International Trade, Volatility, and Income Differences

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Job Market Paper

Last version available here

This Version: November 8, 2021

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

* I want to thank George Alessandria and Yan Bai for their helpful guidance, support, and encouragement, as well as Joe Steinberg and Gaston Chaumont for their direction and countless suggestions. I am also highly grateful to Federico Mandelman, Jon Willis, Mark Bils, Toni Braun, Lorenzo Caliendo, Maximiliano Dvorkin, Hamid Firooz, Simon Fuchs, Stepan Gordeev, Roozbeh Hosseini, Narayana Kocherlakota, Fernando Leibovici, Paulo Lins, Veronika Penciakova, B. Ravikumar, Diego Restuccia, Juan Sanchez, Ana Maria Santacreu and Walter Steingress for their valuable discussions and suggestions. I also thank the participants of the Brown Bag Seminar at the Federal Reserve of Atlanta, the 2021 Ph.D. Interns Workshop at the Federal Reserve of St. Louis, the LACEA-RIDGE job market showcase, the macro workshop at the University of Rochester, and the participants at the international reading group at the University of Rochester for their comments and suggestions. All errors are my own.
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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 some 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.

[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)

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 transactions 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 stochastic general equilibrium 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 all the 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. 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

[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.

their aggregate and firm-level productivity. I compute the ergodic distribution of the model 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 well-known wait and see 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.

[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)

Arellano et al. (2019) and Merga (2020)]; and (3) the existence of sticky prices [e.g. Basu 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 for this enviroment.

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 the I use several data sources: Penn World table database, the Dynamic Exporter Database from the WorldBank, the Enterprise Survey from the World Bank, and CEPII database, which I will describe more in detail in the following subsection.

While for the micro-level data and the model estimation, I use three primary data sources. Administrative data from Colombia customs, and the Administrative data from "Superintendencia de Sociedades" from Colombia, which reports firms' balance sheet data. To estimate some model parameters, I use the Colombian manufacturer survey.

2.1 Cross country Data

Penn World Tables. This data cover 183 countries between the years 1950 and 2019. I mainly use this data source to obtain data in the total factor productivity for each country, and other aggregate variables as GDP, export and import prices, population[7].

Dynamic Exporter Database. I use this data source to obtain data on the number of exporters, average exports per exporter, entry and exit rate, and new exporters' growth. The data is at the origin-destination-year. While this data is new, it has been used by A. M. Fernandes et al. (2019) and A. Fernandes et al. (2015). The advantage of this data set is that 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. The disadvantage is the limited coverage of countries. In particular, this data set covers 70 countries for a period goes from 1990 to 2012, but for most of the countries, the period covered runs from 2005-2012.

CEPII. I use three main datasets from the CEPII foundation. These data set are the "Gravity" data set, the "TradeProd" data set [8]. The first data set allows me to control for variables

[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

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.

The second data set, the ”TradeProd” data set, provides information for bilateral trade, production, and protection figures in compatible industry classification for developed and developing countries; this data runs from 1980-2006 for 26 industrial sectors within the manufacturing sector (in the ISIC Revision 2). I use these data set is to obtain data on the bilateral product level of exports across countries. The advantage of this data source over the Dynamic exporter database is the extended period and the higher number of countries for which bilateral trade flows are reported. The disadvantage is the lack of data on the margins of trade for different exporters. For this reason, I use this data set to understand how the country’s level of volatility is associated with aggregate exports. I use the data on manufactures exports as a robustness check that the result is not driven by sectoral compositional differences that vary across development levels.

Enterprise Survey from the World Bank. To obtain estimates on the volatility at the firm-level, I need comparable data across countries on sales, labor, capital for firms in each country. This is the purpose of this data set. Among some other variables, I can observe sales, labor, and labor productivity changes for the past three years for a firm within a country. I use this data set to construct comparable measures of the microeconomic volatility in each country, as I will explain later.

2.2 Firm-level Data

I use two administrative data set from Colombia to measure variables at the firm-level data. The first data set reports the exports of each firm at the 8-digit product level for each destination 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, and it covers the period from 2006-2019. Using monthly frequency to understand exporters’ dynamic behavior over longer frequencies raises a genuine concern given the documented lumpiness that characterized export shipments [9]. To avoid this problem, I aggregate export flows for each firm product destination at the year frequency.

I merge this data with the firm-level data from "Superintendencia de Sociedades". This data reports the variables that firms declared in their balance sheet information. This allows me to observe, total income, operational income, operation cost, total costs, profits and operational profits among other set of variables. All of these variables are in nominal Colombian Pesos, which I deflate using the production price index when necessary. The data sets cover a sub-sample 20 thousand firms, the biggest firms, that also represent around 90% of the total value added. The fact that the sample is skewed towards larger firms generates a concern due to the possible biased that this fact may entail for the firm-level empirical facts. While important, the focus on exporters, who are generally the largest firms in the economy, and given the level of concentration of total exports on larger firm, this concern is alleviated. Even though this argument may alleviate this concerns I show that the firm-level facts are robust to the inclusion or not of this data set in the appendix.

3 International Trade and Volatility Around the World

In this section, I focus on the cross-country level data. I document three novel facts. First, I start by revisiting the already documented fact that those countries with higher volatility levels also have smaller levels of GDP per capita. I refer to this as the aggregate fact 1. 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). Second, I then reexamine the relationship between the average exports and the country's level of development consistent with the results in the literature. I show that, unconditional on the level of volatility of a country, there exist a positive relationship between aggregate exports and level of development across countries, as in Waugh (2010), Fieler (2011), Blum et al. (2019), A. Fernandes et al. (2015) and de Sousa et al. (2012). I refer

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

to this fact as the aggregate fact 2. 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 and, in some cases, becomes negligible. In other words, I show that aggregate fact 1 can explain aggregate fact 2. I refer to this as the 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.

3.1 Cross-country Volatility Measure

In this subsection, I present how I measure macro and microeconomic volatility for each data. In 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 estimate TFP for each country. This captures how volatile is the cyclical component of an economy around its trends. To measure this, 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. I detrend the series by using an H-P filter with a smooth parameter equal to 100 (I am using annual frequency data). The measure of TFP comes from the estimates of Penn World Tables. [10] I then proceed to estimate equation (1):

$$\ln \widehat{tfp}_{i,t} = \alpha_0 + \rho_i \ln \widehat{tfp}_{t-1} + e_{i,t} \tag{1}$$

[10] Ideally one would like to have the volatility of the actual shocks, instead of the estimated one, since this may purge any of the potential country conditions that may be amplifying the actual shocks. Unfortunately this is not possible, and I use the estimated TFP as a proxy. See Feenstra et al. (2015) for more detail on its construction.

Equation (1) states 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, which gives generates 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 each country i macroeconomic volatility as the standard deviation of the variance of the unconditional process, under the assumption that the detrended process of the aggregate TFP evolves as an ar(1) process, as shown in the following equation:

$$\sigma_i^a = \left(\frac{\sigma_i^2}{1 - \rho_i^2} \right)^{\frac{1}{2}}$$

Where σ_i^2 is the sample variance of $\hat{e}_{i,t}$.

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

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

Where $\varDelta$labor prod is the log change (in a year) in the labor productivity (defined as total sales over total workers) for a firm f at year t. 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. $\gamma_{i,j,t}$ denotes country-industry-year fixed effects. Equation (2) is a simple way to obtain the firm-level changes in labor productivity, purging out the common changes due to the macroeconomic conditions that may have affected a particular all firms within a country-industry-period. In this, sense $e_{f,i,j,t}$ can be interpreted as the pure firm-level shocks.

Once I obtain the firm-level shock, denoted by $\hat{e}_{f,t}$ I proceed to compute the average observed standard deviation of each year for each country. I defined each country i microeconomic volatility as the average cross section standard deviation of $\hat{e}_{f,t}$ for all firms in country i, as stated in equation (3).

$$\sigma_i^{\omega} := \sum_{t=1}^{T} \frac{\sqrt{\sum_{f \in F_{i,t}} \frac{\left(\hat{e}_{f,t} - \mu_t^{e_f}\right)^2}{|F_{i,t}|-1}}}{T} \tag{3}$$

Where $\mu_{i,t}^{e_f}$ denotes the average of $\hat{e}_{f,i,j,t}$ across firm at year t, and $|F_{i,t}|$ is the total number of firms in the data in country i.[11]

One concern of using this measured based on the observed standard deviation of the firm's labor TFP is computed conditional on firms surviving. This implies that for those firms whose shocks are so large that they end up exiting the market, the shock is not computed since they are not available in the sample. This implies that the volatility measure is likely to be under-estimated. Furthermore, the severity of this underestimation can be correlated across the level of development. For example, if given the same shock, firms in developing economies are more likely to exit, the underestimation will be higher in developing economies. This may be the case because of the lower level of financial development in developing economies.

3.2 The Aggregate Facts

I proceed to document the three aggregate facts. Aggregate facts shows that developing economies are more volatile. Aggregate fact 2, shows that when we do not condition on the level of development, the unexplained component of exports is positively related with the level of development of countries. Aggregate fact 3 shows that aggregate fact 2 is significantly reduce once we control for the countries level of development. Given that the aggregate fact 2 and aggregate fact 3 are well know by the literature I focus my attention on the robustness of the aggregate fact 3.

Aggregate Fact 1: Negative relationship between per capita GDP and volatility. Figure 1, shows that there exist a negative relationship between the average level of GDP per

[11] 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.

Capita (Y-axis) and each measure of volatility (X-axis). Each of the variables are presented in logs, and the standard deviations for each measure are in percentage points.

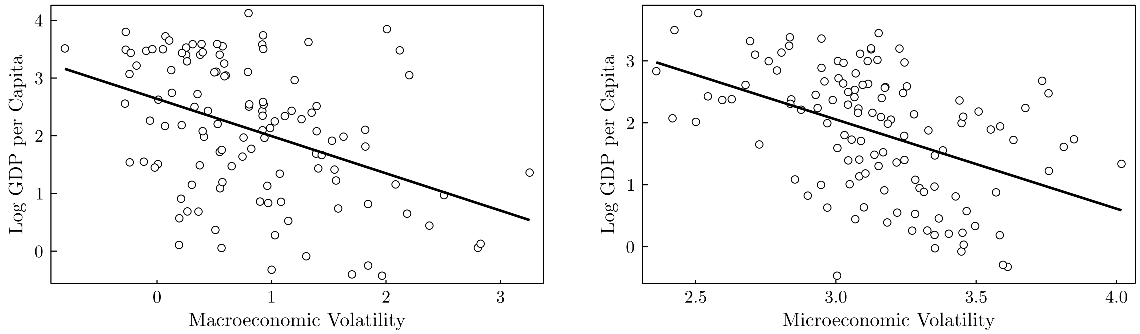


Figure 1: Volatility and GDP per Capita

Exports, volatility and income differences: Conceptual framework. Before documenting aggregate facts 2 and 3, I explain the framework developed by recent literature on the determinants of bilateral trade across nations. Following this framework allows me to estimate the relationship between the average 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, the bilateral exports to be given by the following equation (4). Equation (4) states that conditional on exporting, the logarithm of country i's exports to country j (denoted by $\ln(x_{ij})$), can be decomposed in an origin country fixed effect α_i, a destination fixed effect γ_j and a vector of bilateral variables captured by $\boldsymbol{y}_{ij}$ [12].

$$\ln(x_{ij}) = \alpha_i + \gamma_j + \boldsymbol{\beta}\boldsymbol{y}_{ij} + \epsilon_{ij} \tag{4}$$

The rest of this section is devoted to answering the following question: How is α_i related to the macro and microeconomic volatility that characterized each country?

To answer this question, I follow Keith Head et al. (2014) and Eaton et al. (2002) by using a two-step procedure. First, I estimate a gravity equation to back up the origin fixed effects, but instead of using equation (4) I estimate the following equation that states a similar relation

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

at the product destination level:

$$\ln(x_{ijht}) = \alpha_i + \gamma_{jht} + \boldsymbol{\beta} \boldsymbol{y}_{ijt} \times \omega_h + \boldsymbol{\beta_2} \boldsymbol{h}_{it} \times \omega_h + \epsilon_{ij} \tag{5}$$

These equations states that the logarithm of exports from country i to country j of product h at time t (denoted by $\ln(x_{ijht})$), can be decomposed in an origin country fixed effect α_i, which is the object of interest, a market-time fixed effects (γ_{jht}), a vector of bilateral-product variables that varies across product and time captured by $\boldsymbol{y}_{ijht}$. To control for the time varying domestic components its differential relationship across products, I intersect each aggregate variable with a dummy variable for each product.

After estimating α_i from (5) (denoted by $\hat{\alpha}_i$), I proceed estimate equation (6):

$$\hat{\alpha}_i = \beta_0^{\alpha} + \beta_1^{\alpha} \ln \sigma_i + \beta_2^{\alpha} \ln \frac{GDP}{L} + \boldsymbol{\alpha_3} \bar{\boldsymbol{y}}_{ij} + \boldsymbol{\alpha_4} \bar{\boldsymbol{h}}_i + \boldsymbol{\alpha_5} \bar{\boldsymbol{Q}}_i + e_i \tag{6}$$

Equation (6), states that countries origin fixed are related to country's i level of volatility, its level of GDP per capita, the average of the bilateral-product-time variables, and of the origin time-varying variables, and a vector of different indexes that captures county's i quality in different institution, denoted by σ_i, $\frac{GDP}{L}$, $\bar{\boldsymbol{y}}_{ij}$, $\bar{\boldsymbol{h}}_i$, and $\bar{\boldsymbol{Q}}_i$, respectively. The additions of this controls follow Keith Head et al. (2014). Finally, $\bar{Q}_i$ is a vector of three indexes developed by the World Bank that captures the quality of the contract enforcement and of the financial institutions available in country i, and the direct average export costs that exporters in each country face. The inclusion of these three indexes obeys the recent development in the literature showing how institutions and financial conditions affects international trade (as for example in Manova (2008), Manova (2013), Kohn et al. (2020)), and the declared export costs for different countries as showed by Blum et al. (2019). I do this because these variables may affect how volatile a country is and its total exports. The two main coefficient of 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.

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]
$\log(\text{Macro-Volatility}_i)$		-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 $\times$ Destination $\times$ 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]
$\log(\text{Micro-Volatility}_i)$		-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 $\times$ Destination $\times$ Product FE	✓	✓	✓	✓
Gravity Controls	✓	✓	✓	✓
Doing Business	Exp.	Exp.	Exp/Cred/Cont	Exp/Cred/Cont

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

Aggregate Fact 2: Positive relationship between exports and income per capita. Table 1 presents the results using both the macro and the microeconomic volatility measure. Each of the 4 column presents different specification with small variations. Column (1) and (3) estimates equation (6) without controlling for the volatility of a country. In columns (1) and (2) I only controls for the declared exports cost by exporters in the Doing Business survey, column (3) and (4) I also add controls for the level of financial and contractual enforcement index for each country reported in the same data set. Both results shows significant and relevant relations between the level of development and the average export to each market, even after controlling by country size proxy by the average level of GDP and population of each country, consistent with the findings of Waugh (2010), Fieler (2011) and Blum et al. (2019).

Aggregate Fact 3: Negative relationship between volatility and exports. In table 1 column (2) and (3) are the homologous to column (1) and column (2) but now adding the variable of interest, the macro or microeconomic volatility measure of each country. The results presented on column (2) and column (3) of panel 1, shows that the estimated relationship between exports and the level of GDP par capita drops between 40% and 50% once we control 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 the microeconomic volatility the relationship between average exports and the level of GDP per capita reduces by around 35%. There are one difference that is worth to mention among these panels, as mentioned before The second difference, as I have only data on firms' labor productivity changes for a subset of countries, restricting the amount of countries on Panel 2 of table 1.

The previous results show that macroeconomic and microeconomic volatility are essential variables to predict average exports to each market. They do 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 of countries in previous works as in Waugh (2010), Fieler (2011) and Blum et al. (2019). The 3 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 by the standard determinants of international trade.

3.3 Volatility and The Margins of Export

But what are the margins through which trade is reacting to these different levels of volatility? To answer this question, I estimate the relative importance of each margin of trade to understand how differences in volatility translate to smaller total exports.

The three margins of exports: Conceptual framework. Total exports from country i to j, ($X_{ij,t}$) can be written as in equation (7). The equation states that the total exports from i to j, can be written as the number of exporters available on the economy (which I denote by $N^{exp}_{ij,t}$) multiplied by the average export per active exporter from i to j (denoted by $\bar{x}_{ij,t}$):

$$X_{ij,t} = N^{exp}_{i,t} \underbrace{\int_{z_t^*}^{\infty} x_{ij}(z_{f,t}) dG(z_{f,t})}_{=\bar{x}_{ij,t}} \tag{7}$$

Let N^{exp}_{ijt} 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 $z_{f,t}$. Assuming these variable are a function of the the micro or macro volatility of country i, we can get an equation to decompose the relevance of each margin. Equation (7) follows after applying logs to (7) and taking the derivative with respect to the volatility measure $\ln \sigma^x$, making use of the Leibniz integral rule:

$$
\begin{aligned}
\frac{\ln X}{\ln \sigma^x} = & \underbrace{\frac{\ln N^{exp}}{\ln \sigma^x}}_{\textit{Ext. margin}} \\
& + \frac{1}{\bar{x}} \underbrace{\left(\int_{z_t^*}^{\infty} \overbrace{\frac{\partial \ln x(z_f)}{\partial \ln \sigma^x}}^{\textit{Unc. adjustment}} x(z_f) dG(z_f) + \overbrace{\frac{\partial \ln g(z)}{\partial \ln \sigma^x}}^{\textit{Distr. adjustment}} x(z_f) dG(z_f) \right)}_{\textit{Int. Margin}} \\
& + \frac{1}{\bar{x}} \underbrace{\frac{\partial z^*}{\partial \ln \sigma^x} \frac{g(z^*)}{1 - G(z^*)} x(z^*)}_{\textit{Comp. margin}}
\end{aligned}
\tag{8}
$$

Where in equation (8) I have also dropped the sub-index denoting the pair of countries (ij) and time (t) to simplify notation. Equation (8) states that the response of total exports to changes in volatility can be decomposed in three margins: 1) the extensive margin (the first term of equation (8)), 2) the intensive margin (the second term of equation (8)), and 3) the compositional margin (the third term of equation (8)).

The first term, the changes in the extensive margin, states how the number of exporters responds to changes in volatility. The second term, the changes in the intensive margin, says how exporters - conditional on exporting (the incumbent exporters)- change their exports in response to changes in the volatility. The third term, the compositional margin, states how much the exports of the marginal exporters change as a response to changes in the measure of volatility.

Furthermore, equation (8) 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 the changes in the distribution of productivity conditional on the export level of each exporter, and I call it the distributional channel.

For example, if conditional on each firm's productivity, the effect of volatility on the 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 the realized productivity. This is the case in any static type of model where all the decisions are statics (conditional on the aggregate variables like wages and productivity). 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 conditional on the firms' level of productivity, the exports will be the same. 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 three components. The effect of volatility over total exports, over the extensive margin and the intensive, while the compositional difference cannot be directly observed in the data. Then following Keith Head et al. (2014) we can treat this compositional effect as the residual of the between the effects on total effect, and its consequences on the intensive plus extensive margin, as expressed in the following equation:

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

To measure the relative importance of each margin, I follow the two-step strategy as described before, but now changing 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 when I use the 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. Column 3 and 4 show the relationship between the number of the exporter (the extensive margin) and the average exports per incumbent (the intensive margin). Similar to the case when I used trade flows from CEPPI, 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. 85% of the relationship between exports and aggregate volatility is due to the extensive margin, 30% is due to the intensive margin, and the rest (-15%) is the compositional margin.

Panel 2 of table 2 shows the result when I use the microeconomic volatility measure. 68% of the average reduction in exports is due to the intensive margin, and 55% is due to the extensive margin. These results imply that -23% is associated with the compositional margin. This finding suggests that volatility generates higher sorting into the export market. The relevance of the intensive margin implies 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 by the literature, aggregate fact 3 is new. I discuss and describe different robustness checks I perform 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 following this estimation strategy is to what extent the results are robust to other measures of the origin country volatility. To check if results hold to different volatility measures, I also compute the aggregate volatility using the standard deviation of log changes of the estimated TFP and using the same procedures but using GDP instead of estimated TFP. 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 I am using may reflect both global and domestic components. Suppose foreign demand volatility discourages exports, and that is also making some coun-

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. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

tries more volatile. In that case, this may generate a similar prediction as the one observed but due to the partner's more volatility. To deal with this potential problem, I regress the cyclical component of the TFP against a year fixed and use the residuals of this estimation to construct the volatility of each country. This allows me to purge out the effect that is common across countries. I find that results hold regardless of any of these approaches.

Measurement of microeconomic volatility. There are some potential 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 maybe just a reflection of the average markups of the firm. To solve this problem, I also use sales and labor changes to compute the domestic volatility. I find similar results regardless of using variables such as domestic sales, labor changes, or just focusing on firms without tight links to the foreign markets.

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 producing an industry for whose product is particularly difficult to export, but its production is also more volatile. In this case, its not that volatility is behind the country's low export performance but its structure of production behind this relationship. To test for this possibility, I focus only on the manufacturer sector and proceed in the same way as described before. I find that performing these exercises does not change the findings documenting in aggregate fact 3.

Reverse causality problem. Another concern of the relationship that I document is the fact that it is low trade that 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, they will be less able to smooth the domestic shocks through international borrowing and lending. This lack of ability to smooth the shocks may increase a country's level of volatility in the estimated TFP, or the GDP. While possible, Razin et al. (2015) reject changes in the volatility of countries after they went through trade or capital flows liberalization. To test if this may be a big concern, I proceed in the following way. First, 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 to 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 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 this section, I focus on the exporter micro-level data from Colombia. I describe before I use two data sets containing administrative data on the firm level of exports and their balance sheet. The data on exporters allows me to observe the exports values and quantities, in a given month, at the 8 digit level to each destination. I merge this data with, another administrative data set at annual frequency from Colombia that cover almost 95% of the total production in Colombia, and shows the balance sheet data reported by firms. To facilitate cross-country comparison, I aggregate the trade flows at the 6-digit level.

I use this data set to analyze and establish a set of facts that relating the export behavior of firms to their exposure to volatility. In particular I focus on the determinants of the growth of exporters. By doing this I document two main micro-level facts. First, that exporters growth in each markets through increases in the demand they face. Second, that as exporters are more exposed to domestic volatility thy grow less over their life cycle.

Micro-level fact 1: New exporters grow through increases in their demand. I revisit the facts documented in Fitzgerald et al. (2021) to understand how Colombian exporters grow over their life cycle. The main difference between the empirical approach follow by Fitzgerald et al. (2021) and the one here, is that I use the initial level of exports of each exporter after entry for each particular product-destination instead of using as a base the initial exports of those exporter with an spell of one year.

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.

To pin-down the evolution of quantities in a particular market (product-destination pair), purging out the common component in the firm evolution I proceed by estimating the following equation:

$$\ln \text{export}_{i,d,l,t} = \sum_{h=0}^{5} \beta_h \mathbb{I}^h_{\{age=h\}} + \ln p_{i,d,l,t} + \gamma^a_{i,l,t} + \gamma^b_{d,l,t} + \epsilon_{i,d,l,t} \tag{9}$$

In the equation (9) $\text{export}_{i,d,l,t}$ represents the total exports value that firm i is selling of product l to destination d during year t. In the equation total exports are projected 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. Also in the estimation, $p_{i,d,l,t}$ are the unit values for the product l that firm i is selling to destination d at time t, $\gamma^a_{i,l,t}$, $\gamma^b_{d,l,t}$ represents firm-product-time fixed effects and product-destination-time fixed effects respectively. The addition of this fixed effects allows me to capture the common variation in sales for firm i of product l at time t, while the second set of fixed effects allows to capture the common variation across exporters within a destination product time. For example, if suddenly the firm invest in reducing the cost of production or increasing the quality of a particular product for all the destination that is serving, this will be absorbed by $\gamma^a_{i,l,t}$, while the variation in the destination market for a particular product, as for example changes in tariff or aggregate shocks that affect the demand of a particular product will be absorbed by $\gamma^b_{d,l,t}$. In this sense, $\{\beta_h\}^H_{h=1}$ will capture the log changes in sales in the export market at the age h of the exporter, relative to its entry level of sales ($\beta_0 = 0$ by construction). In particular, I understand $\{\beta_h\}^H_{h=1}$ as capturing the results of the market-specific investment exporters does to grow into a particular market (product-destination pair)

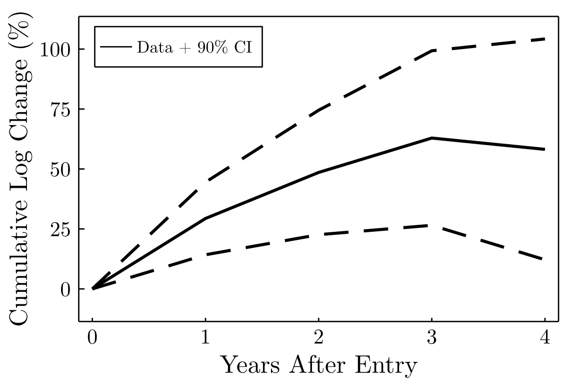
To pin-down the price dynamics over the exporter life cycle I proceed in a similar but without controlling for prices:

$$\ln p_{i,d,l,t} = \sum_{h=0}^{5} \beta_h^p \mathbb{I}_{\{age=h\}}^h + \gamma_p^a{}_{i,l,t} + \gamma_p^b{}_{d,l,t} + \gamma_p^c{}_{\text{cohorts}} + \epsilon_{i,d,l,t} \tag{10}$$

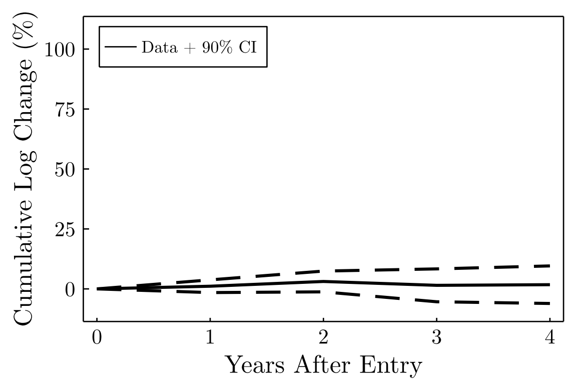
In this case β_h^p captures the differential changes in prices over the life cycle of the exporter relative to the common variation in prices for that product l at destination d, at time t.

In both cases, by construction β_0^p and β_0 are set to zero, so that each estimate of $\{\beta_h\}_{h=1}^H$ or $\{\beta_h^p\}_{h=1}^H$ is relative to the entry value of the corresponding variable. I defined a new exporter as an exporter that did not export any positive amount to that product-destination market in the last 3 years [13].

Figure 2 presents the results of the estimation by plotting the estimates of β_h and β_h^p. Each estimate should be interpreted as the cumulative log change relative to the entry period for the firm. Not surprisingly, and consistent with the findings by Fitzgerald et al. (2021) and Steinberg (2021) I find that while export sales grow over the life cycle of the exporter relative to the sales of the same product in other destination, the prices are basically constant. In this regard, it seems to be the case that exporters grow into markets by facing higher demand conditional on prices.



(a) Sales Dynamics



(b) Price Dynamics

Figure 2: New Exporter Dynamics

[13] This implies that I loose the first three of my sample, since I cannot observed if the exporters did any export before

4.1 Firm's Exposure to Volatility

I now proceed to analyse how the domestic volatility that firms are exposed to is related with their growth rate in specific markets. There are two main constraint that are imposed by the data set. One is the inability to observe total amount of worker per firm which does not allow me to construct a measure of labor productivity to construct microeconomic volatility as in previous sections.

To solve this issue I use sales changes to construct the measure of firms' exposure to volatility. The use of total sales or only exports sales to compute the origin has at least two main concerns. First, that they may be affected by foreign demand changes, or picking up foreign demand volatility, while this may be another relevant source of volatility, this is beyond the scope of this work. Second, if to solve the the first problem we use other firms exports selling similar products and/or destination, we may end up attributing relations to the origin volatility to exports to particular firms strategic behavior.

To solve for this concern I first focus on the domestic sales of the other firms at the same industry. I proceed as follow to compute the exposure of different firms the domestic volatility. First, I compute the log change of sales (denoted by $\Delta s^{D}_{f,t}$). I purged the aggregate and industry shocks that are common to firms every year, 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 following 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 equation (11).

$$\Delta s^{D}_{f,t} = \gamma_{j,t} + \Delta\hat{s}^{D}_{f,t} \tag{11}$$

Now to construct how each firm f that sells a product in the six digit category h, is exposed to the domestic volatility I proceed as follow. First I defined the set of those exporters whose main product at the six digit (within the 4-digit category J) level is h^{6}_{J} as $F_{h^{6}_{J}}$. Then 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 I describe in (12):

$$\sigma_{f,t,h^6_J} = \sqrt{\frac{1}{|F_{h^6_J}| - 1} \sum_{j \neq f \in F_{h^6_J}} (\Delta \hat{s}^D_{j,t}) - \bar{\Delta s}^D_{j,t})^2} \tag{12}$$

σ_{f,h^6_J} can be interpreted as the average volatility of the firm-level domestic shocks for those firm whose main export product is within the six digit category h^6_J, leaving out the firm f. Now I defined, as before, 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:

$$\sigma_{f,t} = \sum_{h^6_J \in h^J} \frac{\textit{tot. export}^{h^6_J}_{2006}}{\textit{tot. export}^{h^4}_{2006}} \sigma_{f,t,h^6_J} \tag{13}$$

Equation (13) 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} across those firms 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^6_J 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 4 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 the green tea and the black tea, weighted by how much the green or black tea exports accounted over the total exports of tea.

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 sales changes, I alleviate the concerns that the volatility measure may be affected by the exporter f exposure to foreign demand volatility computations, and that large shock to the firm may be captured as higher volatility, while is actually a bad realization. Second, by fixing the export shares and the main products of the firm at the year 2006, before I observe the shocks to construct the volatility measure, I alleviate the concern that future shocks for some particular products may affect the amount of exports that are produce within a broader category, or within the firm.

Micro-level fact 2: New exporters grow less as they are more exposed to volatility. I estimate equation (14) to understand how conditional on the price exporter change the quantities exporter sold within the 6-digit product changes over time.

$$\ln\left(\frac{\text{exp share}_{i,l,d,t+h}}{\text{Init. exp share}_{i,l,d}}\right)=\sum_{j=1}^{5}\beta_j^1\ln\sigma_{i,t}^{\omega}\mathbb{I}_{\{\text{age}=j\}}+\sum_{j=1}^{5}\beta_h^2\mathbb{I}_{\{\text{age}=j\}}+\gamma_{l,t}^a+\gamma_{d,t}^b+\gamma_i+controls_{i,m,t}+e_{i,m,t} \tag{14}$$

Where exp share$_{i,l,d,t}$ denotes the total value of exports that firm i, at time t of product l 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. $\gamma_{l,t}^a$ and $\gamma_{d,t}^b$ denote product-time and destination fixed effects that capture those variations in the relative growth of the export share that are common to the destination or product for each period of time. γ_i is a firm fixed effect that capture the average growth of the export share that is common within the firm. The identification of $\{\beta_\sigma^j\}_j$ comes from looking at the differences of firms exposure of the firm to volatility across time and markets. At different points in time, the firm has different tenure on each market but they also face a different level of volatility this allows me to compare the relationship between firms volatility and the growth rate at each particular age.

In figure 3 I present the estimates of the difference on the cumulative change of exports over the exporters life cycle. I compare the difference of the median exporter in term of the volatility it face, relative to one exporters facing an 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 5 years. This result provides a potential explanation of what is behind the uncertainty channel as I have documented in the

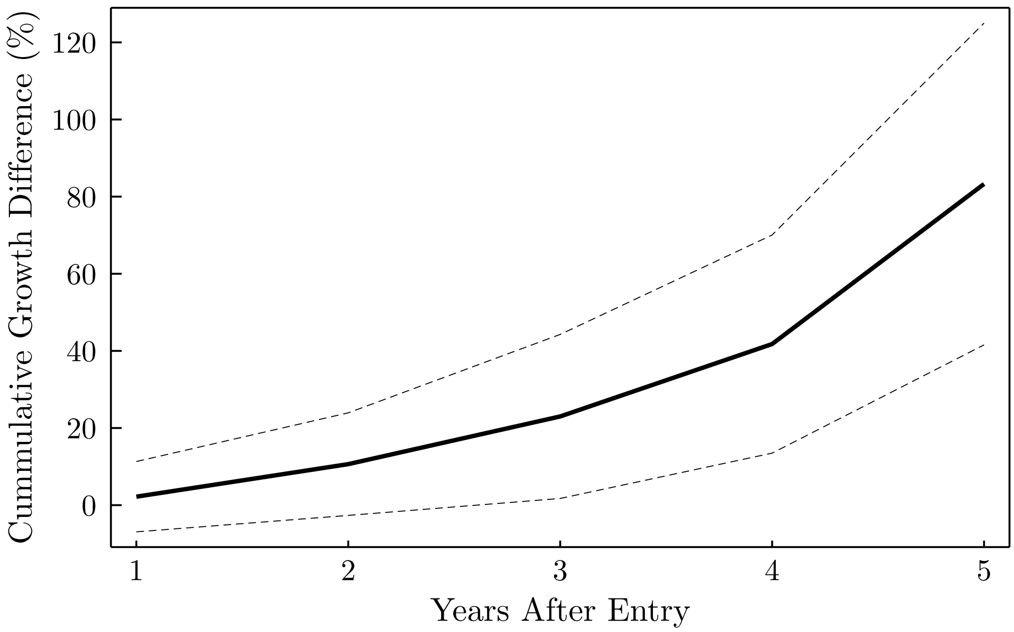


Figure 3: New Exporter Growth and Volatility

previous section, as firm face more uncertainty they reduce the investment they do to grow into foreign markets.

5 Volatility and Exporters Dynamic under CES Structure

In this section I show that standard models cannot generate the observe relationship in the data. To show this I define a concepts, profits that exhibits risk-loving in their productivity . I show that when profits that exhibits risk-loving in their productivity this generate prediction that contrary to the empirical patterns I have documented. I then conclude by showing that standard models that assumes monopolistic competition, CES demand function, and linear production in labor lies within this category.

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. In what follows I present two main proposition showing that as A capture how new exporters growth 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. But first I define when profits presents the risk-loving or risk-averse behavior in firms productivity, and when A works as a demand shifter.

Definition 1: Risk-loving profits. *A profit function* $\pi : (z, A) \rightarrow \mathbb{R}_+$ *present risk-loving in its productivity* z*, if for two random variable* Z_a *and* Z_b*, such that* $\mathbb{E}\{Z_a\} = \mathbb{E}\{Z_b\}$ *and* $\mathbb{V}\{Z_a\} > \mathbb{V}\{Z_b\}$*, the expected profits increases with a mean preserving spread* $\mathbb{E}_{\mathbb{Z}_\supset}\{\pi\} \geq \mathbb{E}_{\mathbb{Z}}\{\pi\}$*.*

Definition 2: 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)* $\pi(z, A) = f(A)\pi(z, 1)$ *and (2) optimal prices do not depend on* 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: Demand shifter. *A is a demand shifter.*

Assumption 3: Profits function. $\pi(z, A)$ *is a continuous differentiable function in both arguments, that presents risk loving behavior in its productivity*

Proposition 1: *For all* $A > 0$ *and* $z > 0$*, under assumption A1-A5, 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 function presents risk-loving behavior in its productivity.*

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.*

Corollary 1 establish that under the standard assumption used by the literature, the growth rate of firms into the export market is increasing. It shows that under these assumption, firms more exposed to domestic volatility will grow more contrary to the data.

In the next section I propose a solution to these counterfactual result just by relaxing one assumption. If we relax the assumption of constant price elasticity the profits function does not present the risk-loving in the firms' productivity. I build a model that nest 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. Providing an explanation for the underlying mechanism that generate why developing countries trade less.

6 The Model

Motivated by these empirical finding, I nest an 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 the demand they face up, 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, that I parametrize following the work of Klenow et al. (2016) and Gopinath et al. (2010), as it will be clear in the following sections. In the following sections I show that allowing for variable price elasticity, allows the model to generate the aggregate fact 3 and the micro-level fact on the negative relationship between exporters and volatility. I show that once the model is estimated we cannot reject in the data the existence of variable markups.

In the model a firm is tuple of productivity (ω_i) and customer capital (A_i). The firm makes two static decisions, it has decides to export or not and the prices that will charge to each of the destination taking into account the demand it face and the marginal cost of production. Firms will produce using a technology that is linear in labor, denoted by l. In case the firm decide to export today, it collect the profits of selling abroad and pay a fixed cost of exporting f_{exp}, and it can invest in marketing, i_d, to increase the customer capital it has. The investment on marketing realize at the following year as an increase in demand conditional on the price firm will charge. In case the firm decided not to exports, will not be able to initiate a marketing campaign in the foreign market, and the customer capital it has it will be lost.

6.1 Foreign Consumer's Problem

The foreign consumer will take aggregate quantities and prices, Q^*, P^* as given in their foreign market, and they will solve the following problem:

$$\min_{q(\omega)} \int_{\omega\in\Omega} p(\omega)q(\omega)d\omega \tag{15}$$

s.t.

$$\int_{\omega\in\Omega} A(\omega)^{\alpha}\Upsilon\left(\frac{q(\omega)}{A(\omega)^{\alpha}Q}\right)d\omega = 1 \tag{16}$$

Where $\Upsilon(x)$ denotes the indirect utility function of the representative consumer, I assume following Kimball (1995) that $\Upsilon(1) = 1, \Upsilon'(x) > 0\Upsilon''(x) < 0$. $A(\omega)^{\alpha}$ represent the customer capital that firm ω has when selling to this particular market. Note that $A(\omega)$ is a demand shifter.

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

$$q(p, A) = \psi(\frac{\tilde{Q}p(\omega)}{P})A(\omega)^{\alpha}Q \tag{17}$$

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:

$$\Upsilon(x) = 1 + (\theta-1)e^{\frac{1}{\eta}}\eta^{\frac{\theta}{\eta}-1}\left(\Gamma(\frac{\theta}{\eta},\frac{1}{\eta}) - \Gamma(\frac{\theta}{\eta},\frac{x^{\frac{\eta}{\theta}}}{\eta})\right),\ \theta > 1;\ \eta > 0 \tag{18}$$

Where θ determines the markup elasticity for a firm selling to the whole market, while η determines the super-elasticity parameter, this is, how sensitive is the price elasticity to the firms relative prices or firm's share. As it will become clear later, conditional on θ, η will be a key parameter that will affect how 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 $p \geq p^c$, $q(p) = 0$

Proposition 2: Exist a choke price. If $\Upsilon(x)$ is given by equation (18), $\theta > 1,\ \eta > 0$ and $Q > 0$ and $A > 0$ then exist a price $p^c \ \in \mathbb{R}_+$, such that $q(p, A) = 0$ for all $p \geq p^c$.

Under this definition together with equation (18), we can characterized the choke price as follows:

$$p^c = e^{\frac{1}{\eta}} \frac{\theta - 1}{\theta} \frac{P}{\tilde{Q}} \tag{19}$$

Which together with equation (17) and (18) generates the following demand:

$$\log q(\omega) = \frac{\theta}{\eta} \log(\eta \log(\frac{p(\omega)}{p^c})) + \log A^{\alpha} + \log Q \tag{20}$$

This implies that the demand elasticity to prices, defined as $\epsilon(\omega)$ can be written as a function of the choke price p^c, the price of the firm, and the parameters θ and η:

$$\xi(\omega) = -\frac{\theta}{\eta \log(\frac{p(\omega)}{p^c}))} \tag{21}$$

Note that equation (21) 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) . As I will show later, the CES case is rejected by the data, since the markups to cost shocks depends on the firms' sales share. Furthermore, after describing the model, I show that under the case of $\eta = 0$, the model will generate counterfactual predictions in terms of the relationship between total exports and volatility at both the aggregate and the micro-level.

6.2 Firms Problem

Firm's demand and variable markups. The consumer solve the problem described in (15) and (16), under the assumption that the indirect utility function is given by (18), as in Klenow et al. (2016) and Gopinath et al. (2010). Under standard arguments the optimal price that a firm with marginal cost of production, $\nu(\omega)$, will decide to charge will be given by:

$$p(\omega) = \mu(\omega)\nu(\omega) \tag{22}$$

$\mu(\omega)$ denotes the markups that the firm producing the variety ω will charge to the market that is selling to. Using condition (21), the optimal markup the firm will charge is given by:

$$\mu(\omega) = \frac{\theta}{\theta + \eta \log(\frac{p}{p^c})} \tag{23}$$

Note that equation (23) implies that the markup are decreasing in the price that firms decides to charge. This result follows directly from the fact that in this model firms face a price elasticity of demand that depends on the relative prices they post. Put it differently, more productive firms will charge higher markups, while less productive firms, and on average more smaller will charge smaller markups. A result consistent with the findings by De Loecker et al. (2016).

Firm's operational profits. I assume that each firm i produce a variety. This implies that the firm productivity level, $z_{i,t}$ and the level of costumer capital $A_{i,t}$ will characterize a firm that produce only one variety ω. To simplify notation, 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 (24) where $\mu(z_i)$ denotes the markups that firms with productivity level z_i will decide to optimally impose to their customer.

$$\pi(z_i, A_i) = p_i q_i^d(p_i, A_i) \left(1 - \frac{1}{\underbrace{\mu(z_i)}_{markup}} \right) \tag{24}$$

Note that in equation (24) the customer level that firms face does not affect the level of markups it will decide to charge. Remember that the customer capital here works as a demand shifter conditional on prices. Then by proposition 1 we can re-write equation (24) as in (25), where I denote $\tilde{q}_i^d(p_i) = q_i^d(p_i, 1)$

$$\pi(z_i, A_i) = A_i^{\alpha} p_i \tilde{q}_i^d(p_i) \left(1 - \frac{1}{\mu(z_i)} \right) \tag{25}$$

Law of motion for customer capital. In the model firms will make investment, i_d, to increase the demand they face conditional on prices. This investment will translate into new customer every period, after the firm loose some customer in the process. I follow Fitzgerald et al. (2021), and assume that the law of motion of customer is given by equation (26). The equation shows how the law of motions of customer works in the model. Conditional on exporting today, $m = 1$, firms will accumulate new customer capital A_i in a linear fashion, after they face a lost of δ share of customer capital depreciation. If firms decide not to export today, $m = 0$, they will not be able to invest in accumulating customer capital, and they will face a higher level of depreciation of the customer capital they have in the foreign market, which I denote with δ^{nexp}. I assume that $\delta^{nexp} \geq \delta$, that is to say, those firms without presence in the market will loose customer more rapidly.

$$A'_i = m\left(i_d + A_i(1-\delta)\right) + (1-m)A_i(1-\delta^{nexp}) \tag{26}$$

As it will become clear later, this feature of higher depreciation rate depending on the presence or not in the market that firm is selling to will imply that the the existence of hysteresis in the exporters behavior as have been widely documented by the literature as for example in Giovannetti et al. (1996). The intuition of this behavior is due to the fact that as exporters enter to the market and already did a sunk cost investment in increasing the customer capital, they will be more reluctant to exit the export market, since they will be loosing partly of the sunk investment the did. Or in another words, the difference in depreciation rate of the customer capital, creates an option value that makes exporters more willing to wait to exit the market.

Firm's dynamic problem. In the model firms take two decision that will have an impact on their future expected profits and by so, in the expect value of the firm. These decision 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 (53) 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 with Θ the aggregate state variables that in this model captures the share of exporters, the distribution of customer base across firms, and the distribution of productivity of firms active in this economy, and the total bond hold in the economy.

$$V(\omega_i, A_i, a, \Theta) = \max_{m\in\{0;1\};i_d\in[0;\infty)} \pi^d(z_i, 1) + m(\pi(z_i, A_i) - f_{exp}) - \\ -c(i_d, A_i) + \beta\mathbb{E}\left[V(\omega_i', A_i', a', \Theta')\right] \tag{27}$$

s.t.: (25), (26)

The decision of exporting or not in this model is a discrete decision given by $m \in \{0; 1\}$. If $m = 1$ firms will decide to export, and they will collect the total profits from exporting which are the operational profits from exporting $\pi(z_i, A_i)$ minus the fixed cost firms need to pay to get access to the export market, 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 do is to decide how much they want to invest in building customer capital, denoted by $i_d \in [0; \infty)$. While doing firms, are deciding how much investment to do to grow their foreign demand, which allows exporters to grow in the foreign market they are selling to. In this sense, the investment that firms does capture a market-specific type of investment. Note that the decision in building customer for the firm is irreversible, this enters in a model as the inability of firms to sell their capital on customer - firms cannot being make negative investment-. The cost of investing in increasing the customer capital is given by $i_d + \frac{\phi}{2}\left(\frac{i_d}{A_i}\right)^2$, where the second term denotes the convex cost of investing, which is a simple way 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 (28), pins down the optimal capital customer the firm decides to have in next period. The second one, given in equation (29), 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.

$$\frac{\partial i_d(A^*,A)+\frac{\phi}{2}\left(\frac{i_d(A^*,A)}{A_i}\right)^2}{\partial A^*}\leq\beta\mathbb{E}_a\left\{\overbrace{(1-Pr(\omega_i'^*))}^{\text{export prob.}}\overbrace{\mathbb{E}_{\omega_i}\left\{\frac{\partial V(A^*,z')}{\partial A^*}|\omega_i'>\omega_i'^*\right\}}^{\text{Expected MR conditional on exp.}}\right\} \tag{28}$$

Equation (28) shows the optimal level of customer capital, A^*. It 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 (28), to the expected marginal return on investment, the right-hand side of the same equation. Using Leibniz rule, we can show that there 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 this term will be affected by the uncertainty that firms face with respect to the realization of future shocks, as I will explain later.

The second equation that will characterize the exporters decision is given by equation (29), which characterize the minimum of productivity at which firms will pay the export cost to stay in the export market, denoted by ω'^*. The marginal firm will be indifferent between staying or not in the export market if the operational profits of doing it so plus the optional value of not loosing the customer capital she has accumulated is equal to the investment cost plus the exporting fixed cost. It is worth to note that the decision of customer accumulation do not only affect the intensive margin of firms, but also the extensive margin.

$$\hat{\pi}(\omega_i^*, a_t, A) + \overbrace{\beta\mathbb{E}\{V(A^*, z') - V((1-\delta^{exp})A, z')\}}^{\Delta\text{Option value}} = fe + i_d + \frac{\phi}{2}\left(\frac{i_d(A^*, A)}{A}\right) \tag{29}$$

6.3 Volatility in The Model

Before proceeding to the firm's problem is worth to show how uncertainty enters in the model. Consistently with the cross-country evidence, uncertainty and volatility in the model will enter through the changes in marginal cost of production that firms face. In the model, I assume by simplicity that the production is linear in labor, changes to the firm's productivity will also affect, the the firm's labor productivity, its marginal cost of production and firm's total productivity. In the model there are two types of components that determines the productivity of the firms. A common component to all firms that will vary over time to which I refer as the aggregate productivity, a_t, and firms' specific component that will vary across firms and time $\omega_{i,t}$. I further assume that this two component will enter in a log-additive way to determines the total level of productivity that firm face which I denote by $z_{i,t}$, as shown in equation (30).

$$\ln z_{i,t} = \ln \omega_{i,t} + \ln a_t \tag{30}$$

I further assume that each component of the firms' productivity level, $z_{i,t}$ follows an ar(1) process as shown by equation (31) and (32). In the model the two sources of volatility, the microeconomic and macroeconomic levels of volatility, will be given by σ^ω and σ^a, respectively. Note that each level of volatility will have different implications in terms of how it affects directly the economy. The former, the microeconomic level of volatility, σ^ω, will generate higher dispersion of firms around the particular mean, provided that we impose

$\nu^{\omega} =$. While the higher macroeconomic volatility will imply that what will become more volatile is the mean level of the distribution across time, under that assumption that ν^{a} [14].

$$\ln \omega_{i,t} = \nu^{\omega} + \rho^{\omega} \ln \omega_{i,t-1} + \sigma^{\omega} \epsilon_{i,t}, \quad \epsilon_{i,t} \sim N(0,1) \tag{31}$$

$$\ln a_t = \nu^{a} + \rho^{a} \ln a_{t-1} + \sigma^{a} e_t, \quad e_t \sim N(0,1) \tag{32}$$

6.4 Domestic Consumers, Final Good Production and The Bond Market

Domestic consumers. This economy is also populated by households. The behavior of all the consumers in this economy, is captured by a representative consumer that besides being the owner of the firms and supply labor inelastic-ally ($Ł^s$), she will also hold bonds and decide how much to consume of the non-tradable final good, which I denote by C_t. The consumer observes the aggregate state of the economy which denoted by Θ, the amount of risk free bonds she holds and she decides how much to consume today and how much to save from the total income she obtains this period. In particular, the consumer problem is given by equation (33).

$$V^{c}(b,\Theta) = \max_{b',C} u(C) + \beta \mathbb{E}\left\{V^{c}(b',\Theta')\right\} \tag{33}$$

s.t.

$$P^{C}C + b' = wL^{s} + \varPi^{dom} + \varPi^{exp} + r_t b' \tag{34}$$

In this case, the representative consumer's problem is standard and it is characterized by the standard Euler condition together with (34). Furthermore, by simplicity I assume that b will be provided in zero net supply at all the time. This implies that the trade is balance in this economy, and that the interest rate will adjust for this to be the case.

[14] Note that under the assumption that the mean is given by $\nu^{\omega} =$ and that the shocks are log-normal distributed, there are two moments that are affected by changes in volatility. The second moment, and the third moment, which are given by $E(x^2) =$ and $E(x^3) =$. Implying that is type of shocks generates not only change in the variance but also in the skewness of the distribution . Also the first moment is unchanged an given by $zzzz$

Final good production. The consumption good bundle is produced by a a representative firm that operates in a competitive market. This firm uses two goods as inputs, a bundle of imports 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 consist in minimize the expenditure of the inputs necessary to produce the quantity of final good C. The problem is then given by:

$$\min_{M,D} P^m M + P^D D \tag{35}$$

s.t.

$$\left(M^{\frac{\gamma-1}{\gamma}}\nu + D^{\frac{\gamma-1}{\gamma}}\right)^{\frac{\gamma}{\gamma-1}} \geq C \tag{36}$$

The equation (36) states that the production of the final good depends on both the the domestic bundle and the import bundle, 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 will be given by:

$$D = M\omega^{-\gamma}(P^d)^{-\gamma} \tag{37}$$

Note that equation (37) together with the assumption that trade is balanced all the time, implies that the amount of exports will pin down the demand for the domestic for each level of P^D.

Domestic bundle. The domestic bundle is produced using the intermediates goods produce by the domestic firms in the economy. The production will be given a similar problem as the one described in equations (15) and (16). By simplicity I assume that to sell to the domestic markets the firm's will be able to reach all the consumers, so that the investment in customer capital will become worthless.

This assumption obeys two main reason. 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 with the macro and microeconomic volatility of the country is beyond the scope of this work [15]. As before the problem for the producer of the domestic bundle in this case will be given by:

$$\min_{q(\omega)} \int_{\omega \in \Omega} p^d(\omega) q^d(\omega) d\omega \tag{38}$$

s.t.

$$\int_{\omega \in \Omega^d} \Upsilon\left(\frac{q^d(\omega)}{D}\right) d\omega = 1 \tag{39}$$

As before I assume that $\Upsilon(.)$ will be given by equation (18), 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 exist a choke price which I denote by p^d. But there is a main difference between p^c_d, and the choke price of the foreign market, p^c_f. While the former is an equilibrium object that depends on the state of the domestic economy, the latter is treated as a parameter that I estimate. This distinction follows from the assumption of the domestic economic being an small open economy. As the foreign economy is not affected by the exports of the domestic country, the aggregate prices and the maximum price at which foreign consumers are willing to buy a good, the choke price p^c_f, should not be affected by neither the exports prices or quantities of the domestic economy.

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.

[15] The structure of this paper may be used to understand how a similar mechanism may be helpful to explain why the firm's growth may differed across countries with different level of developments as recently documented by Hsieh et al. (2014). This is a natural research path provided the necessary micro-level data to properly compare the growth rate of domestic firms across countries.

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 capital decision rule $A'(\Theta, \omega_i, A_i)$, the export decision $I^{exp}(\Theta, \omega_i, A_i)$ 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 $P^c(\Theta)$, 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 and are equal to zero.
6. *Consistency*: The policy function of the individual bond and the aggregate bond are consistent. And the evolution of distribution of exporters, customer capital, and active firms are consistent with the belief and decision of firms and consumers.

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 a third set of parameters are estimated within the model.

The model is governed by 5 set of parameters. The parameters that determines the differential exporter growth, the parameters that govern the demand elasticity, the parameters governing the export entry/exit decision, the parameters governing the aggregate and firm level shocks, and the parameters governing the representative consumer. I use the Colombian administrative firm-level and the survey to manufacturer to estimate most of the parameters in the model. The parameters are estimated together in the model to match some moments, but some of the moments are directly related to the parameters of the models, providing a clear identification between the parameters and the moments to match.

There are several parameters that are pre-set. I estimate the parameters that determine the aggregate and firm's productivity shocks directly from the data, assuming that the productivity behaves as an ar(1)For the idiosyncratic productivity I use the data from the labor productivity in the Colombian survey of 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}, as the standard deviation of the residual of the ar(1) estimates. I proceed in the similar way to estimate the parameters that pin-down the aggregate productivity, ρ^{a} σ^{a}, but 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 10 years, and the last one is assume to be one, implying log utility. I use data from the Colombian Manufacturer Survey to estimate the exporting fixed cost such that it match the average share of exporting firms in Colombia of 19.5%.

To estimate 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 empirical 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 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 estimated in the data.

Dynamic moments. Let h be the age of an exporter that enter h periods before the export market, and that exporter every period since then. Let $Q_{i,t,h}^f$ 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 are given by:

$$\log Q_{i,t,h}^f - \log Q_{i,t,0}^f = \log A_{i,t,h}^\alpha - \log A_{i,t,0}^\alpha + \underbrace{\log \hat{q}(p_{i,t,h}^f) - \log \hat{q}(p_{i,t,h}^f)}_{\gamma_{l,d,t}+\gamma_{i,d,t}+\Delta p_{i,t,h}^f} \tag{40}$$

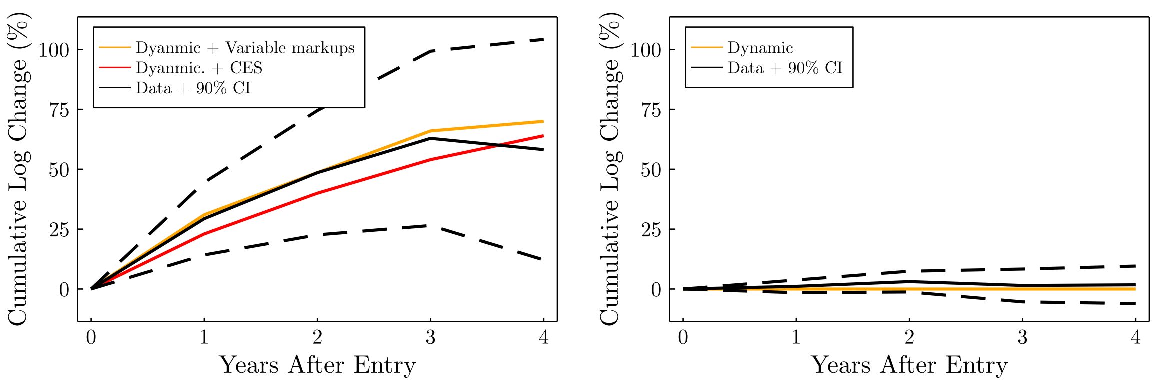
Where as defined before $\hat{q}(p,1) = q(p,1)$, which is given by equation (20). Note that according to (20) $\hat{q}(p,1)$ is composed by three main components, the foreign market component, that is common to all exporters exporting to f, such as the total demand, Q or the foreign choke prices p_f^c, a firm component that is common to all the market the firm serves as is the firm's productivity, and the last component that is an interaction between firms productivity and the choke prices p_f^c for that market.

Given the richness of the exporter administrative data that presents data at the firm i, product,l destination,d and year, t, this three component predicted by the theory can be approximated in the data by, a product-destination-year fixed effect, $\gamma_{l,d,t}$, a firm-product-year fixed effect, $\gamma_{i,d,t}$, and the change in prices that firm is charging to that market $\Delta p_{i,l,d,h,t}^f$. Following the predictions of the theory I estimate the following equation (41), to capture the differential growth of firms in the export market:

$$\ln q_{i,d,l,t} = \sum_{h=1}^{H} \beta^h \mathbb{I}_{\{age_{i,d,l}=h\}}^h + \ln p_{i,d,l,t} + \gamma_{i,d,l} + \gamma_{l,d,t}^1 + \gamma_{i,d,t}^2 + \epsilon_{i,l,d,t} \tag{41}$$

Where $\ln q_{i,j,l,t}$ represents the total quantities exported by firm i, of product l at time t. $\mathbb{I}_{\{age_{i,d,l}=h\}}^h$ is a dummy variable that captures when the age of the firm i, exporting product l, to destination d is equal to h. This implies that β^h captures the log differences of the quantity exported by the firm at age h, relative to its first exports amounts when enter the market. To properly capture the evolution of the new exporter, I focus on those exporters that I observed exporting for the first time to the market, after the year 2009 (3 years after my first year of observation). I also, defined as a new exporter those exporters that did not export for the last three year before to the time period t. In this line, I restrict the sample only to those exporters that continue exporting until h. This allows me to interpret $\{\beta^h\}_{h=1}^{H}$ as the log change in quantities relative to the exported quantities at the first year of the firm.

Figure 4, presents the estimates of the data and the model predictions in terms of the exporter growth for two versions, the dynamic model with variable markups and the one with constant variable price elasticity ($\eta \rightarrow 0$). as expected both model can capture the growth of exports relative to total firms sale over the life cycle quite well over the whole exporter life, despite of having only two parameters that are directly tight to the exporter growth. 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^c_f 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:

$$\Phi_{i,f} = \frac{\theta + \eta \log(\frac{p_i}{p^f_c})}{\theta + \eta \log(\frac{p_i}{p^f_c}) + \eta} \tag{42}$$

According to equation (42), 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. Naturally, this is hard to directly observe in the data, given the inability to observe the maximum price that consumers are willing to pay for the goods corresponding to a particular product. Fortunately, the theory underlying the model also implies that this ratio of prices can be approximated by the firms sales share to this market. This the intuition for the empirical estimates I perform in the next subsection.

I then use the empirical estimates of (50) on how the firms markups response to cost changes depend on their sales share to discipline this two parameters. In the model I simulate two different economies. One economy at its ergodic mean, and the second economy ones there is a wage drop of 10%. In this case, the wage drop of the model simulates a depreciation of the domestic currency.

To compute the price changes to a cost shocks I proceed as follows. I compute the log price difference for each firm and each period, between the the economy 1 and 2, which I denoted by $\Delta p^{e1,e2}_{i,t}$. For each period in time I then compare the price change for those exporter in 25^{th}, 50^{th} and 75^{th} of sales distribution (at the economy 1). 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 40 years that 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. The empirical analogous of the price change is given by equation (43).

$$\Delta p_{i,l,d,t} = (\beta^{IV} \times \text{exp. share}_{i,l,d,t} - 1)\Delta e_{d,t} \tag{43}$$

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 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[16].

I use these 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 and be able to estimate the two parameters, η and p^c_f, that relates the firms' export share to the relative changes in prices among firms. These two moments are directly related to the super-elasticity parameter, η and the foreign choke price in the model ^c_f. Since the η parameters governs the curvature of the price response to changes in the marginal cost and the foreign choke price governs the marginal firm that is able to sell to that market, for whose markups are constant in the model. As a consequence, these two moments are directly related to this parameters, by capturing the price response of the relatively big and small firms in the model.

Estimating the markup elasticity in the data . The objective of this sub-section serve several purposes. The first is to test the existence and relevance of variable markups. In particular test the model predictions in terms of how the variable markups are related to the relative size of firms. Second, the estimation results will help me to discipline the model to properly capture how exporters adjust their markup in response to marginal cost shocks as I have described above.

To accomplish these objectives I do not need to estimate the level of markups. I only need to obtain estimates on how the markup elasticity to firm's cost of production varies with exporters share. This allows me to avoid the need of having information over firms'

[16] A market is a product-destination combination

marginal cost to sell to each market. I follow the insights of Arkolakis et al. (2017) and use bilateral exchange rate variation as shock across destination that the firm serve to identify how the markups response to shocks in the marginal cost of production varies with firms characteristic in that market.

Conceptual framework. I define markups as the ratio between the price and the marginal cost of production of a particular product for each market the firm served. By this definition, prices are given by are given by equation (44) 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 that the firm is selling to:

$$p_{i,d,l,t} = \mu_{i,d,l,t} \; Mc^f_{i,d,l,t} \tag{44}$$

We can assume that firms sales are set ultimately in the currency of the market selling to [17]. Assuming also the the marginal cost of production is set in domestic currency then we can re-write equation (44) as in (45), 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:

$$p_{i,d,l,t} = \mu_{i,d,l,t} \; \frac{Mc_{i,d,l,t}}{e_{d,t}} \tag{45}$$

After taking logs to equation (45), 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

[17] 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.

incomplete and more recently it has been shown that these changes are related to exporter share as shown by Berman et al. (2012).

To be able to only estimate the changes on markups due to changes in the exchange rate I need to control fort 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. 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. 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 as I explain in what follows. At this point is 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[18].

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

$$\ln p_{i,d,l,t} = \ln \mu_{i,d,l,t} + \ln Mc^a_{i,l,t} - \ln(e_{d,t}) + \ln Mc^b_{l,d,t} \tag{46}$$

[18] 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.

By differentiating (46) with respect to the relative exchange rate we have (48). 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.

$$\frac{\partial \ln p_{i,d,l,t}}{\partial e_{d,t}} = \frac{\partial \ln \mu_{i,d,l,t}}{\partial e_{d,t}} + \underbrace{\frac{\partial \ln Mc^1_{i,l,t}}{\partial e_{d,t}}}_{\theta_{i,l,t}} \underbrace{-1 + \frac{\partial + \ln Mc^2_{l,d,t}}{\partial e_{d,t}}}_{\gamma_{l,d,t}} \tag{47}$$

If the markup elasticity varies across firm we can use exchange rate shocks to recover this [19]. Using equation (48), and assuming that markups are a function of exchange rate we can estimate equation (48) to test if markups are non-constant if the markup elasticity to changes in the exchange rate varies with the exporters share.

$$\Delta p_{i,d,l,t} = \beta \Delta e_{i,d,l,t} \times \text{exp. share}_{i,d,l,t-1} + \beta_2 \text{exp. share}_{i,d,l,t-1} + \theta_{i,l,t} + \theta_{i,l,d} + \gamma_{l,d,t} + e_{i,d,l,t} \tag{48}$$

I then proceed to estimate (48) where Δ denotes log differences of the variables over a year. I add firm-product-time fixed effects, and product-destination-fixed effects, since by this addition we can fully control for the changes that exchange rate movements may have over the marginal cost of production under the assumption already stated above, I also add fixed effects at the firm-product-destination, to capture the case that firms may have a particular trend in price changes that may be related with their export share to that market. In another words, under the assumption of separability of the marginal cost, β captures the markup elasticity to changes in the exchange as the function of the exporter share over total sales on that market.

There are at least two concerns in estimating equation (48). First 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

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

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 [20]. Second the second important assumption is that exchange rate variation do no have large effect on the flow of remittances. To alleviate the concerns of this assumption not holding, I do not use the bilateral flows of remittances but the flows from third countries. Using third countries remittances flows 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 has been shown that the remittances are unlikely to vary due to exchange rate variation as in Mandelman et al. (2020).

Another concern is that the theoretical model does not predict a direct relationship between the export share and the markup of the firm, this is relationship in the model is given to the export relative productivity, since in the data I can observe the relative productivity I proxy this with by the exporter share. This implies that the mapping between relative productivity and export share is more likely to be diffused in the early ages of the 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.

[20] See central Bank from Colombia to obtain the relevance on remittances

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

$$\begin{aligned}\Delta e_{i,d,l,t} \times \text{exp. share}_{i,d,l,t} = \Delta remittances_{d,t} \times \text{exp. share}_{i,d,l,2007} + \\ + \text{exp. share}_{i,d,l,t-1} \times crtl_{d,t} + \theta_{i,l,t}\gamma_{l,d,t} + e_{i,d,l,t}\end{aligned} \tag{49}$$

And then in the second stage I proceed to estimate:

$$\begin{aligned}\Delta p_{i,d,l,t} = \beta \Delta e_{i,d,l,t} \times \widehat{\text{exp. share}}_{i,d,l,t-1} + \text{exp. share}_{i,d,l,t-1} \times crtl_{d,t} + \\ + \theta_{i,l,t} + \gamma_{l,d,t} + \theta_{i,l,d} + \epsilon_{i,d,l,t}\end{aligned} \tag{50}$$

Note that the exclusion restriction for this estimation states the conditional on $\theta_{i,l,t}$, $\gamma_{l,d,t}$, $\theta_{i,l,d}$ correlation between $\epsilon_{i,d,l,t}$ and $\Delta remittances_{d,t} \times \text{exp. share}_{i,d,l,2007}$ is equal to zero. I another words this condition will be violated if a shocks to the remittances to Colombia from other countries than the destination is correlated with another another shock that makes the firms to change the price of its 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.

An extreme example will be as follow, imagine that there is a shock to the production of particular product worldwide. If it happen to be that the people sending money from the USA to Colombia is highly exposed to these shock, and if also happen to be the case that Brazil is relatively more exposed to this industry, then it may be the case that changes in remittances flows will be correlated with a shock that will push Colombian exporter to change the relative price between Argentina and Brazil. Furthermore, for this problem to be significant we will need this to be the case repeatedly over time, since I am exploiting the time variation of the exchange rates.

Micro-level fact 3: Markups changes increases with export shares. Table 3 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 week instruments for all of the cases I presented. As expected the relevance of the instrument increases as I focus on older exporters. 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, and 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.

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.

Estimated parameters. Table 4 shows the parameters of the model. From this parameters, the only parameter I pre-set and that I take from the literature are the discount rate, β, which is set to match an average risk-free interest rate of 4%, and the average price elasticity parameter, θ which I set to be equal to 5 as in Klenow et al. (2016), Gopinath et al. (2010). The set of parameters that characterised the process of the aggregate and idiosyncratic productivity are taking from the data. In order to estimate these parameter I estimate an ar(1) process for the labor productivity of firms, including time fixed effect to net out the common

Table 3: 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. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

components using Colombia data on the manufacturing survey. For the aggregate productivity, I estimate an ar(1) process over the time series of the H-P filtered series of the total factor productivity reported by Penn-World Tables.

Table 4: Estimated 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	Import bias
p_f^c	1.15	Foreign choke price
η	3.70	Super elasticity
f_{exp}	2.95	Exporter fixed costs
α	0.97	Endogenous Demand (curvature)
ϕ	5.10	Investment Adjustment Cost
δ	0.08	Depreciation of A_i

The final set of parameters to be calibrated are estimated within the model. For one of the most important parameters, the one that pin down the price elasticity sensitivity, η, I make the model to match the relative price change of those exporter in the median of the distribution of sales relative to the one in 75th percentile to be the same as what I estimate in the data, as in table 3. In the model, to get this relative price change I feed a 10% productivity shock as equivalent to the exchange rate use in the empirical section. For the parameters that determine the cost and depreciation of the customer capital a firm has, ϕ and δ I match the average geometric growth of new exporters after 2 and 4 years. I set the exporter fixed cost f_{exp}, to match the share of exporter in the manufacturing sector, which are on average the 19% according to the Colombian survey of manufacturing. And I finally, estimate α to math the share of total sales that the top 5% exporters represents, which in this case is on average equal to 54%. Naturally all this parameters are pin-down together after the model is able to match them, but there is in the model a direct link between the parameters and the moment described. Table 5 presents the model prediction in term of the the target moments beside those related to exporters growth shown in figure **??**.

Table 5: Additional Target Moments

Moment	Data	Model
Cross sectional Pass-through of price: 50th vs 75th	0.87	0.86
Cross sectional Pass-through of price: 25th vs 50th	0.95	0.94
Share of exporters	0.20	0.21
Trade openness	0.32	0.32
Exp share of top 5%	0.33	0.30

6.7 Model Implications

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

I simulate different economies with different levels of macro and microeconomic volatility volatility. To be clear, 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. By doing this, I allow changes in both the uncertainty firms face while making decision and the volatility and actual distribution of firms.

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. As it can be shown in the figure, the model is able to capture almost the full relationship that I have estimated in the empirical part. This is remarkable considering that I am not targeting any moment associated with how firms response to the micro or macroeconomic volatility. While this may seem as a complete success of the model and the mechanism, I will show later that this achieve by the model by predicting too much of response of the extensive margin and qualitatively missing the reaction on the average export per exporters.

Furthermore, in figure 5 I also show the prediction of the other model, the static version of the model ($\alpha = 0$) for both cases variable and constant price elasticity, and for the dynamic case with constant price elasticity. The three simplifying version of the model predicts a positive relationship between exports and volatility. This counterfactual results are due to the fact that in this models, the uncertainty channel that shape the intensive margin is null, or positive. In the static models the uncertainty channel is null by construction, so that higher volatility increases exports by increasing the mass on the right tail of the aggregate shocks, so that on average there are more firms exporting that also react positively to this shocks. For the dynamic model under CES, the uncertainty channel becomes positive. Is the dynamic model with variable markups the only model predicts the uncertainty channel to be negative, and this is the main difference guiding the difference in the prediction of these model versus the other ones.

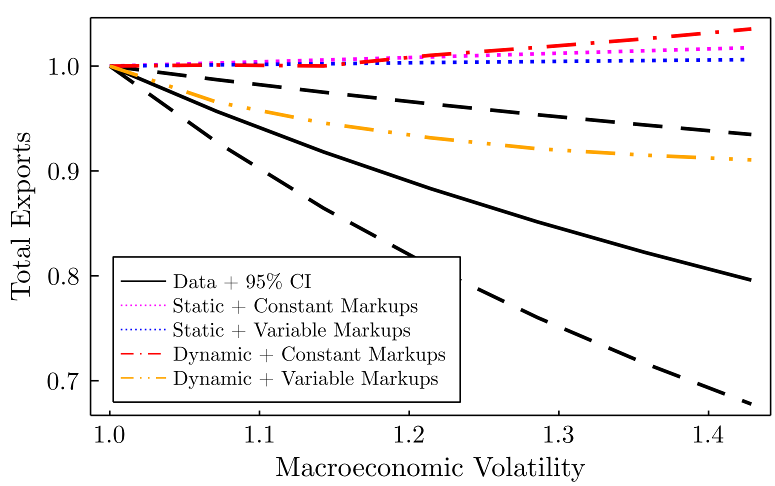


Figure 5: Total Exports and macroeconomic Volatility

The consequences of microeconomic volatility. I now proceed to do a similar experiment but to understand the effects of microeconomic volatility predicted by the model. In this exercises I only vary σ^{ω}. Figure 6 shows that the model predicts around 50% of the total relationship estimated in the data, but, the model prediction lies still within the 90% confidence interval. I will show that the model is also able to generate responses in the extensive and intensive margin that are similar to the ones estimated in the data.

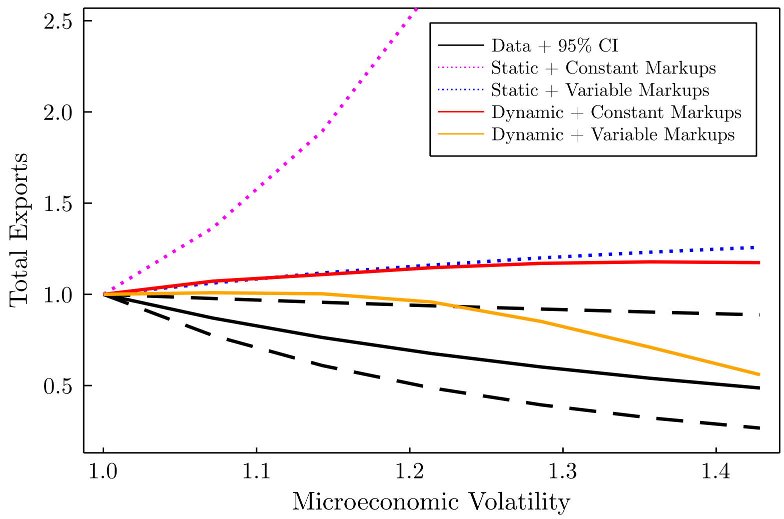


Figure 6: Total Exports and microeconomic Volatility

In this case, when we compare the model prediction between the dynamic model with variable markups and the other models, the differences are more striking. This is because the increase in the weight of more productive firms is stronger for the case generating even more striking differences in terms of the prediction of the model.

6.8 Testing the Model: The Model Margins of Trade

The previous quantitatively results together with the empirical finding using firm-level shows the relevance and importance of the propose mechanism to explain the documented relationship at the aggregate level. But are the underlying mechanism generating the aggregate responses in the model correct?

To answer this question I proceed to test the model in two different dimensions. First I test the model predictions towards these two-types of shocks by asking how much of the extensive margin and average exports per exporters the model is able to capture from what we observe in the cross-country data. After that, I test the model by looking at the firm-level reaction to uncertainty. I test if the model is able to generate similar responses in the growth rate of new exporter when firms face higher levels of volatility. I Finally conclude by testing the main mechanism in the data, that is, if in cases when firms are facing higher variable price elasticity the relationship between volatility and exports becomes stronger.

The margins of trade: Model vs data. Panel b of figure 7 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 7, 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.

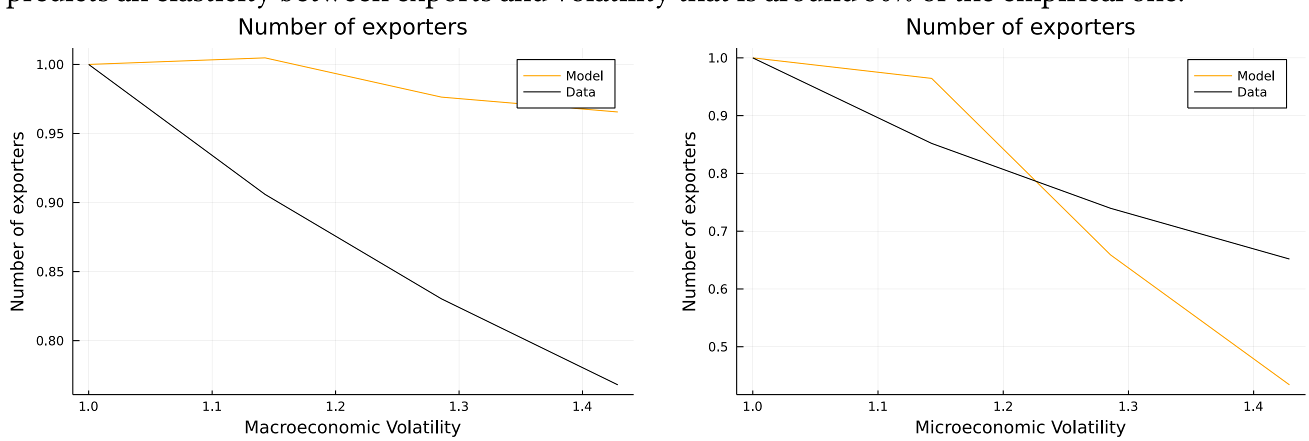


Figure 7: Volatility and Extensive Margin

Figure 7 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.

New exporter growth: Model vs data. I now proceed to test the model's ability to replicate the microlevel data findings in term of the differential growth of exporters relative to the domestic volatility they Face. To do this I compare the the log differences of the growth rate in the export share against the model with two different calibrations. In particular, I compare the prediction of the benchmark model to the ones of the same model but adjusting the idiosyncratic volatility of firms to match a 10% reduction in the domestic volatility, measure as the average cross-section standard deviation in the log change in the sales of domestic volatility.

To follow the experiment in the model as close as possible to the one in the data, I estimate the change in variance such that match the same change in the voaltility of the domestic sales. Figure 8 presents the results of the data and the model [21]. The model can properly predict the qualitative relation in term of the higher domestic volatility and the differential growth on the new exporter. Quantitative the model predicts a higher difference relative to the data during the the first years of life of the exporters, reflecting a potential problem in the way the model is capturing the growth rate of exporters. These results are successful in term of comparing the results with other types of model that will predict null or the contrary relationship in the data as explain before.

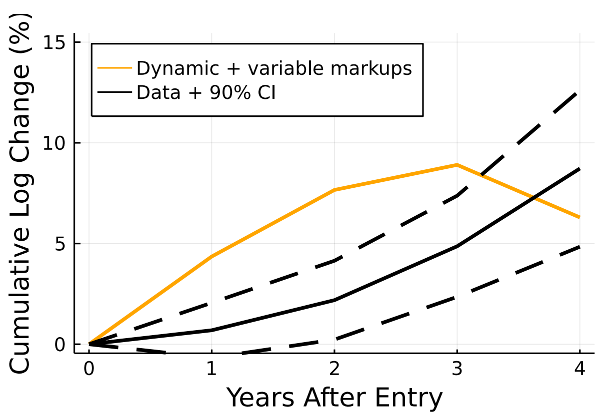


Figure 8: New Exporter Growth and Volatility: Model vs Data

[21] On important difference between the empirical estomate in this case and the ones in the data, is that in this case I am not restricted the sample of exporters to only those that spent 5 years in the markets, but only to the one that continuously exported until each age.

Estimating the markup elasticity across product. The model is successful in being able to replicate the the aggregate and micro-level relationship relative to its counterparts and this is due to a simple mechanism, the interaction between volatility and the existence of variable price elasticity. The differences between the constant elasticity case and the variable price elasticity, shows that the relationship between exports and volatility becomes more negative as firms face higher variable price elasticity. This can be directly test in the data using industry variation.

To achieve this, I estimate the markup elasticity as a function of the export share as before, but now I allow β to be heterogeneous for each of the 2-digit products I have in my sample. I denoted the vector of the the markup elastic industries 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 (49) and (50) 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 proceed now to estimate the same equation as in (51) but allowing the coefficient that pins down the elasticity between exports and firm's exposure to volatility to vary according whether the product that the firm is selling belong to the first, second or third third-tile of the markup elastic distribution that I have estimated above. Table 6 presents the results of this estimation. As expected the results shows that regardless of the additionally controls at firm level, when firms sell products that are in products categories that are more mark-elastic the association between average exports and the volatility they face drops even more. Implying that we cannot reject the hypothesis that as firm face higher variable price elasticity the relationship between export and volatility increases. For example, column 1 of table 6 shows that when a firm sells a product that in on the high markup elasticity group, the negative relationship between exports and volatility become almost 62% higher in absolute terms, similar results are shown in column 2 and 3, when we compare results within firm across product-destination, or within firm-destination across products.

Table 6: 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 × Volatility$_i$	-0.04	-0.04	-0.07
	[0.59]	[0.04]	[0.05]
High Markup - elastic × 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.

References

Aghion, P., Angeletos, G.-M., Banerjee, A., & Manova, K. (2010). Volatility and growth: Credit constraints and the composition of investment. *Journal of Monetary Economics*, *57*(3), 246–265. https://doi.org/10.1016/j.jmoneco.2010.02.005

Alessandria, G., & Choi, H. (2021a). The Dynamics of the U.S. Trade Balance and Real Exchange Rate: The J Curve and Trade Costs? 69.

Alessandria, G., Arkolakis, C., & Ruhl, K. J. (2021b). Firm Dynamics and Trade, 42.

Alessandria, G., Khan, S. Y., & Khederlarian, A. (2021c). Taking Stock of Trade Policy Uncertainty: Evidence from China's Pre-WTO Accession, 55.

Amiti, M., Itskhoki, O., & Konings, J. (2014). Importers, Exporters, and Exchange Rate Disconnect. *American Economic Review*, *104*(7), 1942–1978. https://doi.org/10.1257/aer.104.7.1942

Andrew, B. A. (1983). Optimal Investment Under Uncertainty. *The American Economic Review*, *73*(1), 228–233.

Arellano, C., Bai, Y., & Kehoe, P. J. (2019). Financial frictions and fluctuations in volatility. *Journal of Political Economy*.

Arkolakis, C., & Morlacco, M. (2017). Variable Demand Elasticity, Markups, and Pass-Through, 36.

Badinger, H. (2010). Output volatility and economic growth. *Economics Letters*, *106*(1), 15–18.

Basu, S., & Bundick, B. (2017). Uncertainty shocks in a model of effective demand. *Econometrica*, *85*(3), 937–958.

Berman, N., Martin, P., & Mayer, T. (2012). How do Different Exporters React to Exchange Rate Changes? *The Quarterly Journal of Economics*, *127*(1), 437–492. https://doi.org/10.1093/qje/qjr057

Bloom, N. (2007). Uncertainty and the Dynamics of RD. *American Economic Review*, *97*(2), 250–255.

Bloom, N. (2009). The impact of uncertainty shocks. *Econometrica*, *77*(3), 623–685.

Blum, B. S., Claro, S., Dasgupta, K., & Horstmann, I. J. (2019). Inventory Management, Product Quality, and Cross-Country Income Differences. *American Economic Journal: Macroeconomics*, *11*(1), 338–388. https://doi.org/10.1257/mac.20170080

Das, S., Roberts, M. J., & Tybout, J. R. (2007). Market entry costs, producer heterogeneity and export dynamics. *Econometrica*, *75*(3), 837–873.

De Loecker, J., Goldberg, P. K., Khandelwal, A. K., & Pavcnik, N. (2016). Prices, Markups, and Trade Reform. *Econometrica*, *84*(2), 445–510. https://doi.org/10.3982/ECTA11042

De Sousa, J., Mayer, T., & Zignago, S. (2012). Market access in global and regional trade. *Regional Science and Urban Economics*, *42*(6), 1037–1052. Retrieved August 23, 2021, from https://mpra.ub.uni-muenchen.de/31398/1/MPRA_paper_31398.pdf

de Sousa, J., Mayer, T., & Zignago, S. (2012). Market access in global and regional trade. *Regional Science and Urban Economics*, *42*(6), 1037–1052. https://doi.org/10.1016/j.regsciurbeco.2012.07.011

di Giovanni, J., Levchenko, A. A., Mejean, I., & Polytechnique, C.-E. (2021). Foreign Shocks as Granular Fluctuations, 49.

Eaton, J., & Kortum, S. (2002). Technology, Geography, and Trade. *Econometrica*, *70*(5), 1741–1779. https://doi.org/10.1111/1468-0262.00352

Einav, L., Klenow, P. J., Levin, J. D., & Murciano-Goroff, R. (2021). Customers and retail growth. *Journal of Monetary Economics*, *88*(5), 2037–2073.

Feenstra, R. C., Inklaar, R., & Marcel, P. T. (2015). The next generation of the penn world table. *American Economic Review*, *105*(10), 3150–3182. Retrieved August 23, 2021, from https://mpra.ub.uni-muenchen.de/31398/1/MPRA_paper_31398.pdf

Fernandes, A. M., Klenow, P. J., & Meleshchuk, S. (2019). The Intensive Margin in Trade: How Big and How Important? 76.

Fernandes, A., C, F., & M, P. (2015). Exporter behavior, country size and stage of development: Evidence from the exporter dynamics database. *The World Bank*.

Fernández-Villaverde, J., Guerrón-Quintana, P., Kuester, K., & Rubio-Ramírez, J. (2015). Fiscal volatility shocks and economic activity. *Econometrica*, *105*(11), 3352–84.

Fieler, C. (2011). Nonhomotheticity and Bilateral Trade: Evidence and a Quantitative Explanation. *Econometrica*, *79*(4), 1069–1101. https://doi.org/10.3982/ECTA8346

Fitzgerald, D., & Priolo, A. (2018). How Do Firms Build Market Share? *National Bureau of Economic Research*, *No. w24794*, 2037–2073.

Fitzgerald, D., Haller, S., & Yedid-Levi, Y. (2021). How exporters grow. *National Bureau of Economic Research*, (w21935).

Giovannetti, G., & Samiei, H. (1996). Hysteresis in exports. *CEPR Discussion Papers*, *No. 1352*, 2037–2073.

Gopinath, G., & Itskhoki, O. (2010). FREQUENCY OF PRICE ADJUSTMENT AND PASS-THROUGH. *QUARTERLY JOURNAL OF ECONOMICS*, 53.

Handley, K., & Limão, N. (2017). Policy uncertainty, trade, and welfare: Theory and evidence for China and the United States. *American Economic Review*, *107*(9), 2731–83.

Hartman, R. (1972). The Effects of Price and Cost Uncertainty on Investment. *Journal of Economic Theory*, *5*(2), 258–266.

Head, K. [Keith], & Mayer, T. (2014). Gravity Equations: Workhorse,Toolkit, and Cookbook, In *Handbook of International Economics*. Elsevier. https://doi.org/10.1016/B978-0-444-54314-1.00003-3

Head, K. [K.], Mayer, T., & Ries, J. (2010). The erosion of colonial trade linkages after independence. *Journal of international Economics*, *81*(1), 1–14.

Hsieh, C. T., & Klenow, P. J. (2014). The life cycle of plants in India and Mexico. *The Quarterly Journal of Economics*, *129*(3), 1035–1084.

Imbs, J. (2007). Growth and volatility. *Journal of Monetary Economics*, *54*(7), 1848–1862.

Kimball, M. S. (1995). The Quantitative Analytics of the Basic Neomonetarist Model. *Journal of Money, Credit, and Banking*, *27*, 1241–1277.

Klenow, P. J., & Willis, J. L. (2016). Real Rigidities and Nominal Price Changes. *Economica*, *83*(331), 443–472. https://doi.org/10.1111/ecca.12191

Kohn, D., Leibovici, F., & Szkup, M. (2020). Financial frictions and export dynamics in large devaluations. *Journal of International Economics*, *122*, 103257. https://doi.org/10.1016/j.jinteco.2019.103257

Koren, M., & Tenreyro, S. (2007). Volatility and development. *The Quarterly Journal of Economics*, *122*(1), 243–287.

Lartey, E. K., Mandelman, F. S., & Acosta, P. A. (2012). Remittances, Exchange Rate Regimes, and the Dutch Disease: A Panel Data Analysis. *Review of International Economics*, *20*(2), 377–395.

Limao, N., & Venables, A. J. (2001). Infrastructure, geographical disadvantage, transport costs, and trade. *The world bank economic review*, *15*(3), 451–479.

Lucas, J., Robert E, & Prescott, . C. (1971). Investment under uncertainty. *Econometrica*, *39*(5), 659–681.

Mandelman, F. S. (2013). Monetary and Exchange Rate Policy under Remittance Fluctuations. *Journal of Development Economics*, *102*, 128–147.

Mandelman, F. S., & Vilán, D. (2020). Remittances and COVID-19: A Tale of Two Countries. *FEDS Notes*, *2020*(2803). https://doi.org/10.17016/2380-7172.2803

Manova, K. (2008). Credit constraints, equity market liberalizations and international trade. *Journal of International Economics*, *76*(1), 33–47. https://doi.org/10.1016/j.jinteco.2008.03.008

Manova, K. (2013). Credit Constraints, Heterogeneous Firms, and International Trade. *The Review of Economic Studies*, *80*(2), 711–744. https://doi.org/10.1093/restud/rds036

Martin, J., Mejean, I., & Parenti, M. (2020). Relationship stickiness, international trade, and economic uncertainty. *Working paper*, *88*(5), 2037–2073.

Merga, R. (2020). Real Exchange Rate Uncertainty Matters: Trade, Shipping Lags, and Default. *Working paper*.

Novy, D., & Taylor, A. M. (2020). Trade and Uncertainty. *The Review of Economics and Statistics*, *102*(4), 749–765. https://doi.org/10.1162/rest_a_00885

Pindyck, R. S. (1982). Adjustment Costs, Uncertainty, and the Behavior of the Firm. *The American Economic Review*, *72*(3), 415–427.

Ramey, G., & Ramey, V. A. (1995). Cross-country evidence on the link between volatility and growth. *The American Economic Review*, *88*(5), 1138–1151.

Razin, A., & Rose, A. K. (2015). Business cycle volatility and openness: An exploratory cross-section analysis. *NBER Working Paper*.

Redding, S., & Venables, A. J. (2004). Economic geography and international inequality. *Journal of International Economics*, 30.

Rodrik, D. (1998). Trade policy and economic performance in sub-saharan africa. *NBER working paper*, *w6562*(5).

Ruhl, K. J., & Willis, J. L. (2017). New exporter dynamics. *International Economic Review*, *58*(3), 703–726.

Steinberg, J. B. (2021). Export Market Penetration Dynamics, 52.

Stokey, N. L., Lucas, R. E., & Prescott, E. (1989). Recursive methods in dynamic economics. *Cambridge, MA: Harvard University*.

Waugh, M. E. (2010). International Trade and Income Differences. *American Economic Review*, *100*(5), 2093–2124. https://doi.org/10.1257/aer.100.5.2093

Yeh, C. (2021). Revisiting the origins of business cycles with the size-variance relationship, 41.

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. (2015) 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 $\text{Macro-Vol.}_i^{\text{pre-sample}}$. The last row of the table presents a similar measure but using the cyclical component of the real GDP $\text{Macro-Vol.}_i^{\text{GDP, pre-sample}}$

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.
$\frac{\text{GDP}}{\text{L}}$	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. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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 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.5.

Table A.2: 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	43091	36339
R^2	0.85	0.89	0.94	0.88
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. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

B Appendix: Firm-level Estimation

B.1 Price Dynamics Over Exporter Life Cycle

Table A.3: 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 country * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

B.2 Sales Dynamics Over Exporter Life Cycle

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

	(1)	(2)	(3)	(4)	(5)	(6)
	ΔQ_{ildt}	ΔQ_{ildt}	ΔQ_{ildt}	ΔQ_{ildt}	$\Delta \frac{\text{exp}_{ildt}}{\text{dom. sales}}$	$\Delta \frac{\text{exp}_{ildt}}{\text{dom. sales}}$
$\mathbb{I}_{age_{ildt}=1}$	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 origin country. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

B.3 Volatility and Sales Dynamics Over Exporter Life Cycle

Table A.5: Volatility and sales dynamics over exporter life cycle.

	(1)	(2)	(3)	(4)	(5)
	$\Delta\frac{\text{exp}_{ildt}}{\text{dom. sales}}$	$\Delta\frac{\text{exp}_{ildt}}{\text{dom. sales}}$	$\Delta\frac{\text{exp}_{ildt}}{\text{dom. sales}}$	$\Delta\frac{\text{exp}_{ildt}}{\text{dom. sales}}$	$\Delta\frac{\text{exp}_{ildt}}{\text{dom. sales}}$
$\ln \text{Volatility}_{it}$	0.12*	0.04*	0.02	-0.00	0.00
	[0.06]	[0.02]	[0.05]	[0.02]	[.]
$\mathbb{I}_{\{age_{ildt}=1\}} \times \ln \text{Volatility}_{it}$	0.02	-0.01	-0.03	0.01	-0.03
	[0.07]	[0.04]	[0.05]	[0.03]	[0.07]
$\mathbb{I}_{\{age_{ildt}=2\}} \times \ln \text{Volatility}_{it}$	-0.02	-0.04	-0.02	0.01	-0.14
	[0.08]	[0.04]	[0.06]	[0.04]	[0.11]
$\mathbb{I}_{\{age_{ildt}=3\}} \times \ln \text{Volatility}_{it}$	-0.16	-0.11*	-0.02	-0.04	-0.30*
	[0.10]	[0.06]	[0.08]	[0.04]	[0.17]
$\mathbb{I}_{\{age_{ildt}=4\}} \times \ln \text{Volatility}_{it}$	-0.43***	-0.34***	-0.23**	-0.24***	-0.55**
	[0.13]	[0.09]	[0.10]	[0.08]	[0.23]
$\mathbb{I}_{\{age_{ildt}=5\}} \times \ln \text{Volatility}_{it}$	-0.77***	-0.48***	-0.57***	-0.45***	-1.09***
	[0.21]	[0.16]	[0.17]	[0.14]	[0.33]
Observations	6,625	18,346	11,621	32,656	10,031
R^2	0.33	0.19	0.27	0.16	0.42

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

B.4 Volatility and Incumbent exporters.

Given the measure of volatility I estimate the following equation:

$$\ln \mathbf{exp}_{i,m,t} = \beta^1 \ln \sigma_i^z + \beta^0 \ln \sigma_i^z + \gamma_{m,t}^1 + \gamma_{mth,y_1}^2 + \gamma_{age}^3 + controls_{i,m,t} + e_{i,m,t} \qquad (51)$$

Where $\gamma_{m,t}^1$ denotes fixed effects at 2-digit product-destination-year and are fixed effects for cohort γ_{mth,y_1}^2, γ_{age}^3 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.6.

Results in table A.6 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.6: 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	288389	81916	55426
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 52:*

$$\frac{\partial c(A_i', A_i)}{\partial A_i'} \geq \frac{\partial \mathbb{E}\{V(A_i', z_i, \Omega)\}}{\partial A_i'} \tag{52}$$

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

$$V(A_i, z_i, \Omega) = \max_{m \in \{0;1\}; A_i' \in [A_i;\infty)} \pi^d(z_i, 1) + m(\pi(z_i, A_i) - f_{exp}) - c(A_i', A_i) + \beta \mathbb{E} V\left(A_i', z_i', \Omega'\right) \tag{53}$$

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:*

$$\frac{\partial \mathbb{E}\{V(A_i', z_i, \Omega)\}}{\partial A_i'} = \frac{\partial f(A_i')}{\partial A_i'} \mathbb{E}\{\pi(1, z_i, \Omega)\} - \mathbb{E}\left\{\frac{\partial c(A_i'', A_i')}{\partial A_i'}\right\} \tag{54}$$

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

$$\frac{\partial \mathbb{E}\{V(A_i', z_i, \Omega)\}}{\partial A_i'} = \frac{\partial \mathbb{E}\left\{\pi(A_i', z_i, \Omega) - c(A_i'', A_i')\right\}}{\partial A_i'} \tag{55}$$

Then equation (54), 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:

$$\frac{\partial c(A'_i, A_i)}{\partial A'_i} \geq \frac{\partial f(A'_i)}{\partial A'_i}\mathbb{E}\{\pi(1, z_i, \Omega)\} - \mathbb{E}\left\{\frac{\partial c(A''_i, A'_i)}{\partial A'_i}\right\} \tag{56}$$

If equation 61 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 61 increases as we perform a mean preserving spread. When equation 61 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:*

$$\frac{\partial \mathbb{E}\{V(A'_i, z_i, \Omega)\}}{\partial A'_i} = (1-F_z(z'^*))\left[\frac{\partial f(A'_i)}{\partial A'_i}\mathbb{E}\{\pi(1, z_i, \Omega)|z \geq z'^*\} - \mathbb{E}\left\{\frac{\partial c(A''_i, A'_i)}{\partial A'_i}|z \geq z'^*\right\}\right] \tag{57}$$

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

$$\frac{\partial \mathbb{E}\{V(A'_i, z_i, \Omega)\}}{\partial A'_i} = (1 - F_z(z'^*))\left[\frac{\partial \mathbb{E}\left\{\pi(A'_i, z_i, \Omega) - c(A''_i, A'_i)|z \geq z'^*\right\}}{\partial A'_i}\right] \tag{58}$$

Equation (58) follows from applying the Leibniz integral rule under the case that $z'^{*}(A_i')$. From equation (58), equation (57) 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:

$$F_z(z^*) = \Phi(\frac{\ln z^* - \mu}{\sigma}) \tag{59}$$

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:

$$\pi(z_i^*, a_t, A) = fe + c(A_i', A_i) - \beta \mathbb{E}\{V(A_i', z', \Omega') - V((1 - \delta^{exp})A_i, z', \Omega')\} \tag{60}$$

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:

$$\frac{\partial c(A_i', A_i)}{\partial A_i'} \geq (1 - F_z(z'^*)) \left[\frac{\partial f(A_i')}{\partial A_i'} \mathbb{E}\{\pi(1, z_i, \Omega) | z \geq z'^*\} - \mathbb{E}\left\{ \frac{\partial c(A_i'', A_i')}{\partial A_i'} | z \geq z'^* \right\} \right] \tag{61}$$

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 □

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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:

$$\pi(z_i, A_i) = A_i B w^{1-\theta} z_i^{\theta-1} \ \ ; \ \ B = \left(\frac{\theta - 1}{\theta}\right)^{\theta-1} \frac{1}{\theta} \tag{62}$$

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. □