International Trade, Volatility, and Income Differences

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Abstract Developing countries trade less than rich countries. I show that this lack of involvement in trade arises because high domestic volatility discourages exporters' investments in foreign market access. At the cross-country level, I find that the country's TFP volatility explains 40% of the relationship between trade and GDP per capita. Using Colombian micro-level data, I document that those exporters facing higher domestic sales volatility export less. New exporters expand less over their life cycle in industries with higher domestic sales volatility. 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 developed an international trade model with new exporter dynamics and non-CES demand that account for the novel facts at the firm and the cross-country level. These results suggest that estimated trade frictions using static trade models reflect the consequences of domestic volatility on exporters' investment decisions to grow into foreign markets. Indeed, my quantitative findings show that the volatility differences across countries are crucial to account for the trade difference between developed and developing economies.

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

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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. Firms' domestic volatility affects their incentives to invest in 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 domestic volatility and the trade frictions that affect firm growth in foreign markets explains most of the relationship between development and international trade once we allow for demand to present variable price elasticity in a way that is consistent with the micro-level data.

I start by documenting new facts about domestic volatility and trade at the cross-country level. 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 equation 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 Fernandes et al. (2015) for a study of the relationship between exporter characteristics and development.
[2] See Waugh (2010), Blum et al. (2019), Fieler (2011) and de Sousa et al. (2012).
[3] See Das et al. (2007), Alessandria et al. (2021).

I then focus on the firm-level data to identify plausible mechanisms behind the aggregate results. I find that industry volatility shapes individual firms' expansion patterns. 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 market demand, similar to the findings of Fitzgerald et al. (2021) and Steinberg (2021). Second, exporters more exposed to domestic volatility grow slower rates in their export markets; higher domestic volatility reduces exporters' incentive to invest in foreign markets. The relevance of these findings lines with the fact that new exporter dynamics models assuming CES demand structure can't replicate this fact, unlike models featuring variable markups. Based on this theoretical result, I test the existence of variable markups and use these estimates to will feed into the general equilibrium model. I do this by using a novel identification strategy that requires minimum assumption over the production function to estimate markup responses.

I then build a dynamic model with firm heterogeneity and new exporter dynamics to quantify the role of volatility in trade. The model extends the new exporting dynamic model to allow for a variable price elasticity and, thus, variable markup. The model is such that depending on two parameters, it nests four possible types of models. These four models are (1) a standard static model with firm heterogeneity, (2) a static model with variable markups, (3) a dynamic model with constant price elasticity, and (4) a dynamic model with variable markups.

I show that the standard models with CES demand cannot match the documented micro-level facts. Models of international trade that assume CES demand cannot generate a negative relationship between volatility and international trade because they present the "Oi-Hartman-Abel" effect.[5] However, allowing for variable price elasticity generates volatility to reduce firms' investment incentives. When we depart from the CES-demand framework and allow the price elasticity to vary with firms' productivity, higher uncertainty reduces

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

[5] See Bloom (2013) about the "Oi-Hartman-Abel" effect. The "Oi-Hartman-Abel" refers to the case in which higher volatility increases the firms' expected return because the expected profits in good times compensate for the profits of bad times.

the firm's expected marginal return on investment, decreasing exporters' growth and total exports. This result follows because firms' profits become concave on productivity when variable price elasticities are sensitive enough.

Finally, I use the model to perform a quantitative analysis. The goal is to test the extent to which the micro-level mechanisms can explain the novel aggregate and micro-level findings regarding exports and volatility. I estimate the model's parameters to match Colombian aggregate average trade openness, the evolution of exporters over their life cycle at the firm-level, and my causal estimates on heterogeneous markup response to changes in firms' marginal cost, among other standard moments.

The benchmark model accounts for the firm-level facts regarding the adverse effects of higher domestic sales volatility on exporters' growth, the cross-country relation between total exports and volatility, and total exports and GDP per capita. Nonetheless, the rest of the models fail to generate quantitative or qualitatively similar predictions to what is observed in the data. These results show the macroeconomic relevance of the micro-level findings documented in the data. Assuming that exporters make a static decision or face demand with constant price elasticity comes at the cost of missing the relationship between aggregate export and the level of volatility.

Furthermore, 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 by 40%. In addition, the model generates a relationship between total exports and GDP per capita similar to the one observed in the data. These results highlight the importance of domestic volatility as a determinant of endogenous trade barriers. The interaction between domestic volatility and firms' investment cost to grow into foreign markets significantly affects exports once we properly account for their demand characteristics.

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 the relevance of domestic volatility to explain 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; 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 non-homothetic preferences in demand for goods are important to understand this relationship. These findings follow models where firms face static decisions; hence, volatility cannot play any role by design. 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 from 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 its life-cycle. There is 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]

More broadly, the present work proposes a new mechanism through which volatility discourages investment — the existence of variable price elasticity — contributing to the literature on how economic frictions interact with uncertainty affecting firm investment decisions. Until now the literature has focused on the three main frictions: (1) investments frictions that generate the real option effect (e.g. Pindyck (1982), Bloom (2007), Bloom (2009),

[6] Recent work has found that this investment that works 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. (2021), Fitzgerald et al. (2018), Einav et al. (2021).

Novy et al. (2020), Alessandria et al. (2019), Martin et al. (2020),Handley et al. (2017)); (2) financial frictions to explain why uncertainty reduces firms investment (e.g. Arellano et al. (2019) and Merga (2020)); and (3) the existence of sticky prices e.g. (Basu et al. (2017), and Fernández-Villaverde et al. (2015)). My empirical and quantitative findings show the existence and relevance of variable price elasticity and its consequent variable markups 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 general equilibrium 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 unclear whether markup or cost changes drive the price response. I solve this problem by proposing an estimation procedure to compute the pure markup response to exchange rate shocks without estimating the markup level. 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 consequently, exchange rate changes affect the marginal cost of production. I also propose a new instrumental variable approach to solve the endogeneity problems between exchange rate changes and domestic or foreign shocks affecting the pricing decision of firms.

Layout. The rest of the paper is structured as follows. Section 2 presents a toy model to highlight the main mechanism and the relevance of different assumptions to understand how volatility affects exports. Section 3 presents the data sources. Section 5 presents the estimation strategy and results for the aggregate facts. Section 6 turns to the micro-level facts using administrative firm-level data from Colombia. Section 5 presents the general equilibrium model, and section 7 deals with its estimation and quantitative results. Section 7 concludes.

2 Mechanism in a Simple Example

Prior to delving into the empirical outcomes and the full general equilibrium model, I will establish a simple example to highlight the primary mechanism in its most intuitive form. The goal here is to demonstrate how the assumption of variable or constant price elasticity can reshape the relationship between firms' volatility, total exports, and exporters' growth. This illustration will be conducted within the framework of exporters utilizing a linear production function that expands through an augmentation in customer capital in the market they sell. This serves to underscore the importance of exporters' dynamic decisions in understanding how volatility impacts their choices. In this particular context, our initial focus will be on how the influence of volatility on total exports hinges on the curvature of the revenue function with respect to firms' productivity. Subsequently, I will emphasize the impact of assumptions about price elasticity on this curvature.

Consider a model with a continuum of exporters that solves a one-period problem. These firms initiate their endeavors with a certain amount of customer capital, which we denote as A. The decision of whether or not to engage in exporting is imposed exogenously upon them. Their production process hinges on a linear technology, $q = zl$, and they optimize their value by allocating resources, specifically labor and investments in customer capital. The dynamic problem they face is to determine how much to invest in their customer capital for the upcoming period, all before the idiosyncratic productivity shock z unfolds and before they gain insight into the binary outcome of exporting ($m = 1$) or not ($m = 0$). These productivity shocks are drawn from a continuous distribution, $F(z)$, and exhibit a standard deviation denoted as σ_z. The exporting decision variable,m, follows a Bernoulli distribution (with probability $pr(m = 1) = \iota$). The demand for a firm's product is given by

$$q(A, p) = A^{\alpha}\hat{q}(p)Q^{f},$$

A^{α} is the intercept of demand that depends on firms' customer capital, $\hat{q}(p) := q(1, p)$ denotes the static component of demand as a function price, p. The firm's static problem is to choose p to maximize its profits, $\pi(A, z, m)$, after it observed z and m. Firms' optimal profits can be re-written as

$$\pi(A, z, m) = A^{\alpha}\hat{\pi}(z, m),$$

where $\hat{\pi}(z, m) := \pi(1, z, m)$. Because firms use labor to invest in customer capital, which fully depreciates in the next period, their dynamic problem is

$$\max_{A'} A^{\alpha}\hat{\pi}(z, m) - wA' + \beta\mathbb{E}_{F'}\big\{A'^{\alpha}\hat{\pi}(z', m')|_{z=z}\big\} \tag{1}$$

s.t.

$$A' \geq 0$$

If firms do not export, $m = 0$, then $\hat{\pi}(z, 0) = 0$, where profits denotes the operational profits firms obtain from engaging in export activities. The optimal condition for customer capital tomorrow is given by

$$A'(z) = \left\{\frac{\alpha\iota\beta}{w}\mathbb{E}_{F'}\big\{\hat{\pi}(z', 1)|_{z=z}\big\}\right\}^{\frac{1}{1-\alpha}} \tag{2}$$

this optimal investment decision underscores how the curvature of operational profits in relation to firms' productivity plays a pivotal role in determining the impact of higher uncertainty on investment choices. When profits are convex with respect to firms' productivity, greater uncertainty, due to a mean-preserving spread, leads to higher investments by exporters. In contrast, a mean-preserving spread reduces investment if profits exhibit concavity. To comprehend these outcomes, consider the following intuition: heightened uncertainty increases the likelihood of both better and worse productivity outcomes. When profits are convex, the expected profit gains from better outcomes outweigh the profit reductions from worse outcomes, resulting in a higher expected return for acquiring an additional customer. Conversely, the opposite holds when profits exhibit concave behavior in relation to firms' productivity.

Differences in the profit function, arising from variations in the curvature of the revenue function, yield significant implications for how increased uncertainty affects the exporters' growth over time and, consequently, the total exports. To highlight the core mechanism, let's assume that firms' productivity follows an independently and identically distributed (iid) pattern, allowing us to express cumulative exports as

$$Exp = A^{\alpha} \int p(z)\hat{q}(z)dF(z)$$

where $A'(z) = A \; \forall \; z$ since $z \sim iid$. To better understand how the curvature of the revenue function determines volatility effects on total exports, let G represent a second cumulative distribution function derived from F via a mean-preserving spread and denote variables x_G as variable x derived under distribution G. We can right the export differences between a country with low and high uncertainty as,

$$\ln\left(\frac{Exp_G}{Exp}\right) = \underbrace{\ln\left(\frac{A_G^{\alpha}}{A^{\alpha}}\right)}_{\text{dynamic response}} + \underbrace{\ln\left(\frac{\int p(z)\hat{q}(z)dG(z)}{\int p(z)\hat{q}(z)dF(z)}\right)}_{\text{static response}} \tag{3}$$

The overall export response to increased volatility depends on the interaction of dynamic and static reactions, as described in the first and second terms of equation 3. The dynamic response deals with how heightened uncertainty impacts firms' expected gains from acquiring more customers, which is closely tied to the curvature of the firm's profit function, as we've previously discussed. Meanwhile, the static response reflects alterations in the distribution of sales. It's worth noting that, conditionally on the firm's productivity, the static sales component - $p\hat{q}$ - remains the same for different distributions. Thus, the static response captures shifts in total sales due to changes in the productivity distribution.

The direction of the dynamic and static responses depends on the curvature of the revenue function. When considering a linear production function, profits will exhibit concavity if a firm's revenue is concave to productivity. This aligns with our previous discussion. When revenues are concave, the expected increase in revenue from more favorable outcomes isn't sufficient to offset the expected revenue decline due to a higher likelihood of unfavorable outcomes. Consequently, total expected revenues decrease, resulting in a negative dynamic response to uncertainty. Similarly, the static response becomes negative when revenues display concavity. In this scenario, the reduction in total sales due to a higher share of less productive firms surpassing the sales increase attributed to a larger share of more productive firms.

Neglecting the importance of domestic volatility or inaccuracies in specifying the revenue function can significantly impact the estimation of trade determinants, particularly in estimating trade costs at the origin country. For instance, let's consider a scenario where the data-generating process results in revenue being concave with respect to firm productivity. If we employ a static or dynamic model with a convex revenue function, we will end up estimating higher trade costs for exports to all destinations from the origin country. This is because the model will predict increased exports as firms' volatility rises, whereas, in the actual data-generating process, greater volatility reduces total exports. Similarly, if we accurately account for the curvature of the revenue function but use a static model when the data-generating process is dynamic, we will overlook the dynamic response to volatility. As a consequence, models with incorrectly specified revenue functions and lacking dynamic elements will fail to capture the correct relationships between total trade and volatility, leading to inflated estimates of export costs in the origin country.

I now turn my attention to exploring how the assumption of variable or constant price elasticity can impact the curvature of revenue and profit functions. Consider that the transformation of productivity into revenue can be dissected into two primary effects: a direct effect and an indirect effect. The direct effect relates to how changes in marginal costs affect prices, while the indirect effect pertains to how changes in prices impact quantities sold. In the context of constant price elasticity, if firms' productivity increases, they will fully transmit the cost reduction into lower prices, constituting the direct effect. Yet, when price elasticity surpasses two, the price decline is more than offset by the increase in quantities sold - this is the indirect effect. Consequently, revenues rise in a manner that exceeds the proportionality to firms' productivity due to the strong response of quantities to price changes. This, however, does not hold true when price elasticity varies in conjunction with quantities sold, resulting in a weakening of both the direct and indirect effects. In such instances, as firms' productivity increases, they reduce prices less compared to previous scenarios, thereby increasing their markup and mitigating the shift along the demand curve. Additionally, as firms decrease their prices, quantities become less responsive to price changes, damping the indirect effect. Consequently, if price elasticity is sufficiently responsive, revenues will increase with firms' productivity, albeit in a less-than-proportional manner.

3 Data

To document the aggregate facts, I use several data sources: Penn World table database, the Dynamic Exporter Database from World Bank, the Enterprise Survey from the World Bank, and CEPII database. Appendix A.1 contains the details of the cross-country data.

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

I use two administrative data sets from Colombia to measure variables at the firm level. The first data set reports exports of each firm at the 8-digit product level for each destination and period. The data is monthly and provides information on the quantities shipped and the value of the shipment in Colombian pesos and U.S. dollars over the period 2006-2019. I aggregate export flows for each firm-product-destination yearly to avoid the usual problems with lumpiness in trade.[7]

[7]See Alessandria et al. (2019) as an example of the lumpiness in trade and its relevance for exporter behavior at high frequency.

I merge this data with firm-level data from "Superintendencia de Sociedades" which reports the variables firms declared in their balance sheet information. This dataset provides information on firms' total income, operational income, operational cost, total costs, profits, and operational profits, among other variables. These variables are in nominal Colombian Pesos, which I deflate with the production price index. The data sets cover a sub-sample of 20,000, the largest firms representing around 90% of total value-added in the country. The sample is skewed towards larger firms, generating a concern due to possible bias for firm-level empirical facts. But since the focus of the paper is on exporters' behavior, this alleviates this concern for two reasons. First, the largest firms in the economy are the ones that are exporters, and second, exports are highly concentrated on larger firms. Furthermore, I show that the firm-level facts are robust enough to include this data in the appendix.

4 Cross-country evidence

This section focuses on cross-country evidence. I document two facts. I start by reexamining the relationship between exports and the level of development. I find that unconditional on the level of volatility; there exists a positive relationship between aggregate exports and level of development as in Waugh (2010), Fieler (2011), Blum et al. (2019), Fernandes et al. (2015) and de Sousa et al. (2012). Second, I show that conditional on a country's micro or macroeconomic volatility, the relationship between aggregate exports and GDP per capita reduces almost by half and becomes negligible in some cases. This result can be explained by the fact that, on average, higher volatility is negatively related to export performance and that developing economies tend to be more volatile, as I document in appendix A.2 consistent with the findings of Ramey et al. (1995),Aghion et al. (2010),Badinger (2010), Imbs (2007), Koren et al. (2007).

Macroeconomic volatility measure. I measure the macroeconomic volatility of each country as the time-series standard deviation of the detrended estimated TFP from Penn

World Tables.[8] To pindown the macroeconomic volatility of the country I estimate

$$\widehat{tfp}_{i,t} = \alpha_{0,i} + \rho_i \widehat{tfp}_{t-1} + e_{i,t} (4)$$

where $t\hat{f}p_{it}$ is the detrended value of the log of the TFP of each country c at time t. I estimate the equation for each of the N countries, generating a vector of $\{\rho_i\}_{i \in N}$ and a time series of the estimated residuals for each country $\{e_{i,t}\}_{i \in N}$. I then compute the macroeconomic volatility as the standard deviation of $e_{i,t}$ for each country i. Note that in this case, the volatility measure captures the conditional of past shocks' standard deviation; in the appendix A.3 I redo the exercise using the unconditional standard deviation measure, and I find that results are qualitatively similar.

Microeconomic volatility measure. To pin down the microeconomic volatility, we want to rely on a measure that completely purged out the common effects on firms due to aggregate or sectoral changes. To do this, we can compute the firm-level shocks without the macroeconomic common component that affects firms within a country-industry-year by incorporating the corresponding fixed effects as in Yeh (2021) and Di Giovanni et al. (2020), so then we can estimate,

$$\Delta \text{labor prod}_{i,c,t} = \gamma_{c,j(i),t} + e_{i,c,t} \tag{5}$$

where Δlabor prod$_{i,c,j,t}$ is the percentage change in labor productivity of firm i, in country origin c, in year t. Labor productivity is defined as total sales over total workers. $\gamma_{c,j(i),t}$ denotes country-industry-year fixed effects, where industry belongs to the main industry that firms belong to,$j(i)$, so that $e_{i,c,t}$ can be interpreted as pure firm-level changes in labor productivity. To avoid these changes to being directly related to foreign demand or supply shocks, I restrict my sample to those firms that do not declare any direct or indirect export or import in the database. Once we have the firm-level shock estimates, we can compute the microeconomic volatility as the average observed standard deviation across time for each

[8] The time series are detrended using an H-P filter with a smooth parameter equal to 100

country i as,

$$\sigma_c^{\omega} := \sum_{t=1}^{T} \frac{\sqrt{\sum_{i \in N_{c,t}} \frac{\left(\hat{e}_{i,c,t} - \mu_{c,t}^{e}\right)^2}{|N_{i,t}|-1}}}{T}$$

where $\mu_{c,t}^{e}$ denotes the average of $\hat{e}_{i,c,t}$ across firms at year t, and $|N_{i,t}|$ represents the total number of firms in country c.[9]

Exports, volatility, and income differences: Estimation. To empirically understand the relevance of macro and micro volatility on international trade I estimate a gravity equation. I decompose the logarithm of origin country c's exports to destination country d (denoted by$\ln(x_{cdt})$), in an origin country fixed effect (α_C), a destination time fixed effect (γ_{dt}), and a vector of bilateral variables ($\boldsymbol{y}_{cdt}$)[10],

$$\ln(x_{cdt}) = \alpha_c + \gamma_{dt} + \boldsymbol{\beta} \boldsymbol{y}_{cdt} + \epsilon_{cdt} \tag{6}$$

as in Head et al. (2014) and Eaton et al. (2002) I proceed in a two-step procedure to understand the variables that relate with the origin component of a country, α_c. Once, I have estimated $\hat{\alpha_c}$, I project them against a set of variables to understand how they relate to different country characteristics, as follows

$$\hat{\alpha}_i = \beta_0^{\alpha} + \beta_1^{\alpha} \ln \sigma_i + \beta_2^{\alpha} \ln \frac{GDP}{L} + \boldsymbol{\alpha_3} \bar{\boldsymbol{y}}_{ij} + \boldsymbol{\alpha_4} \bar{\boldsymbol{h}}_i + \boldsymbol{\alpha_5} \bar{\boldsymbol{Q}}_i + e_i \tag{7}$$

in the above equation, I project that countries origin fixed, $\hat{\alpha}_i$, against are related to the country c level of volatility,σ_i, its GDP per capita, $\frac{GDP}{L}$, the average of the bilateral-time variables,$\bar{\boldsymbol{y}}_{cd}$, the average of the origin time-varying variables, $\bar{\boldsymbol{h}}_c$. I also control for countries' quality institution, it level of financial development, and direct measures of exporting costs represented by the vector $\bar{\boldsymbol{Q}}_c$. I use the three indexes developed by the World Bank that capture the quality of the contract enforcement, the financial development of a country c,

[9] 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.

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

and the declared export costs that exporters face.[11] The two main coefficients of interest are β_1^α and β_2^α, as the former captures the relationship between the average exports of a country and its volatility, and the latter captures the relationship between the average exports and its level of development.

Table 1 presents the results of the estimated coefficients for β_1^α and β_2^α. In this specifications, the gravity controls row denotes controls for the origin country such as its GDP, the standard deviations of the terms of trade (TOT), the bilateral exchange rate, and countries' TOT, country-pair trade agreement, a dummy for country-pair that belongs to a currency union, if country-pair currencies are peg, the average bilateral tariff, the size in sq feet for the country and its population, the distance and the level and changes of country's TFP. In the Doing Business row, Exp denotes controls for total export declared costs, Cred denotes controls for the financial development index of the country, and Cot denotes control for the contract enforceability of the country.

Aggregate Fact 1: Positive Relationship between Exports and Income per Capita. Table 1 presents the results for two estimations, the case without controlling by countries' volatility measures and the case when we control by its volatility. Columns (1) and (3) shows the estimates (7) without controlling for the volatility measure. Both results show significant and relevant relations between the level of development and the average export to each market even after controlling by country size, the declared cost to export, and the institutional environment of the country (column 3). This result is consistent with the findings documented by Waugh (2010), Blum et al. (2019), Fernandes et al. (2015) and de Sousa et al. (2012).

Aggregate Fact 2: Negative relationship between volatility and exports. Columns (2) and (4) of table 1 are homologous to columns (1) and column (2) but when adding the variable of interest, the macro or microeconomic volatility measures. Panel 1 presents the case after controlling for the macroeconomic volatility of the country. Two results are important to highlight. First, the estimated relationship between exports and the level of GDP

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

per capita drops between around 45%, after controlling for the level of volatility, and those relationships become non-significantly different from zero. Second, there exists a negative relationship between average exports and countries' volatility. We found a similar result after controlling for the microeconomic volatility of the country; nonetheless, the drop in the relationship between exports and GDP per capita is somewhat smaller, in the other of 32%. A difference to highlight between the second and first panels is the difference in the sample size due to the lack of country data, as labor productivity changes are reported for a subset of countries.

While aggregate fact 1 is well-known and documented in the literature, the second aggregate fact 2 is new to the literature. Hence, I performed several robustness checks of this result in appendix A.3. I find that the results are robust to using different measures of macro or microeconomic volatility, constructing the volatility measure without global common factors, looking at trade only in manufacturing to test the relevance of trade composition, or using past volatility and that findings are also consistent with the firm-level responses at the intensive and the extensive margin.

These aggregate facts provide a new potential explanation of why export costs and values seem to be empirically associated with variations in the level of development even after controlling for the standard determinants of international trade. As discussed in the simple model section, standard models with firm heterogeneity, assuming constant elasticity of substitution, cannot replicate these empirical observations, so the differences between the models' predictions and the data will be loaded in the estimated iceberg costs.

Nonetheless, these aggregate relationships documented in this section are not necessarily causal. Because of the cross-country nature of the exercise and, despite the efforts to control for those variables that might be related to domestic volatility and the literature found to be important for trade levels, the existence of a potential omitted-variable bias cannot be ruled out. This is the reason why, in the following sections, I will proceed in two ways to provide more evidence for this new explanation. First, I will focus on micro-level data from Colombia, where I will test the firm-level assumptions and predictions highlighted in the previous models' section. Second, after showing that neither the assumptions nor the predictions at the firm level can be rejected, I proceed to estimate a full flesh general equilibrium small open economy, with heterogeneous firms and dynamics to use it as a laboratory to observe what are the models predictions regarding higher microeconomic volatility, in terms of total trade, GDP per capita, and what would be the estimated iceberg cost needed in static models to account for this patterns.

5 Firm level facts

The previous section showed that macro and microeconomic volatility are relevant variables for predicting average exports. Volatility does not only predict considerable variations of average exports across countries but also captures a significant share of the variations that had been attributed to the level of development in previous works such as in Waugh (2010), Fieler (2011), and Blum et al. (2019). As previously discussed this can be due to the effect that higher volatility exerts on exports when price elasticity is responsive enough.

I turn now to use the micro-level data from Colombia to show three facts supporting the assumptions and predictions of the main mechanism underlying in section 1. In the first part of this section, I focus on how exporters adjust their prices to changes in their marginal cost of production; I document evidence supporting that price elasticity varies with firms' relative size. In the second part of the section, I focus on the exporter's dynamic behavior. The models' discussion in the first section, hinges on the assumption that exporter grows by expanding the intercept of their demand. Additionally, if price elasticity is responsive enough, the model predicts that volatility will reduce exporters' optimal growth path over the life cycle. I find that the micro-level findings support the models' assumption and its implications.

Estimating the markup elasticity in the data. The objective is to test if, as firms are more productive, they respond more by changing markups to changes in their marginal cost. To test this, I use exchange rate shocks as changes in the marginal cost in foreign currency and firms' market share in the market as a proxy for the ratio of the exporters' relative productivity in that market [12].

To understand how we can estimate the markup responses by observing changes in prices, let's start with the markup definition. Markups are defined as the ratio between the product's price and the product's marginal cost of being sold to the market. By this definition, prices are given by equation (5) where i, l, d, t represent the firm, product, destination, and time, respectively. $\frac{Mc_{i,d,l,t}}{e_{d,t}}$ denotes the marginal cost of production in foreign currency, since $e_{d,t}$ is the bilateral exchange rate, $p_{i,d,l,t}$ denotes prices and $\mu_{i,d,l,t}$ represents the markups at time t that firm i set sell to market (d, l). I assume that firms' sales are set ultimately in the currency of the market selling to

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

It is important to highlight two consequences that follow this definition. The markup definition implies 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, if a firm faces the same markup-elasticity to prices in all its destination markets, exchange rate pass-through should not vary across destinations. The literature has extensively documented that exchange rate pass-through to prices is incomplete and that these changes are related to exporters' market share as shown by Berman et al. (2012).

We aim to estimate the changes in markups due to changes in the exchange rate by observing the change in prices; hence, we need to control the changes that exchange rate movements have on the cost of production. Otherwise, we would obtain biased estimates of markup responses to shocks. [13] To address this concern, we can exploit variation across destinations within firm-product-time. To understand how this assumption allows us to identify markup responses, note that if we assume that the firm's i marginal cost can be decomposed into two components: (1) the marginal cost of production, common to all desti-

[12] See Arkolakis et al. (2017) for a discussion of models with variable markups and their predictions over heterogeneous exchange rate pass-through

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

nations, denoted as $Mc^{a}_{i,l,t}$, and (2) the cost of selling the product to a destination d, denoted by $Mc^{b}_{l,d,t}$, which we generally refer as iceberg cost; then we can control for the changes in the marginal cost of production. By exploiting variation across destinations within firm-product-time and product-time-destination, we can recover the markup changes by observing the price responses to changes in cost. The following equation should clarify this result,

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

If the markup elasticity varies across destinations within the exporter, depending on its relative productivity to that market, we can use exchange rate shocks interacting with the exporter market share to recover the differential reaction of firms' markup changes in their marginal cost. To test if markup changes vary with exporters' market share, we then estimate,

$$\varDelta p_{i,d,l,t} = \beta \varDelta e_{i,d,l,t} \times \text{exp. share}_{i,d,l,t-1} + \beta_2 \text{exp. share}_{i,d,l,t-1} + \gamma^{1}_{i,l,t} + \gamma^{2}_{i,l,d} + \gamma^{3}_{l,d,t} + e_{i,d,l,t} \quad (8)$$

where $\varDelta$ denotes log differences of the variables over a year. $\gamma^{1}_{i,l,t}$ denotes the firm-product-time fixed effects and ,$\gamma^{3}_{l,d,t}$ denotes the product-destination-fixed effects. Under the assumption of separable marginal cost previously discussed, these fixed effects fully control changes in the marginal cost of production due to changes in exchange rates. Consequently, β captures the differential markup responses to movements in the exchange rate due to firms' differences in their market share. Note that while this estimation producer captures the markup responses to shocks, it cant be used to estimate the level of markups. I also control for potential trends in prices, as the ones we would expect to be driven by inflation, by adding firm-product-destination fixed effects $\gamma^{2}_{i,l,d}$, but the qualitative results are invariant to the addition of these fixed effects.

A concern of directly estimating 8 is that as exchange rate variation might reflect changes in the destination country, this can bias the estimate. However, we can use an instrumental variable approach to solve this concern. I instrument the bilateral exchange rate variation intersected with the firm's sales shares with the remittances flows from third countries to Colombia interacted with firms' sales shares to the destination in 2007. The first stage is then given by

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

Two assumptions are needed to validate this procedure. First, the remittance flows to Colombia affect the exchange rate of Colombia with the rest of the countries; this seems natural as the average net remittances to Colombia represent, on average, 10% of the total export flow. Also, it has been documented that the remittances are unlikely to vary due to exchange rate variation. [14]

The second assumption is that shocks affecting the remittances to Colombia from a third country do not generate differential price changes for a product sold in several destinations. For example, imagine we have Colombia and three other countries: the USA, Argentina, and Brazil. To violate this exclusion restriction, we would need the shock that changes the remittance flows from the USA to Colombia to affect the Colombian firm's relative price changes between Brazil and Argentina after controlling for the common shocks that may hit all the destination countries.

Firm-level fact 1: Markup changes increase with market shares. Table 2 presents the estimation results. Panel 1, shows the estimates for the first stage; the F-statistic is on the order of 40, alleviating the concerns of the possibility of weak instruments for all of the cases I presented. Second, as expected, when we compare the OLS results (column 1), with the IV ones (column 2 or 3), we find that our concern about the possible estimation bias triggered by shocks in the destination economy was valid; nonetheless, all estimates are positive and significant. The results show that the markup response to shocks in the marginal cost is increasing in the exporter's market share. Particularly, a firm with a 1% higher market share

[14] See Mandelman (2013) and Lartey et al. (2012) for a discussion on the effect and relevance of remittances on the exchange rate, and Mandelman et al. (2020) for the small response of remittances to exchange rates

will optimally decide to do an exchange rate pass-through that is between 0.71% and 1.20% lower, as shown by columns (2) and (3) of Panel 2, respectively, consistent with the findings by Berman et al. (2012).

Panel 3 presents a similar estimate but looks at quantities as the dependent variable. The estimation results provide insights into the soundness of the instrument. Note that the OLS estimate predicts a quantity change that seems inconsistent with predicted changes in prices in panel 2. Column 2 and 3 shows that once we use the instrumental variable approach, not only do quantities respond negatively as firms have higher market share, as expected, but also that the magnitude of the coefficients is larger in absolute terms than the one for prices, as we would be expected for the case when average price elasticity is on average higher than 1.

Domestic Volatility and Exporters' Growth. The previous results showed that as firms have higher market share, their markups are more responsive to changes in the marginal cost of production. As shown in the toy model of section one, this can have important implications for explaining the negative relationship between total exports and volatility. When exporters grow over their life cycle by shifting their intercept of demand, higher volatility discourages their incentives to grow if markups are responsive enough. I proceed now to test the validity of the former assumption and its implication for exporters' growth under higher uncertainty.

Firm-level fact 2: New exporters grow by shifting in their demand. I revisit the facts documented in Fitzgerald et al. (2021) and Steinberg (2021) to understand how Colombian exporters grow over their life cycle. I find that while, on average, exporters increase the number of exports over their life cycle, this is not true for observed prices. Exporters grow into foreign markets by shifting their demand, conditional on prices. The evolution of quantities in a particular market, defined as a six-digit product and destination pair, by estimating:

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

where $\text{export}_{i,d,l,t}$ represents the total export value that firm i is selling of product l to destination d in year t. I project total markets against a dummy variable $\mathbb{I}^{h}_{\{age=h\}}$ that equals one when the exporters spent h years continuously selling product l to destination d. I control for the prices of the product, $p_{i,d,l,t}$, and I include firm-product-time fixed effects, $\gamma^{a}_{i,l,t}$, and product-destination-time fixed effects $\gamma^{b}_{d,l,t}$. Adding these fixed effects allows me to purge out the common variation in sales for firm i of product l at time t; the second set of fixed effects allows me to purge out the common variation across exporters within a destination product time. To understand the price dynamics over the exporter's life cycle, I estimate the same equation but without controlling for prices:

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

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

By construction β^{p}_{0} and β_0 are set to zero so that each estimate of $\{\beta_h\}^{H}_{h=1}$ or $\{\beta^{p}_{h}\}^{H}_{h=1}$ captures the cumulative change of the dependent variable to the exporter entry value. New exporters, the ones with an age equal to zero, are defined as those exporters that did not export any positive amount to that product-destination market in the last three years[15].

Figure 1 presents the results of the estimation by plotting the estimates of β_h (panel a) and β^{p}_{h} (panel b) over the exporter life cycle. Consistent with Fitzgerald et al. (2021) and Steinberg (2021), the results show that the prices are constant while exported quantities grow over the exporters' life cycle. Exporters grow into markets by shifting their demand conditional on prices.

Firm's Exposure to Volatility and Exporters' Growth. The previous firm-level facts show that we can't reject two key assumptions presented in the toy model in section 1; the variable markups and exporters' grow by shifting their demand up. One of the model predictions is that, in this case, it is likely that higher volatility will reduce exporters' growth over their life cycle. I turn now to test this prediction.

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

To compute firms' exposure to domestic volatility, I start by computing the firms' shocks to domestic sales. I do this by taking out the shocks that are common for firms in the same industry, as in Yeh (2021) and Di Giovanni et al. (2020). I do this by regressing the change of the log change of domestic sales against industry-year fixed, as follows

$$\Delta s_{i,t}^{D} = \gamma_{j(i),t} + \Delta \hat{s}_{i,t}^{D}.$$

where $\Delta s_{i,t}^{D}$ denotes the log difference of domestic sales over time, $\gamma_{j(i),t}$ is the industry-time fixed effects - $j(i)$ denotes firm i main industry-, and $\Delta \hat{s}_{i,t}^{D}$ is the residual component that captures the firms level shocks. Then, we can use the shocks to other firms in the same industry to compute firms' exposure to domestic volatility. The focus on shocks to domestic sales to third firms obeys two reasons: first, it allows me to avoid the volatility measure being related to foreign demand shocks, and second, it prevents the measure from being related to shocks to the firm itself. For this I compute the average cross-sectional standard deviation of firm-level shocks $\Delta \hat{s}_{i,t}^{D}$, at time t, for all the firms besides the firm i, whose main export product, at the sixth digit level is l^{6d} as,

$$\sigma_{i,l^{6d},t} = \sqrt{\frac{\sum_{j \neq i \in N_{l^{6d}}} \left(\Delta \hat{s}_{j,t}^{D}\right)^2}{|N_{l^{6d},t}| - 1}}$$

where $|N_{l^{6d},t}|$ denotes the number of firms exporting the sixth digit product l^{6d} $\sigma_{i,l,t}$ measures the average volatility of the firm-level domestic shocks to the firms other than i that share its main product of export l. Firms' i exposure to volatility at the four-digit product category l, is defined as the weighted sum of exports product - at the six-digit - of $\sigma_{i,l^{6d},t}$

$$\sigma_{i,l,t} = \sum_{l^{6d} \in l} \frac{\textit{tot. export}_{2006}^{l^{6d}}}{\textit{tot. export}_{2006}^{l}} \sigma_{f,t,l^{6d}} \tag{9}$$

I fixed the export shares and the main products of firm i in 2006 to alleviate the concern that future shocks to some particular products may change total exports and, through that, biased the relationship between volatility and exporters' growth. Appendix A.5, presents the construction and results using different measures of robustness.

Firm-level fact 2: New exporters grow less as they are more exposed to domestic volatility. Using the above-mentioned measure, I estimate the following equation to asses how domestic volatility relates to exporters' dynamics,

$$
\begin{aligned}
\ln\left(\frac{\text{exp int}_{i,l,d,t+h}}{\text{exp int}_{i,l,d,0}}\right) &= \sum_{j=1}^{5} \beta_j^1 \ln \sigma_{i,t}^{\omega} \mathbb{I}_{\{\text{age}=j\}} + \sum_{j=1}^{5} \beta_h^2 \mathbb{I}_{\{\text{age}=j\}} \\
&\quad + \gamma_{l,t}^a + \gamma_{d,t}^b + \gamma_{i,t}^c + controls_{i,m,t} + e_{i,m,t}
\end{aligned} \tag{10}
$$

where $\text{exp int}_{i,l,d,t}$ denotes the export intensity of product l of firm i, at time t sells to destination d, defined as the exports divided by the firm's total sales.$\text{exp int}_{i,l,d,0}$ is the value of $\text{exp int}_{i,l,d,t}$ 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 firm's age in that particular market is h. $\gamma_{l,t}^a$ and $\gamma_{d,t}^b$ represent product-time and destination-time fixed effects, capturing those variations in export intensity that are common to the destination or product for each period. γ_i represents the firm-fixed effects to capture the average growth of the export intensity that are common within the firm across different products and destination.

The focus of export intensity as a dependent variable follows from the insight of the model presented in section 1. Note that under the assumption highlighted in the model, the evolution of export intensity allows us to understand the relationship between firms' customer capital evolution and domestic volatility. This is because,

$$
\text{exp int}_{i,l,d,t+h} = A_{i,l,d,t+h}^{\alpha} \frac{\hat{q}(p_{i,l,d,t})}{\hat{q}(p_{i,l,\text{dom},t})} \ ,
$$

since price dynamics do not evolve differently over firms' life cycle in each market, common shocks to the firm will affect similarly the static component, and hence $\frac{\hat{q}(p_{i,l,d,t})}{\hat{q}(p_{i,l,\text{dom},t})} \approx 1$. Therefore, $\{\beta_{\sigma}^{j}\}_j$ captures the relationship between domestic uncertainty and exporters' cumulative investment to grow their customer capital in selling to a particular market.

Results of the estimation are presented in Figure 2. The figure shows the estimated differences in the cumulative change of exports over the exporters' life cycle with a tenure of at least five years for each market. It compares the difference of the median exporter in terms of exposure to domestic volatility relative to the exporter facing a standard deviation smaller than the median volatility. The results show after five years a firm facing one standard deviation smaller level of uncertainty is almost 80% larger , than one facing the median level of domestic volatility. The estimated coefficients are presented in column (3) of Table A.5, where several robustness checks are also presented.

6 The Model

We now turn to our general model, a dynamic small open general equilibrium economy model that incorporates variable markups, extensive and intensive margin decisions into exporting, and persistent firm-level shocks. The economy has a continuum of firms producing intermediate goods, a representative firm producing a domestic bundle, a final good firm producing the consumption good, and a representative household. The household provides labor inelastically and uses labor and profits income to consume a final good. The final consumption goods and the domestic bundle firms are competitive and have a technology that converts domestic intermediate and imported goods into final goods. The intermediate goods firms operate in a monopolistic competitive market and use labor to produce differentiated products using a linear production function. These firms have three important characteristics: they can sell to foreign markets by incurring a fixed cost, f_e; they can also invest in acquiring customer capital in the foreign markets; and they face variable price elasticity in all the markets they serve. There are no aggregate shocks.

The timing in the model is as follows. At the end of any given period, firms decide how much to invest in foreign customer capital. At the beginning of the next period, idiosyncratic shocks are realized. Intermediate goods firms decide if they export or not, and firms set their prices for each market they serve, produce, and sell their products to final goods firms or foreign markets in case they face a positive demand. The firm producing the domestic bundle buys the intermediate goods and sells them to the final good firm, which also buys the import bundle to produce the final goods. Households consume and receive payments for their work and their firms' profits. Trade is balanced, so aggregate savings are equal to zero.

Domestic consumers. The representative consumer of this economy is the owner of the firms, supplying labor inelastically by L^s units and holding risk-free bonds that are in zero net supply. Every period, she observes her bond holdings, b, and the aggregate state of the economy S, decides how much to consume and save, and provides labor inelastically. Her problem is given by:

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

s.t.

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

In equilibrium $b = 0$, implying that total exports are equal to total imports, the net trade balance in this economy is zero, and the interest rate will adjust for this to be the case. The household problem determines the stochastic discount factor for the firm given by $\Lambda = \beta \frac{u_c(C',L')}{u_c(C,L)}$.

Final good production. The final good is produced by a representative firm that operates in a competitive market and uses two goods as inputs: a bundle of imported goods, M, and a bundle of domestic goods, D, which are combined in the following way to produce the final good C,

$$\left(M^{\frac{\gamma-1}{\gamma}}\upsilon + (1-\upsilon)D^{\frac{\gamma-1}{\gamma}}\right)^{\frac{\gamma}{\gamma-1}} \geq C\ , \tag{11}$$

where υ represents the home bias preferences as usual. Since the price of each of these bundles is given by P^m and P^D, respectively, and P^m are always equal to one, the final good firm chooses the amount of domestic and imported consumption bundles to solve

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

subject to 11. The solution to this problem yields the following demand for the domestic bundle:

$$D = M\left(\frac{\nu}{1-\nu}\right)^{-\gamma}\left(P^D\right)^{-\gamma}$$

Domestic bundle. The domestic bundle is produced using intermediate differentiated goods produced by the domestic firms in the economy, and it is sold into a competitive market to the final good producer. The production for the domestic bundle is such that it satisfies the following conditions,

$$\int_{\omega\in\Omega^d} \Upsilon\left(\frac{q^d(\omega)}{D}\right) d\omega = 1 \tag{12}$$

where, as in Klenow et al. (2016), $\Upsilon(x)$ is given by

$$\Upsilon(x) = 1 + (\theta-1)e^{\frac{1}{\eta}}\eta^{\frac{\theta}{\eta}-1}\left(\Gamma(\frac{\theta}{\eta},\frac{1}{\eta}) - \Gamma(\frac{\theta}{\eta},\frac{x^{\frac{\eta}{\theta}}}{\eta})\right),\ \theta > 1;\ \eta > 0 \tag{13}$$

where $\Gamma(a,b)$, represents the incomplete gamma function, θ I called the price elasticity parameter, and η as the super-elasticity parameter. As it will be clear later, conditional on θ, η shapes a firm's markup responses to changes in the intermediate goods prices. The producer of the domestic bundle will observe intermediate good prices $\{p^d(\omega)\}$ and choose the intermediate quantities $q^d(\omega)$ of the variety ω to solve,

$$\min_{q(\omega)} \int_{\omega\in\Omega} p^d(\omega)q^d(\omega)d\omega \tag{14}$$

subject to equations (13), and (12). The solution to this problem yields the following demand for variety ω,

$$\log q(\omega) = \frac{\theta}{\eta}\log(-\eta\log(\frac{p^d(\omega)}{p_c^d})) + \log D \quad \text{if } p^d < p_c^d \tag{15}$$

where p_c^d is the choke price for the domestic varieties in the economy - the maximum price at which the domestic bundle producer will be willing to buy a variety - and is given by

$$p^c = e^{\frac{1}{\eta}} \frac{\theta - 1}{\theta} \frac{P}{\tilde{D}} \tag{16}$$

where P is the price index for the intermediate goods, defined as $P := \int_\Omega \frac{q(\omega)}{D} p(\omega) d\omega$, and $\tilde{D}$ is defined as $\tilde{D} := \int_\Omega \Upsilon'(\frac{q(\omega)}{D}) \frac{q(\omega)}{D} d\omega$.

Foreign Consumer's Problem Intermediate firms can sell to a foreign importer. The importer takes aggregate demand, Q^*, and foreign prices, P^*, as given [16]. The importer observes the prices of the intermediate goods and solves,

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

s.t.

$$\int_{\omega \in \Omega^*} A(\omega)^\alpha \Upsilon \left(\frac{q^*(\omega)}{A(\omega)^\alpha Q^*} \right) d\omega = 1 \tag{17}$$

where $\Upsilon(x)$ denotes the indirect utility function of the representative consumer and is given by (13); $A(\omega)$ represents the customer capital that the domestic exporter producing variety ω has when selling to this foreign market, and α is the elasticity of customer capital to demand; this follows from the demand as its given by

$$\log q^*(A, p^*) = \frac{\theta}{\eta} \log(-\eta \log(\frac{p^*(\omega)}{p^{c*}})) + \log A^\alpha + \log Q^* \quad \text{for } p^*(\omega) < p^{c*}, \tag{18}$$

as I will explain in the next subsection, $A(\omega)$ ends up being a demand shifter, over which firms can invest and grow into the foreign market as in Fitzgerald et al. (2021). As before, p^{c*} denotes the choke price of the foreign economy, but because the domestic economy is a small open economy, p^{c*} is assumed to be constant, unlike p^c that is an equilibrium object of the domestic economy.

[16] As the domestic economy is small, foreign price and foreign demand are assumed to be invariant to the condition of the domestic market.

Intermediate good firms. As stated before, a continuum of firms with the potential to produce intermediate goods populates the economy. Each potential producer of a variety can produce using a linear production function with time-varying labor productivity. Because the production of each variety, ω, is the same conditional on the firm's i productivity, z_i, and its customer capital, A_i, we can characterize each variety by these two characteristics. Consequently, the joint distribution of productivity and customer capital will be enough to characterize the distribution of intermediate firms, denoted by $\Psi(z, A)$. Firms' productivity follows a Markov process governed by the transition probability $f(z', z)$.

The timing is as follows. At the beginning of time t, firm i observes its productivity z_i and the level of customer capital A_i and decides if it wants to sell in the domestic and international markets. Contingent on selling to each market, it sets the prices for each market, hires the workers, and produces. At the end of the period, it decides how much to invest in customer capital for the following period to sell in the foreign market. When selling to the domestic market, they can reach all the customers available so there are no gains for investing in domestic customer capital. On top of the investment cost in customer capital, reaching the international market has additional costs. To be able to sell to foreign markets, firms need to pay the fixed cost, f_e, and they also face an iceberg cost, τ. Furthermore, the firms' customer capital depends on firms being present in the market; when a firm stops exporting, it loses the customer capital it accumulated. Consequently, the firms' problem can be decomposed into a static and a dynamic problem.

Firms' static problem. Now I characterized the firms' static problem when selling to the international market, but if we set $\alpha = 0$, and $\tau = 1$, the coming equations can also characterize the static problem when selling to the domestic economy. The firms' static problem is consistent in choosing the optimal price such that it maximizes it operational profits, given its production technology, the economy choke price, p^c, and the aggregate quantities, as in

$$\pi(z_i, A_i) = \max_{p_i, l_i} p_i^* q_i^*(A, p_i) - w l_i$$

subject to its production technology, $q_i^* = \frac{l_i \tau}{z_i}$, and equation (18), where $\tau > 1$ captures the iceberg cost of exporting. By choosing the price to maximize their profits, firms are implicitly choosing their products' price elasticity, conditional on their demand behavior. By staring at equation (18), one can realize the firms price elasticity, ξ is given by,

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

the usual maximization argument implies that firms markups are given by,

$$\mu(p) = \frac{\theta}{\theta + \eta \log(\frac{p}{p^{c*}})} \quad \text{for all } p \leq p^{c*} \tag{19}$$

hence markups are decreasing in the price that firms charge. Put differently, it implies that more productive firms will charge higher markups while less productive firms will charge smaller markups. This result is consistent with the findings by De Loecker et al. (2016), Berman et al. (2012), and the firm-level fact one presented in the previous section. Additionally, the price elasticity equation and the markup equation imply boundaries the optimal prices are such that $\mu(p) \geq 1$, and $\xi(p) \geq 1$

As discussed in section 1, the behavior of price elasticity and, consequently firm's markup is essential to understand how the shape of the profit in terms of firms' productivity function hinges on the variability of price elasticity. In this case, the price elasticity will ultimately depend on two parameters, θ, and η. Depending on their value, the model will generate standard "Oi-Hartman-Abel", under which higher volatility on firms will increase exports, sales, and GDP or shut it down, generating the opposite relationship. To understand why higher sensitivity on the price elasticity to firms' relative prices determines the effects of volatility on total sales, think in the following way: When a good shock hits the firm, firms will not increase production that much if the sensitivity of price elasticity is higher. This is because the demand becomes less responsive as the firm reduces prices. Consequently, revenues will not increase as much as under the CES case. Additionally, bad shocks become more costly under price elasticity. This is because, under variable price elasticity, as firms translate their bad shock to prices, their consumers' price elasticity increases. Consequently, total sales will drop more rapidly for each additional price increase. As markup becomes more elastic, it reduces the firms' revenue increase in good times and amplifies its reduction in bad times.

Firm's dynamic problem. In the model, firms make two dynamic decisions directly related to the extensive and intensive margin of the firm. These decisions are the exporting decision, denoted by m, since when firms decide not to export, they lose all the investment in customer capital. And the investment decision to accumulate more customers, denoted by i_d is done using workers. Firms can't sell their customer capital, so they can't make negative investments. The amount of labor required to invest, i_d in customer capital is given by

$$c(i_d, A) = i_d - \frac{\phi}{2}\left(\frac{i_d}{A_i}\right)^{\iota} \tag{20}$$

and firms' customer capital is given by two-component

$$A_i = k_i + A^{min} \tag{21}$$

a minimum level of customer A^{min}, that is fixed and equal to all firms, and k_i that is where firms can invest and accumulate customer capital, according to the following law of motion,

$$k_i' = m\left(i_d + k_i(1-\delta)\right), \tag{22}$$

where is clear firms that do not export, $m = 0$, then will lose all the accumulated customer capital and only have $A' = A^{min}$, the following period. Denoting with an apostrophe the variables next period, and by S_t the vector of aggregate state variables, the firm dynamic problem is to solve

$$\begin{aligned} V(z_i, A_i, S) = \max_{m\in\{0;1\};i_d\in[0;\infty)} & \pi^d(z_i, 1) + m(\pi(z_i, A_i) - wf_e) - \\ & - wc(i_d, A_i) + \mathbb{E}\left[\Lambda(S)V(z_i', A_i', a', S')\right] \end{aligned} \tag{23}$$

subject to (21) and (22). The decision of exporting or not in this model is a discrete decision given by $m \in \{0; 1\}$. If firms decide to export $m = 1$, they will collect the total profits from exports, given by the operational profits $\pi(z_i, A_i)$ minus the fixed cost of exporting, f_e. Suppose they decide not to export $(m = 0)$. In that case, firms will only collect the profits for selling to the domestic market, $\pi^d(z_i, 1)$ for which I normalize the domestic customer capital of the economy to one.

Firm's optimal dynamic behavior. Two main equations characterize the firms' exporter behavior. The first equation, equation (24), pins down the optimal capital customer the firm decides to have in the next period. The second one, described in equation (25), characterized the optimal decision of firms in exporting. It denotes the minimum level of productivity for which the firm will be willing to export.

$$\frac{\partial wc(i_d, A)}{\partial A'} \geq \mathbb{E}_a \left\{ \Lambda \overbrace{(1 - Pr(z_i'^*))}^{\text{export prob.}} \overbrace{\mathbb{E}_{z_i} \left\{ \frac{\partial V(A', z')}{\partial A'} \, | z_i' > z_i'^* \right\}}^{\text{Expected MR conditional on exp.}} \right\} \tag{24}$$

Equation (24) holds with equality when firms decide to invest in customer capital, $i_d > 0$. In this case, firms decide to equalize the marginal cost of investment, the left-hand side of equation (24), to the expected marginal return on investment, the right-hand side of the same equation, which by the Leibniz rule, is determined by two components. The first is the expected probability that in the next period, the firm will export, where I use z'^* 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 denotes the marginal expected return of investment conditional on exporting. Both of these terms are affected by the uncertainty that firms face with respect to the realization of future shocks.

As in Melitz (2003), firms will export if productivity is higher than the productivity threshold $z^*(A, S)$. They will decide the contrary when their productivity is below that threshold. The firm productivity threshold is then characterized by the case when the firm is indifferent to export or not, given by

$$\hat{\pi}(z_i^*, A, \Theta) + \overbrace{\mathbb{E}_F\{\Lambda[V(A', z') - V((A^{min}, z')]\}}^{\text{Option value}} = w(fe + c(i_d, A)) \tag{25}$$

the marginal firm is indifferent between staying or not in the export market if the operational profits of doing so plus the optional value of not losing the customer capital she had accumulated is equal to the investment cost plus the exporting fixed cost. In a static case or in an economy where customer capital is unaffected by the exporter's decision, firms will not face any option value. The existence of the option generates that firms with higher customer capital, and consequently, that on average spend more time in the export market, will be less likely to drop their export condition, generating the well-known effects of hysteresis on international trade. The existence of the option value and hysteresis is an important margin to be present in the model, as its absence will upward bias the effects of uncertainty on total trade. This is because the option value might increase under higher uncertainty, delaying export exits as discussed in **Dixit** and Merga (2020).

6.1 Equilibrium

Let me now specify the conditions for an equilibrium for this economy. Market clearing in the labor markets implies that labor inelastically supply, L^s, equals labor demand determined by the sum of labor used for production, investment, and fixed costs,

$$\int l(z, A) d\Psi(z, A) = L^s \quad , \tag{26}$$

total output for the economy is equal to the labor income plus firm profits,

$$Y = wL^s + \int (\pi^d(z_i, 1) + m(\pi(z_i, A_i) - wf_e)) d\Psi(z, A) \quad , \tag{27}$$

and total exports are given by

$$Exp = \int p^*(z, A) q^*(z, A) d\Psi(z, A) \quad , \tag{28}$$

because of the zero net supply of the bond market, trade is balanced, implying that nominal exports and imports are equal, $Exp = Imp$. The demand for the domestic bundle used to produce the final consumption good is given by,

$$D = Imp \left(\frac{\nu}{1-\nu}\right)^{-\gamma} \left(P^d\right)^{-\gamma}$$

where I use that nominal imports, Imp, are equal to the imported quantities, M, since $P^m = 1$. The price of the domestic bundle is given by $P^d = \int \frac{q(z,1)}{D} p(z) d\Psi(z, A)$, and the price of the consumption is given by P^C characterized by the usual price index for CES. The supply for the domestic bundle, D is given by the following condition,

$$\int \Upsilon\left(\frac{q(z,1)}{D}\right) d\Psi(z, A) = 1 \tag{29}$$

characterizing the equilibrium domestic choke price, p^c defined in equation (16). The evolution of the firm productivity and customer capital joint distribution, $\Psi(z, A)$, is given by,

$$H(z_t, A_t; S) = \int f(z_t, z_{t-1}) \phi(A_t, A_{t-1}, z_{t-1}; S) d\Psi(z_{t-1}, A_{t-1}) \tag{30}$$

where $H(.)$ is the transition function for the measure of firms, $\Psi_t = H(St-1)$. Where $f(z_t, z_{t-1})\phi(A_t, A_{t-1}, z_{t-1}; S)$ denotes the measure of firms that will transition from (A_{t-1}, z_{t-1}) to (A_t, z_t), when the aggregate state is given by S_t.

Given the initial measure Φ_0; an equilibrium consists of policy and value functions of intermediate goods firms $\{V(z_t, A_t, S_t), A'((z_t, A_t, S_t), q^s(z_t, S_t), q^{*s}(z_t, A_t, S_t), m(z_t, A_t, S_t)\}$; of consumers $\{V^C(b, S_t)b'(b_t, S_t), c(b_t, S_t)\}$; of final good producers $\{M(S_t), D(S_t)\}$; of domestic bundle producers $\{D(S_t), q^d(S_t)\}$; the price of the export and domestically sold intermediate goods $\{p^s(z, S_t), p^{*s}(z, S_t)\}$; the domestic choke price $\{p^c(S_t)\}$; the price of labor units $\{W(S_t)\}$; the price of the bonds $\{r(S_t)\}$; the price of the consumption good and the domestic bundle, $\{P^c(S_t), P^D(S_t)\}$; and the evolution of the aggregate states Ψ_t governed by the function $H(S_t)$, such that for all time (1) the policy and value function of intermediate good firms satisfy their optimal conditions, (2) domestic consumer decisions are optimal, (3), the final consumption producer and the domestic bundle producer decisions are optimal, (4) the bond market clears and trade is balanced, (5) labor markets clear, (6) the evolution of the measure of firms is consistent with the policy functions of the firms and consumers, and with their shocks.

7 Quantitative Analysis

The objective of the quantitative exercise is to test the models' ability to predict the relationship between total exports, a country's microeconomic volatility, and its GDP per capita. For this, I begin with a discussion of the model's parameterization and describe how I choose parameters using a moment-matching exercise. Since the model is highly nonlinear, I solved the model using global methods.

I then explore the models' implications, starting at the firm level. I begin with an analysis of the relevance of the assumption over variable elasticity of substitution to shape the revenue and the firms' value function in terms of productivity. After this, I study the models' prediction in terms of exporters' dynamics under different levels of micro volatility. I illustrate the different predictions of a model with and without variable price elasticity.

Finally, I test the model predictions for the aggregate variables of interest. I begin by analyzing the four possible model predictions between total aggregate exports and labor productivity relative to the one observed in the data. Then, I analyze the models' predictions in terms of GDP per capita and total exports, decomposing it between the extensive and intensive margin of the economy.

7.1 Model Calibration

I will proceed now to explain the rationale between the moments to match and the parameters. Because the model is highly nonlinear, all parameters affect all the moments, and all are set to match the moments together. Nevertheless, some parameters are more important for certain statistics, as they have a clear empirical moment counterpart based on the model's prediction. There are a set of parameters externally calibrated. These parameters are the consumer's discount rate, β, and the Armington elasticity, γ, set to 0.98, 1.4, and respectively. The home bias, ν is set to match Colombia's trade openness of 0.37. The consumer's utility function is assumed to be given by

$$u(c) = log(c),$$

the firms' productivity follows an AR(1) process,

$$\ln z_{i,t} = \mu + \rho \ln z_{i,t-1} + \epsilon_{i,t}$$

where $\epsilon_{i,t}$ is assume to be normally distributed, with standard deviation σ_z. I assume that $\mu = -\frac{\sigma}{2}$, and $\rho = \hat{\rho}\chi$. These adjustments obey two reasons. The first is to avoid changes in the volatility of the shocks to impact the average productivity, and the second is to avoid the unconditional distribution of productivity to change with $sigma$.

Both ρ and σ are set to match the estimates of the AR(1) process estimated for the domestic sales in Colombia.

The rest of the parameters governing the firms' decisions are set to match the exporter data from Colombia. The parameters τ, and A^{min}, are set to match the average and new exporters' export intensity, while f^e is set to match the share of exporters over the total active firms. The parameters determining the export intensity dynamics, $\{\alpha, \iota, \phi, \delta\}$, are set to match the evolution of the exporter from their first to the fifth year.

Finally, the parameters governing the price elasticity, θ and η, are set to match the lie within the markup range estimated for Colombia, and the empirical results are presented in Table 2. I match these estimates by performing the same exercise in the model as in the data, with two exceptions. First, in the model, I can directly observe the markups. So, in the model, I run the same estimates as in the data but use markups as dependent variables instead of prices. This also prevents me from using the already fixed effects in the empirical section because of the reason mentioned at the time. Second, I use a reduction in wages, similar to the average observed change in the exchange rate in the data, as the change in the marginal cost of production. Lastly, remember that because I am assuming that the domestic economy is a small open economy, p^{c*}, the international choke price, is assumed to be given by a parameter consistent with the foreign demand and the estimated parameters for the price elasticity.[17]

All the values of the parameters for each of the possible models are presented in Table 3, while the target moments and the model predictions are presented in Table 4. Except from the exporters' growth model, the data and model predictions are presented in Panel (a) of Figure 3. Panel (b) of Figure 3 shows the new exporters' dynamic for relative prices. As expected, both models predict non-differential changes in prices over the exporter's life cycle.

7.2 Model Implications

Once the model is calibrated, I proceed to test the models' ability to generate the empirical relations documented in the data section. To achieve this, I simulate four models with or without exporter dynamics and with or without variable markups. For each model, I simulate different economies that vary only in their macro or micro volatility.

New exporter growth: Model vs data. I now test the model's ability to replicate the firm-level fact 2, in which those exporters more to domestic volatility grow less. To do this, I compare the log differences of the growth rate in the export intensity against the model predictions. To follow the model experiment as close as possible to the one in the data, I proceed as follow. I compare the prediction of the benchmark model to a case in which

[17] In this case, p^{c*} is assumed to be the choke price that generates the given foreign demand function, assuming that the foreign economy has the same firm distribution and the same price elasticity parameters, θ and η, than the domestic economy.

the domestic volatility decreases a 10%. To do this I adjust the idiosyncratic volatility that firms face to match a 10% reduction in the domestic volatility, measured as the average cross-section standard deviation in the log change in the sales of domestic volatility. Then I compute the changes in the export intensity for those exporters that in the model export continuously over 5 years, as I did in the data.

Figure 4 presents the results. The benchmark model can properly predict the qualitative relation regarding the higher domestic volatility and the differential growth of the new exporter. Quantitatively, the model predicts a higher difference relative to the data during the first years of the exporters' lives. These results are successful if we compare them to models without the variable price elasticity. As explained in section 1, these other models will predict a null or contrary relationship to the one in the data as shown in previous sections.

Cross-country predictions: Model vs data. Now, I analyze the models' prediction regarding total exports. To do this, change σ^z, adjusting the mean and ρ as described before to maintain the unconditional distribution invariant. I solve for the steady state of the economy for each σ. By doing this, I allow both changes in the uncertainty firms face and changes in the actual conditional distribution of shocks without affecting the unconditional mean and variance of the productivity distribution.

To understand the relevance of volatility and of the proposed mechanism, I simulate two dynamics models, one with variable markup and another without variable markups.[18]

The consequences of microeconomic volatility. Figure 5 shows the results of this quantitative exercise for the two different models. In this case, model predictions are more striking. The dynamic model with variable markups is consistent with both the relationship between total exports and volatility and the relationship between GDP per capita and total exports. In contrast, the dynamic model with constant price elasticity predicts the opposite relationship in both cases. The quantitative results are also striking. The variable markup model predicts an elasticity between the volatility of changes in labor productivity and total

[18]Each model is calibrated to match the same moments when corresponding. Those models with variable markups are estimated to match the markup responses. The model with constant markup elasticity is set to match the exporters' growth, and I allow a small $\eta > 0$.

exports of around -0.6. This result implies that if we could eliminate the differences in microeconomic volatility between developed and developing, exports would grow around 40% in developing economies. Even more surprising are the results presented in panel (b). The changes in micro volatility can generate a relationship between GDP per capita and total exports consistent with the cross-country relationship observed in the data, explaining the puzzling behavior in export costs documented by Waugh (2010) and de Sousa et al. (2012).

8 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 to 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 recent 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 describe how firms respond to all the risks arising from 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 the role of 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. These findings also point toward the need to rethink the sources of gains from trade.

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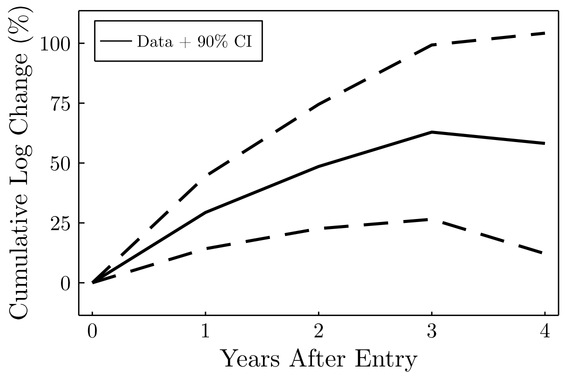
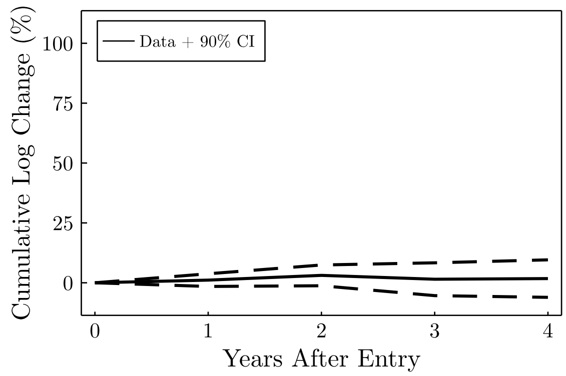
Figures and Tables



(a) Quantity Dynamics



(b) Price Dynamics

Figure 1: New Exporter Dynamics

Note: Panel (a) shows the estimated log cumulative change in quantities relative to firms' first year of export to the market. Panel (b) shows the same but for price changes. A market is a six-digit product-destination combination. Both estimates include firm-product-time, product-destination-time, and cohort fixed effects. Firms in the sample are exporters that continuously export to each market, and a new exporter is a firm that exports at a time t, after three years of not exporting to the market. Standard errors in brackets. Error cluster at the firm level.

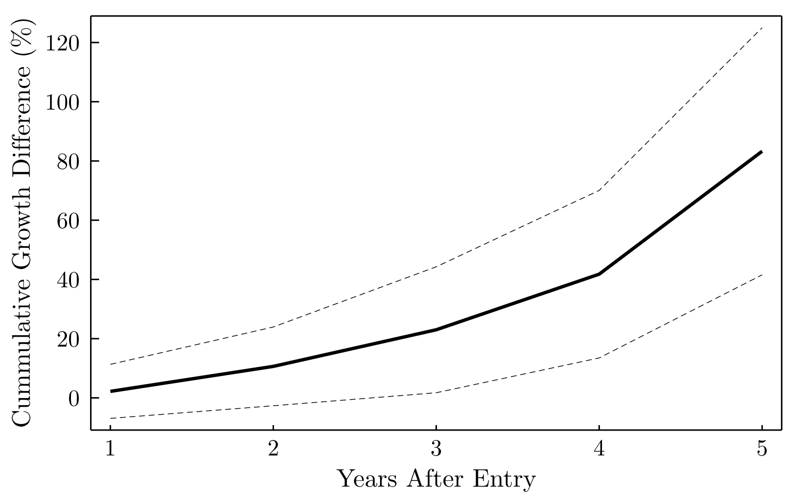
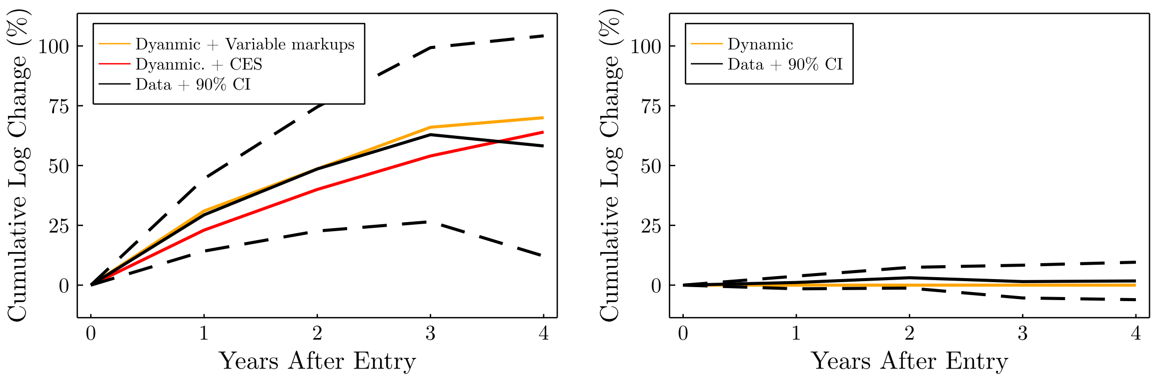


Figure 2: New Exporter Growth and Volatility

Note: Figure shows the cumulative growth difference in export intensities to each market for a firm exposed to the mean minus a standard deviation level relative to one exposed to the mean. A market is a product-destination combination. Estimates include product-time, destination-time, and firm-time fixed effects. Firms in the sample are exporters that continuously export to each market for five years or more. A new exporter is a firm that exports at a time t after three years of not exporting to the market. Dotted lines denote a 90% confidence interval. Error cluster at the firm level.



(a) Quantity dynamics

(b) Price Dynamics

Figure 3: New Exporter Dynamics: Model

Note: The data results are the ones presented in figure 1. In panel (a): the yellow line shows the dynamic model with variable markups, and the red line shows the model with constant markups. Panel (b): the yellow lines show the price evolution over the exporters' life cycle for both models with and without variable markups.
Error cluster at firm level.

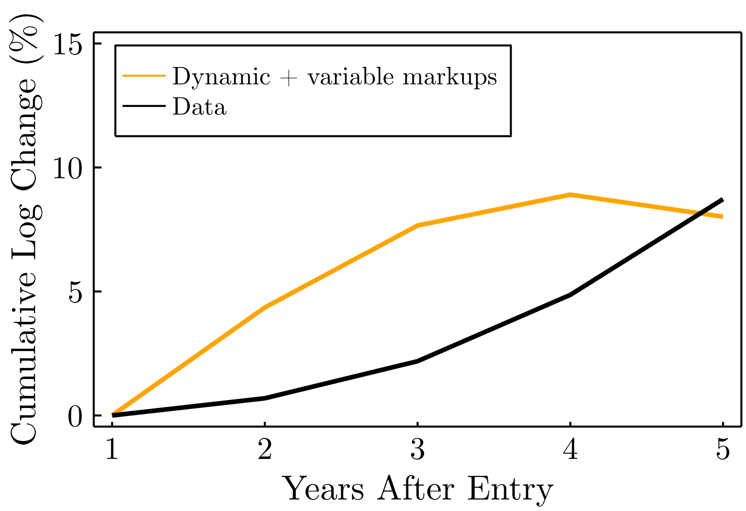
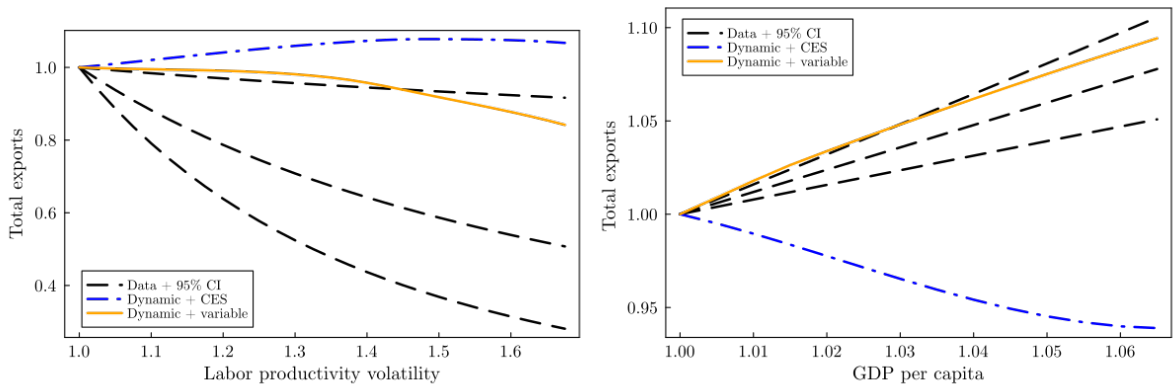


Figure 4: New Exporter Growth and Volatility: Model vs Data

Note: The data results replicates the one figure 2, but comparing a firm with a 10% smaller domestic volatility relative to the mean level. The yellow line shows the cumulative difference in export intensity predicted by the model when the volatility changes generate a 10% smaller domestic sales volatility relative to the benchmark case.



(a) Exports and micro volatility

(b) Exports and GDP per capita

Figure 5: Exports, volatility and GDP per capita

Note: The data results are based on Table 1. Micro volatility refers to the standard deviation of firms' changes in labor productivity.

Table 1: Volatility and Exports Around the World

Panel 1: Macro-Economic Volatility and Average Exports

	Av. Exports	Av. Exports	Av. Exports	Av. Exports
$\ln(\frac{GDP}{L})$	0.50**	0.30	0.40*	0.19
	[0.19]	[0.18]	[0.20]	[0.20]
$\ln(\text{Macro-Volatility}_i)$		-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 × Destination × Product FE	✓	✓	✓	✓
Gravity Controls	✓	✓	✓	✓
Doing Business	Exp.	Exp.	Exp/Cred/Cont	Exp/Cred/Cont

Panel 2: Micro-Economic Volatility and Average Exports

	Av. Exports	Av. Exports	Av. Exports	Av. Exports
$\ln(\frac{GDP}{L})$	1.19***	0.89***	0.63***	0.43**
	[0.21]	[0.20]	[0.17]	[0.20]
$\ln(\text{Micro-Volatility}_i)$		-1.53**		-1.45**
		[0.63]		[0.66]
First-stage Observations	39,439	39,439	39,439	39,439
Numb. Countries	38	38	38	38
R^2	0.76	0.85	0.84	0.86
Year × Destination × Product FE	✓	✓	✓	✓
Gravity Controls	Only Size	Only Size	✓	✓
Doing Business	-	-	Exp/Cred/Cont	Exp/Cred/Cont

Note: Av. Exports denote the estimated value for α_i from equation (6). Trade flows are yearly at frequency. First Stage-Observation denotes the amount of observations used to estimate equation (6). The number of countries equals the observations for the second stage. Doing business denotes controls for declared export cost (Exp.), contract enforceability index, and financial development index (Cred/Cont). Standard errors in brackets are clustered at the origin country level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 2: Heterogeneous markup responses

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	✓	✓	✓
F- Statistic:	-	69.07	69.37
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)
	$\Delta \log p_{i,l,d,t}$	$\Delta \log p_{i,l,d,t}$	$\Delta \log p_{i,l,d,t}$
Δexchange rate$_{d,t}$ $\times$ $share_{i,l,d,t-1}$	0.15***	0.71**	1.20***
	[0.05]	[0.33]	[0.36]

Panel 3: Second Stage (Quantities)

	(OLS)	(IV)	(IV)
	$\Delta \log q_{i,l,d,t}$	$\Delta \log q_{i,l,d,t}$	$\Delta \log q_{i,l,d,t}$
Δexchange rate$_{d,t}$ $\times$ $share_{i,l,d,t-1}$	-0.04	-2.51***	-2.96***
	[0.19]	[0.72]	[0.81]

Note: Panel (1) shows the first stage results. Panel (2) shows the results using the log difference of unit values over a year. Panel (3) shows the estimated results for quantities exported. Exporter age denotes the minimum age of an exporter in the sample. Controls $\times$ $share_{i,l,d,07}$ denotes the addition of controls by intersecting of firms' sales share to that market intersected with the destination market terms of trade and real GDP. Standard errors in brackets.
Error cluster at the destination country. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Calibrated Parameters

Parameters	Value	Rationale
β	0.96	Yearly frequency
γ	1.3	Armington elasticity
	Parameters to estimate within model	
θ	2.90	Average markups
η	5.60	Super elasticity
σ^{ω}	0.48	Firms' labor productivity s.d.
ρ^{ω}	0.61	Firms' labor productivity persistence
ν	0.67	Home bias
f_e	0.08	Exporter fixed costs
α	0.7	Customer capital to demand elasticity
ϕ	3.72	Investment Adjustment Cost
δ	0.25	Depreciation of customer capital
A^{min}	0.01	Initial value of customer capital
τ	0.44	Iceberg cost

Table 4: Target Moments

Moment	Data	Model
Average markup	0.45	0.48
Markup sensitivity estimates	0.71	0.69
Share of exporters	0.19	0.19
Trade openness	0.37	0.37
Weighted average export intensity new exporters	0.39	0.40
Weighted average intensity	0.45	0.51
Sd of shocks to firm's domestic sales	0.36	0.30
Persistence of shocks to firm's domestic sale	0.47	0.46
Av. growth 2nd year	0.13	0.24
Av. growth 3rd year	0.31	0.39
Av. growth 4th year	0.40	0.50
Av. growth 5th year	0.47	0.57
Av. growth 6th year	0.55	0.6

Appendix

A Appendix: Cross country Data and Estimation Robustness

A.1 Cross country Data

Penn World Tables. This data cover 183 countries between 1950 and 2019. I use this data for the country's total factor productivity and other aggregate variables such as GDP, and export and import prices. [19]

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

CEPII. I use two datasets from the CEPII foundation, the "Gravity" data set and the "TradeProd" data set. [20] The first data provides information on variables relevant to explain bilateral trade across countries, such as the existence of trade agreements, geographical characteristics, variables measuring cultural proximity, and the existence of a common currency. The data set covers the years 1948 to 2019.

The "TradeProd" data set provides information on bilateral trade, production, and protection in compatible industry classifications for developed and developing countries. This data runs from 1980 to 2006 for 26 industrial sectors within manufacturing—this data set yields bilateral product level exports across countries. The advantage of this data source over the Dynamic exporter database is the extended period and the number of countries. The disadvantage is the lack of data on the margins of trade for different exporters. The data

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

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

on manufacturers serves as a robustness check to show that the results are not driven by differences in sectoral composition across development levels.

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

A.2 Relationship Between GDP per Capita and Volatility.

Figure A.1 shows a negative relationship between the average level of GDP per Capita (Y-axis) and each measure of volatility (X-axis). Each variable is presented in logs, and the standard deviations for each measure are in percentage points. When I compare the average level of microeconomic volatility, I find that developing countries are 59% more volatile than developed countries for the sub-sample of countries I have data. When I focus on the macroeconomic volatility, developing countries are on average 74% more volatile than developed ones. [21]

A.3 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 by$\text{Macro-Vol.}_i^{\text{Ch}}$), and using the cyclical component of the real GDP (denoted by $\text{Macro-Vol.}_i^{\text{GDP}}$). 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

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

components, to the extent the foreign demand volatility may discourage exports and that is also making some countries more volatile domestically, this may generate similar predictions 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 a year fixed effect using the residuals of this estimation to construct the volatility of each country. I find that results hold regardless of any of these approaches. The results using this measure of volatility that I denote as $\text{Macro-Vol.}_i^{\text{No-global}}$ 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 that generates countries to be more volatile. Particularly, as countries face higher trade costs, they could be less able to smooth the domestic shocks through international borrowing and lending. This lack of ability to smooth the shocks may increase the level of estimated volatility of a country. Razin et al. (1992) did not document this to be the case after observing the volatility of countries after they went from trade or capital account liberalizations. nonetheless, 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 to the observed levels of trade openness observed after 1980. Proceeding this way allows me to use a volatility measure that is potentially unrelated to the shocks happening to the country that may have affected its level of volatility due to its inability to smooth the domestic shocks. 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's 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 products are particularly difficult to export, but that also its production is more volatile. To test for this possibility, I focus only on the manufacturing sector, and I proceed in the same way as described before.

Results hold when doing these exercises. I also run the benchmark estimates but now controlled by the share over total exports of the manufacturer, the agricultural, and the mining sectors; I find results robust to this addition too.

Measurement of microeconomic volatility. There are some potential concerns about 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, labor productivity may be just a reflection of the average markups of the firm. To solve this problem, I also firm labor changes to compute the domestic volatility. The results are presented in Table A.5.

A.4 Volatility and The Margins of Export

I examine how the different margins of trade react to these differences in levels of volatility.

The three margins of exports: Conceptual framework. Let N^{exp}_{cdt} be the number of exporters, z^*_{cdt} be the productivity threshold at which exports decide to exit exporting, and $x(z_{i,t})_{cd}$ be the exports of a firm with productivity $z_{i,t}$. The total exports from country c to d, $X_{c,d,t}$, can be expressed as the number of exporters available in the economy multiplied by the average export per active exporter from c to d, denoted by $\bar{x}_{ij,t}$. Assuming these variables are a function of the micro or macro volatility of the country, we can decompose the relationship between volatility and total export in three margins: (1) the extensive margin, (2) the intensive margin, and (3) the compositional margin as in,

$$
\begin{aligned}
\frac{\ln X}{\ln \sigma^x} = {} & \underbrace{\frac{\ln N^{exp}}{\ln \sigma^x}}_{\textit{Ext. margin}} \\
& + \underbrace{\frac{1}{\bar{x}}\left(\int_{z_t^*}^{\infty} \overbrace{\frac{\partial \ln x(z_f)}{\partial \ln \sigma^x}} x(z_f)dG(z_f) + \int_{z_t^*}^{\infty} \overbrace{\frac{\partial \ln g(z)}{\partial \ln \sigma^x}} x(z_f)dG(z_f)\right)}_{\textit{Int. Margin}} \\
& + \underbrace{\frac{1}{\bar{x}}\frac{\partial z^*}{\partial \ln \sigma^x}\frac{g(z^*)}{1-G(z^*)}x(z^*)}_{\textit{Comp. margin}}
\end{aligned} \tag{31}
$$

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

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

To measure the relative importance of each margin, I follow the two-step strategy described before. I changed the dependent variable to be the log number of the exporter and the average exports per incumbent exporter.

Panel 1 of Table A.4 shows the result with macroeconomic volatility measure as the independent variable. Column 1 shows the relationship between total exports without controlling for volatility. In column 2, I control for the macroeconomic volatility. Columns 3 and 4 show the relationship between the number of exporters, the extensive margin, and the average exports per incumbent, the intensive margin. I find that controlling for the macroeconomic volatility captures around 35% of the relationship between GDP per capita and average exports per destination. Columns 3 and 4 proceed to decompose the margins of trade. The results show that 85% of the relationship between exports and aggregate volatility is due to the extensive margin, 30% to the intensive margin, and -15% to the compositional margin.

Panel 2 of Table A.4 shows the result when I use the microeconomic volatility measure, with 68% of the reduction in exports due to the intensive margin, 55% is because of the extensive margin, and -23% is associated with the compositional margin. This finding suggests that volatility generates higher sorting into the export market and that the uncertainty channel is big enough to counteract the possible positive effect that higher volatility has through the distributional margin.

B Appendix: Firm-level Estimation

B.1 Volatility and Sales Dynamics Over Exporter Life Cycle

Table A.5 presents the estimation of equation (10). Column 1 to column 3 presents the results using the measure of domestic sales volatility as described in (9). Column (1) includes firm fixed effects for those exporters with 2 years or more continuously exporting to the market (product-destination), column (2) includes firm-year fixed effects, and column (3) presents the same estimation of column (2) for those exporters that exported 5 years to each market. Column (4) and (5) presents the estimation results of running the same estimation as in column (2) but using two different measures as described below.

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

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

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

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

$$\Delta exp_{i,l,d,t} = \gamma_{i,t} + \theta_{d,l,t} \tag{32}$$

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

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

C Appendix - Figures and Tables

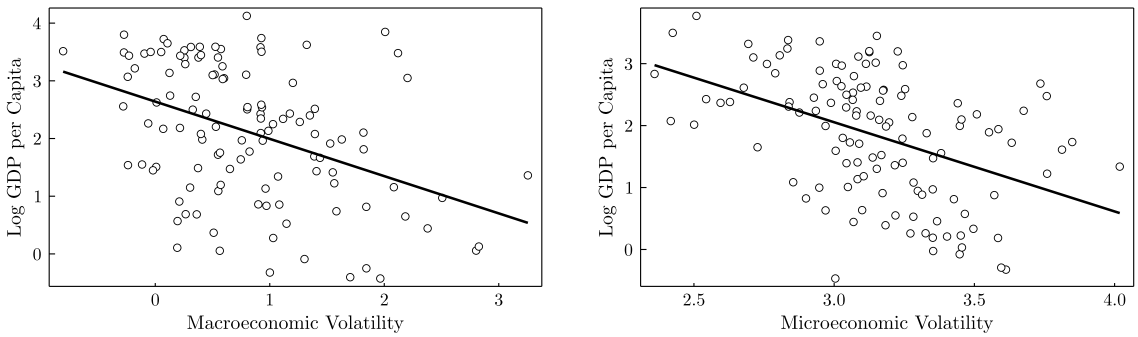


Figure A.1: Volatility and GDP per Capita

Table A.1: Robustness Measures Macroeconomic Volatility and Trade

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

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

Note: The table replicates the results of table 1 using different way of computing aggregate volatility. Standard errors in brackets. Error cluster at origin country. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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

	Av. exp.	Av. exp.	Av. exp.	Av. exp.	Av. exp.	Av. exp.
$\frac{\text{GDP}}{\text{L}}$	0.53**	-0.01	0.09	0.32	0.09	0.11
	[0.21]	[0.27]	[0.27]	[0.20]	[0.23]	[0.21]
ln Macro-Vol.$_i^{\text{Ch}}$		-1.12***				
		[0.36]				
ln Macro-Vol.$_i^{\text{No-global}}$			-1.15**			
			[0.51]			
ln Macro-Vol.$_i^{\text{pre-sample}}$				-1.11**		
				[0.45]		
ln Macro-Vol.$_i^{\text{GDP}}$					-1.05*	
					[0.55]	
ln Macro-Vol.$_i^{\text{GDP,pre-sample}}$						-1.34***
						[0.44]
Observations	138,865	138,865	138,865	138,865	138,865	138,865
R^2	0.62	0.67	0.66	0.65	0.66	0.68
Year × Destination × 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. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Note: The table replicates the results of table 1 and table A.1, conditioning the sample to exports in the manufacturing sector. Standard errors in brackets. Error cluster at origin country. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

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

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

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

Note: The table replicates the results of Panel (b) in table 1 using labor change to measure the macro-economic volatility. Standard errors in brackets. Error cluster at origin country. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.4: Margins of Trade and 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 $\times$ Destination $\times$ 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 $\times$ Destination $\times$ Product FE	✓	✓	✓	✓
Gravity Controls	✓	✓	✓	✓
Doing Business	Exp/Cred/Cont	Exp/Cred/Cont	Exp/Cred/Cont	Exp/Cred/Cont

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

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

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

Note: The table presents the estimation of equation (10). Column (1) use the benchmark measures of domestic exposure to volatility. Column (4) and Column (5) use other two measures of volatility described in B.1. Age exporting denotes the minimum years that exporters continuously export to each market in the sample. Error cluster at firm level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$