ones assuming an exporting decision after the realization of firms' productivity z_i, and for the case in which the exporting decision is taking after the firm the realization. But before I add two additional assumptions that characteristic the stochastic shocks.

Assumption A4. *Firms' productivity is distributed log normal with parameters μ and σ. Furthermore, I assume that $\mu = -\frac{\sigma^2}{2}$, such that $\mathbb{E}(z) = 1$ regardless of the level σ.*

Assumption A5 allows to generate changes in σ in a way that they work as a mean preserving spread over the distribution of shocks. The log-normality is assumed given the extensive use of this distribution on the quantitative works.

Assumption A5. *The exporter threshold, defined as z^*, is such that $z^* \geq e^{\mu+\frac{\sigma^2}{2}}$ for all firms.*

This is a technical assumption that implies that firms' exporter threshold is above the mean value of productivity. In economic terms, assumption A5 implies that no firm's whose productivity is below the average level will export. Theoretically this assumption together with A1-A5 is a sufficient condition to prove propostion 1. In the quantitative framework I do not impose this condition and I find that the standard models predicts this positive relationship.

Lemma 1. *Given Assumptions A1-A5 $V(A_i, z_i, \Omega)$ is continuous and differentiable on A_i.*

This follows from Theorem 9.10 in Stokey et al. (1989). □

Lemma 2. *Let $V(A_i, z_i, \Omega)$ be the value of a firm with customer capital A_i, total productivity z_i, and let Ω be the state of the economy. Under assumptions A1-A5, the optimal investment decision for the firm is given by 31:*

$$\frac{\partial c(A_i', A_i)}{\partial A_i'} \geq \frac{\partial \mathbb{E}\{V(A_i', z_i, \Omega)\}}{\partial A_i'} \tag{31}$$

This follows directly from the firm's dynamic problem that is given by following:

$$V(A_i, z_i, \Omega) = \max_{m \in \{0;1\}; A_i' \in [A_i; \infty)} \pi^d(z_i, 1) + m(\pi(z_i, A_i) - f_{exp}) - c(A_i', A_i) + \beta \mathbb{E} V\left(A_i', z_i', \Omega'\right) \tag{32}$$

Similar results holds if the firm at time t decides m' instead of m. □

Now I split the problem in two cases to show that proposition **??** holds regardless of the assumption of the timing about the exporting decision.

Case 1: Firms decide to export before the realization of the shock. Lemma 3. *Under assumptions A1-A5, the firm's expected marginal benefits of investing in its demand shifter, conditional on exporting (m=1) in the following period is given by:*

$$\frac{\partial \mathbb{E}\{V(A_i', z_i, \Omega)\}}{\partial A_i'} = \frac{\partial f(A_i')}{\partial A_i'} \mathbb{E}\{\pi(1, z_i, \Omega)\} - \mathbb{E}\left\{\frac{\partial c(A_i'', A_i')}{\partial A_i'}\right\} \tag{33}$$

By Lemma 1, we can use the Benveniste and Scheinkman condition to obtain that:

$$\frac{\partial \mathbb{E}\{V(A_i', z_i, \Omega)\}}{\partial A_i'} = \frac{\partial \mathbb{E}\left\{\pi(A_i', z_i, \Omega) - c(A_i'', A_i')\right\}}{\partial A_i'} \tag{34}$$

Then equation (33), follows directly from the definition of the demand shifter, and because firms made their exporting decision at t-1. □

Lemma 4. *Under assumptions A1-A5, if the firms' profits are of the risk loving type then A_i' is weakly increasing for a mean preserving distribution of z*

By Lemma 3 we have that the optimal condition for firms' investment is given by:

$$\frac{\partial c(A_i', A_i)}{\partial A_i'} \geq \frac{\partial f(A_i')}{\partial A_i'} \mathbb{E}\{\pi(1, z_i, \Omega)\} - \mathbb{E}\left\{\frac{\partial c(A_i'', A_i')}{\partial A_i'}\right\} \tag{35}$$

If equation (35) does not hold with equality then $A_i = 0$. In this case there is no growth.

If the profits of the firm are of the risk-loving type, then the first term on the right hand of equation (35) increases as we perform a mean preserving spread. When equation (35) holds with equality the increase in A_i as we do a mean preserving spread follows from the implicit function theorem. □

Lemma 4 proves that in those models in which profits are of the risk-loving type on firms' productivity, and where firms' make the exporter decision a period in advance, there is no negative relationship between exporters growth and the uncertainty they face.

Case 2: Firms decide to export after the realization of the shock. I turn to analyse the case under which firms' take the exporting decision after they know their productivity level z_i. Before I introduce two additional assumptions that are motivated by the quantitative frameworks used in the literature.

Lemma 5. *Under assumptions A1-A5, the firm's expected marginal benefits of investing in its demand shifter, conditional on being in case 2 is given by:*

$$\frac{\partial \mathbb{E}\{V(A_i', z_i, \Omega)\}}{\partial A_i'} = (1-F_z(z'^*))\left[\frac{\partial f(A_i')}{\partial A_i'} \mathbb{E}\{\pi(1, z_i, \Omega)|z \geq z'^*\} - \mathbb{E}\left\{\frac{\partial c(A_i'', A_i')}{\partial A_i'}|z \geq z'^*\right\}\right] \tag{36}$$

By Lemma 1, we can use the Benveniste and Scheinkman condition to obtain that:

$$\frac{\partial \mathbb{E}\{V(A_i', z_i, \Omega)\}}{\partial A_i'} = (1 - F_z(z'^*))\left[\frac{\partial \mathbb{E}\left\{\pi(A_i', z_i, \Omega) - c(A_i'', A_i')|z \geq z'^*\right\}}{\partial A_i'}\right] \tag{37}$$

Equation (37) follows from applying the Leibniz integral rule under the case that $z'^{*}(A'_i)$. From equation (37), equation (36) follows from the definition of demand shifter. □

Lemma 6. *Under assumption A4 and A5, the exporter probability* $(1 - F_z(z'^{*})$ *is increasing in* σ*.*

Since z is distributed log normal we have that:

$$F_z(z^*) = \Phi(\frac{\ln z^* - \mu}{\sigma}) \tag{38}$$

Under assumption Aa2 and taking the derivative with respect to σ, we have that $\frac{\partial F_z(z^*)}{\partial \sigma} < 0$
□

Lemma 7. *Under assumption A1-A5,* z^* *is weakly decreasing in* σ*.*

For a firm i, with capital customer A_i, the productivity threshold z^*, is given by:

$$\pi(z_i^*, a_t, A) = fe + c(A'_i, A_i) - \beta\mathbb{E}\{V(A'_i, z', \Omega') - V((1 - \delta^{exp})A_i, z', \Omega')\} \tag{39}$$

Under assumptions A1-A5, if firms profits are of the risk-loving type, by definition of the demand shifter we have that $\frac{\partial^2 \mathbb{E}\{V(A'_i, z', \Omega')}{\partial\sigma\partial A} \geq 0$. Since $\pi(.)$ is increasing in firms' productivity, z, by the implicit function theorem it follows the result of the Lemma 7. □

Lemma 8. *Under assumptions A1-A5. If the firms' profits are of the risk loving type, then for case 2,* A_i *is weakly increasing in* σ

By Lemma 5 together with Lemma 2, we have that the following condition holds:

$$\frac{\partial c(A'_i, A_i)}{\partial A'_i} \geq (1 - F_z(z'^*)) \left[\frac{\partial f(A'_i)}{\partial A'_i} \mathbb{E}\{\pi(1, z_i, \Omega)|z \geq z'^*\} - \mathbb{E}\left\{ \frac{\partial c(A''_i, A'_i)}{\partial A'_i} |z \geq z'^* \right\} \right] \tag{40}$$

By the implicit function theorem and making use of Lemma 6 and Lemma 7 the result follows. □

Proposition 1. *Given a level of A_i and z_i Under assumptions A1-A5 if the firms' profits are of the risk loving type, then a mean preserving spread over the firms productivity will weakly increase firms' investment on future customer capital.*

The result follows from Lemma 4 and Lemma 8 □

.

Proposition 2. *Under assumption A4-A5 the firm's profit function presents risk-loving behavior in its productivity.* Under this assumption conditional on firm customer base A_i, productivity (z_i), in an economy with wages w, assuming without loss of generality that the total sales and aggregate prices are equal to one, the firms' i profits are given by:

$$\pi(z_i, A_i) = A_i B w^{1-\theta} z_i^{\theta-1} \;\; ; \;\; B = \left(\frac{\theta - 1}{\theta}\right)^{\theta-1} \frac{1}{\theta} \tag{41}$$

This follows from the standard static of the firm, under assumption A2-A4. Since $\theta > 1$ the profits function becomes convex on z_i. The result follows from Jensen's inequality. □

C.2 Estimation of variable markups

Conceptual framework. I define markups as the ratio between the price and the marginal cost of production of a particular product for each market that the firm served. By this definition, prices are given by equation (42) where i, l, d, t represent the firm, product, destination and time respectively. Where $Mc^f_{i,d,l,t}$ represents the marginal cost of production in foreign currency, $p_{i,d,l,t}$ prices and $\mu_{i,d,l,t}$ the markups at time t that firm i set sell to market (d, l) all denoted in the currency of the country that the firm is selling to:

$$p_{i,d,l,t} = \mu_{i,d,l,t}\; Mc^{f}_{i,d,l,t} \tag{42}$$

We can assume that firms sales are set ultimately in the currency of the market selling to. [26] Assuming also the the marginal cost of production is set in domestic currency then we can re-write equation (42) as in (43), where $Mc_{i,d,l,t}$ is the marginal cost of selling to the market in domestic currency and $e_{d,t}$ denotes the nominal bilateral exchange rate:

$$p_{i,d,l,t} = \mu_{i,d,l,t}\; \frac{Mc_{i,d,l,t}}{e_{d,t}} \tag{43}$$

After taking logs to equation (43), there are two results that hold by definition. First, that conditional in the marginal cost of production $Mc_{i,d,l,t}$, the exchange rate pass-through should be equal to minus one if markups are constant. Second, that if all firms face the same markup-elasticity to prices, then exchange rate pass-though should not vary across firms. The literature has extensively document that exchange rate pass-through to prices are incomplete and more recently it has been shown that these changes are related to exporter share as shown by Berman et al. (2012).

To estimate the changes on markups due to changes in the exchange rate we need to control for the changes that exchange rate movements have on the cost of production. In another words, not controlling for the cost of production for a particular product in a firm and how the cost change in response to exchange rate movements will biased the estimates of how markups changes as a function of the exporter's share. [27]

To address this concern I follow a different empirical strategy than the one in Berman et al. (2012) by exploiting variation across destination within firm-product-time. At this point is

[26] Even though the transaction can occur in a common currency, as for example usd dollars, demand of the product in destination d depends on the relative price of the good to other domestic goods which are generally posted in the domestic currency. This implies that the assumption of the currency in which firms posted their prices are irrelevant for relative long horizon where the potential stickiness of prices becomes irrelevant.

[27] This biased is particularly likely to exist since it has been documented in Amiti et al. (2014) that larger exporters also tend to import more.

worth to mention, that the purpose of this estimation is not estimate or provide a mechanism to explain the incomplete pass-through, but to obtain estimates that capture the markup changes to changes in the cost of serving a market.[28]

I assume that the marginal cost that a firm i face to sell to market (d, l) at time t, can be expressed as the product two component: (1) the marginal cost of selling product l at t, denoted by $Mc^a_{i,l,t}$, and (2) the cost (that is common across firms) of selling the product to a destination d, which I denote by denote $Mc^b_{l,d,t}$. Under this assumption we have that:

$$\ln p_{i,d,l,t} = \ln \mu_{i,d,l,t} + \ln Mc^a_{i,l,t} - \ln(e_{d,t}) + \ln Mc^b_{l,d,t} \tag{44}$$

By differentiating (44) with respect to the relative exchange rate we have (46). Where it become clears that if markups are constant, controlling for firms marginal cost, should predict a full exchange-rate pass-trough to prices independent of firms condition on that market.

$$\frac{\partial \ln p_{i,d,l,t}}{\partial e_{d,t}} = \frac{\partial \ln \mu_{i,d,l,t}}{\partial e_{d,t}} + \underbrace{\frac{\partial \ln Mc^1_{i,l,t}}{\partial e_{d,t}}}_{\theta_{i,l,t}} \underbrace{-1 + \frac{\partial \ln Mc^2_{l,d,t}}{\partial e_{d,t}}}_{\gamma_{l,d,t}} \tag{45}$$

If the markup elasticity varies across firm we can use exchange rate shocks to recover the differential reaction of firms due to markups changes in their marginal cost.[29] Using equation (46), and assuming that markups are a function of exchange rate we can estimate equation (46) to test if markups are non-constant, and if the markup elasticity to changes in the exchange rate varies with the exporters share.

$$\Delta p_{i,d,l,t} = \beta \Delta e_{i,d,l,t} \times \text{exp. share}_{i,d,l,t-1} + \beta_2 \text{exp. share}_{i,d,l,t-1} + \theta_{i,l,t} + \theta_{i,l,d} + \gamma_{l,d,t} + e_{i,d,l,t} \tag{46}$$

I estimate equation (46) where Δ denotes log differences of the variables over a year. I add firm-product-time fixed effects and product-destination-fixed effects. By this addi-

[28] The relevance of the existence of variable price elasticity to explain incomplete and heterogeneous exchange rate pass-through is discussed in Alessandria et al. (2021b) and Gopinath et al. (2010) This is beyond the objective of this paper, but the estimation proposed here may help to discipline the changes in prices that are due to changes in markups or due to changes in the cost of production.

[29] See Arkolakis et al. (2017) for a generalization of how different theories and preferences can generate exchange rate pass-through to differ across firms

tion, we can fully control the changes that exchange rate movements may have over the marginal cost of production under the assumption already stated above.[30] Under the assumption stated above, beta captures the markup elasticity to changes in the exchange as the function of the exporter share over total sales on that market.

One concern in estimating equation (46), is that exchange rate shocks are not exogenous, and importantly that may reflect changes in destination country which can be affect the relative demand through changes in the aggregate prices and quantity demanded, by generating a biased on how markup elasticity may depend on firms share (in the model this can be interpreted as shocks affecting the exchange rate also affecting the foreign choke price). For example, if Colombia export to Argentina, and suddenly Argentina has a crisis that also affects the bilateral exchange rate between the two countries, then it is natural to think that β will be downward, since in this case the Colombian exporter will face lower demand (lower choke prices), and may find it optimal to pass-though more -lower β- to prices due to these changes.

I address these concern by instrumenting the exchange rate variation intersected with the firm's sales shares of sales with the remittances flows to Colombia interacted with sales shares to the destination in the year 2007. This implies that we need to assume that remittances flow to Colombia can affect the exchange rate. In this regard is worth noting that on average net remittances to Colombia represent on average 10% of the total export flow to Colombia, also the effect and relevance and remittances on exchange rate has been discussed and shown to be important in Mandelman (2013) and Lartey et al. (2012) among others [31].

I use total remittances from third countries to alleviate the first concern expressed above by cleaning the variation in the bilateral exchange due to changes in the destination country and not in the origin country. Also it has been find that the remittances are unlikely to vary due to exchange rate variation as in Mandelman et al. (2020).

[30] We can also add fixed effects at the firm-product-destination to capture the case that firms may have a particular trend in price changes related to their export share to that market. The addition or not of these fixed effects or not does not change the empirical results.

[31] See Central Bank from Colombia to obtain the relevance on remittances

Another concern is that the theoretical model does not predict a direct relationship between the export share and the markup of the firm. In the model the relative change in markups depends on the relative productivity of the firm. Since in the data I cannot observe the relative productivity of firms, I proxy this with by the exporter share. Since new exporter grow slowly over, this implies that the mapping between relative productivity and export share is weaker in the early age of exporter because they are building up their market share, to solve for this concern I focus on those exporters whose age is above four years.

Then I proceed to estimates the following two equations. In the first stage I estimate:

$$\begin{aligned} \Delta e_{i,d,l,t} \times \text{exp. share}_{i,d,l,t} = \Delta remittances_{d,t} \times \text{exp. share}_{i,d,l,2007} + \\ + \text{exp. share}_{i,d,l,t-1} \times crtl_{d,t} + \theta_{i,l,t}\gamma_{l,d,t} + e_{i,d,l,t} \end{aligned} \tag{47}$$

And then in the second stage I proceed to estimate:

$$\begin{aligned} \Delta p_{i,d,l,t} = \beta \Delta e_{i,d,l,t} \times \widehat{\text{exp. share}}_{i,d,l,t-1} + \text{exp. share}_{i,d,l,t-1} \times crtl_{d,t} + \\ + \theta_{i,l,t} + \gamma_{l,d,t} + \theta_{i,l,d} + \epsilon_{i,d,l,t} \end{aligned} \tag{48}$$

Note that the exclusion restriction for this estimation states the conditional on $\theta_{i,l,t}$, $\gamma_{l,d,t}$, $\theta_{i,l,d}$ the covariance between $\epsilon_{i,d,l,t}$ and $\Delta remittances_{d,t} \times \text{exp. share}_{i,d,l,2007}$ is equal to zero. This condition will be violated if a shocks to the remittances to Colombia from a third country covaries with another shock that makes the firms to change the price of all their product in a differential way than the price change than other destinations. For example, imagine we have Colombia and three other countries, USA, Argentina and Brazil. To violate the exclusion restriction we need that the change in the remittances flows from USA to Colombia to be correlated with a shock that will affect the relatively price that firm i selling product l wants to charge to Brazil than to Argentina, besides the aggregate shocks that hit Colombia and Argentina.

Panel 3 also present similar estimate but looking at quantities. I do this as a robustness check that the IV approach is working as expected. Two results are important, without the IV the OLS estimate predicts a change in quantities that seems unrelated with the predicted change in prices. While after we do the instrument, is not only that quantities respond is negatively, as expected, it is also that the magnitude of the coefficients is much larger for the quantities response than for the prices, as we should expect if its is the case that price elasticity are higher than 1. In particular, the coefficient implies that quantities are responding around 3 times more than the prices. In conclusion, I show that the we can reject the assumption of constant price elasticity, and that the predictions are consistent with the structure of the model.

Mapping empirical estimates to the model. To compute the price changes to a cost shocks in the model I proceed as follows. I compute the log price difference for each firm and each period, between two economies 1 and 2, which I denoted by $\Delta p_{i,t}^{e1,e2}$. The way I capture the the exchange rate shock is by increasing the aggregate wages. Since the empirical facts can be understood as capturing the partial equilibrium, I keep prices constant along these two economies, when I perform this exercises. For each period in time I compare the price change for those exporter in 25^{th}, 50^{th} and 75^{th} of the sales distribution in the economy without the change in wages. I divide the price change of group firms in the 25^{th} to the ones in the 50^{th} (denoted as $\frac{\Delta p_{50^{th},t}}{\Delta p_{25^{th},t}}$), and the ones in the 50^{th} relative to the ones in the 75^{th} (denoted as $\frac{\Delta p_{75^{th},t}}{\Delta p_{50^{th},t}}$). Then I take the average of these two ratios over the all the time I have simulated in my model. After this I obtain two ratios of average price change between those exporters at 25^{th} and 50^{th} percentile, and between those at the 50^{th} and the 75^{th} percentile of the distribution. I make this two moments in the model to match its empirical analogous.

I construct the empirical analogous of the markups response to exchange rate shocks as follow. First I compute the predict changes in prices in the data as follows:

$$\Delta p_{i,l,d,t} = (\beta^{IV} \times \text{exp. share}_{i,l,d,t} - 1)\Delta e_{d,t} \tag{49}$$

where exp. $\text{share}_{i,t}$ represents the share of a firm i exports of product l over the total exports to market m, at time t. $\Delta e_{i,t}$ the log exchange rate change, and $\Delta p_{i,t}$ the estimated change in prices. I compute the empirical analogous of price change by using the average of firm's

Table A.8: Heterogeneous Exchange Rate Pass-through and Exporter share

Panel 1: First Stage

	(OLS)	(IV)	(IV)
	-	Δex. rate$_{d,t}$ $\times$ $share_{i,l,d,t-1}$	Δex. rate$_{d,t}$ $\times$ $share_{i,l,d,t-1}$
Δremittances$_{\neq d,t}$ $\times$ $share_{i,l,d,07}$	-	0.29***	0.41***
	-	[0.04]	[0.05]
Observations	44,369	44,369	27,257
Firm-product-time FE	✓	✓	✓
Destination-product-time FE	✓	✓	✓
Controls $\times$ $share_{i,l,d,07}$	GDP, TOT	GDP, TOT	GDP, TOT
Exporter Age	≥ 3	≥ 3	≥ 4

Panel 2: Second Stage (Prices)

	(OLS)	(IV)	(IV)
	$\Delta \log p_{i,ld,t}$	$\Delta \log p_{i,ld,t}$	$\Delta \log p_{i,ld,t}$
Δexchange rate$_{d,t}$ $\times$ $share_{i,l,d,t-1}$	0.15***	0.71**	1.20***
	[0.05]	[0.33]	[0.36]
Observations	44,369	44,369	27,257
F- Statistic:	-	69.07	69.37
Firm-product-time FE	✓	✓	✓
Destination-product-time FE	✓	✓	✓
Controls $\times$ $share_{i,l,d,07}$	GDP, TOT	GDP, TOT	GDP, TOT
Exporter Age	≥ 3	≥ 3	≥ 4

Panel 3: Second Stage (Quantities)

	(OLS)	(IV)	(IV)
	$\Delta \log q_{i,ld,t}$	$\Delta \log q_{i,ld,t}$	$\Delta \log q_{i,ld,t}$
Δexchange rate$_{d,t}$ $\times$ $share_{i,l,d,t-1}$	-0.04	-2.51***	-2.96***
	[0.19]	[0.72]	[0.81]
Observations	44,369	44,369	27,257
F- Statistic:	-	69.07	69.37
Firm-product-time FE	✓	✓	✓
Destination-product-time FE	✓	✓	✓
Controls $\times$ $share_{i,l,d,07}$	GDP, TOT	GDP, TOT	GDP, TOT
Exporter Age	≥ 3	≥ 3	≥ 4

Standard errors in brackets. Error cluster at destination country. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

share over total exports for each product destination, for those exporters at the 25^{th}, 50^{th} and 75^{th} percentile of the export distribution for each market.[32].

I set η and p_f^c, that relates the firms' export share to the relative changes in prices across firms so that the two empirical moments ($\overline{\frac{\Delta p^e_{50th}}{\Delta p^e_{25th}}}$ and $\overline{\frac{\Delta p^e_{75th}}{\Delta p^e_{50th}}}$) to match its analogous in the model.

The margins of trade: Model vs data. Panel b of figure A.1 shows how the total number of exporters decreases in the model relative to the estimates of the data. It can be observe that the model over-estimate the negative relationship between the number of exporters and the microeconomic volatility relative to the empirical estimates of Table 2. As a consequences of over estimating the reaction of the extensive margin, the model the implies that the reminder exporter will be on average more productive which end up generating a higher level of average export per exporter that is higher than the the estimated in the data, so that the effect of volatility on the intensive margin will be underestimated and the compositional effect overestimating. Panel (a) of the figure A.1, show that the opposite is true for the case of macroeconomic volatility, the model is not able to properly capture the extensive margin responses to volatility, which may also be at the heart of the problem of why the model predicts an elasticity between exports and volatility that is around 50% of the empirical one.

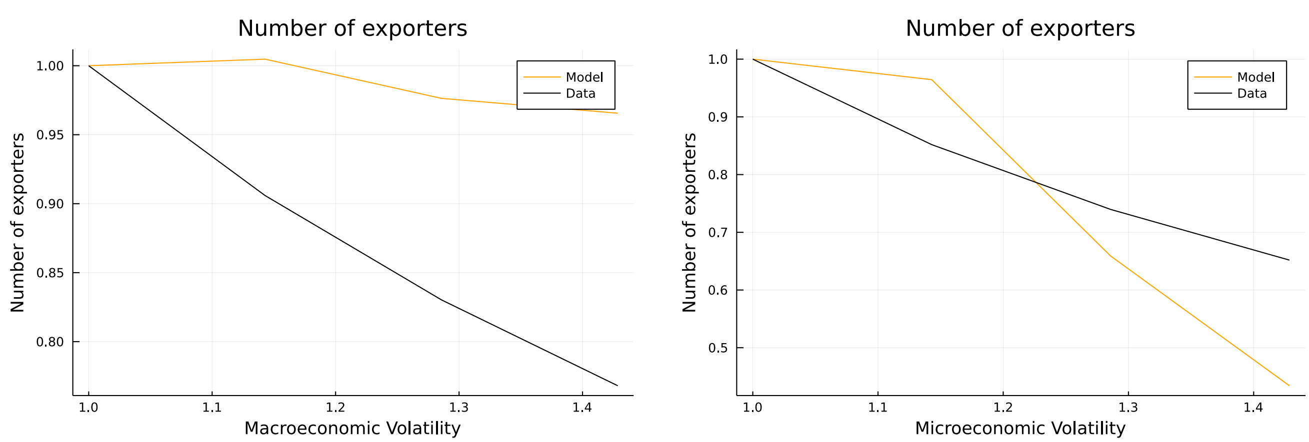

Figure A.1: Volatility and Extensive Margin

[32] A market is a product-destination combination

Figure A.1 shows that while the model is successful in qualitatively generating the reaction of exporters to volatility shocks, it fails in being able to properly capture the quantitatively relationships I find in the data.