International Trade, Volatility, and Income Differences

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Abstract

This paper offers a unified explanation for two puzzles in international trade: the limited participation of developing countries in international trade and the negative correlation between firm-level sales volatility and exports. By extending the standard heterogeneous firm trade model with variable price-demand elasticity and exporter dynamics, the "Oi-Hartman-Abel" effect present in standard models reverses; profit reductions during downturns outweigh boom-time gains. This causes firms in volatile economies to be discouraged from exporting and expanding into foreign markets. Consequently, volatility reduces aggregate exports and total income, explaining nearly two-thirds of the unexplained export differences across development levels and 75% of the observed negative relationship between firm-level sales volatility and exports. *JEL* Codes: F10, F12, F14, F23, F63, O19, O24, L11

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1 Introduction

The stark disparity in living standards across the globe is mirrored in international trade patterns. Developed nations engage in more trade, with a greater number of larger and more persistent exporters (see Besedeš, 2011; Fernandes et al., 2015; Hummels et al., 2005). Existing research estimates that developing economies face higher costs when attempting to export to explain these patterns (Blum et al., 2019; de Sousa et al., 2012; Waugh, 2010). However, the underlying causes driving these higher costs remain unclear, which prevents the development of effective strategies to enable developing economies to capture the full benefits of global market access. I tackle this critical question by showing that the higher microeconomic volatility typically characterizing developing economies acts as a significant deterrent to both international trade and economic development.

I address this by proposing a unifying theory that explains income disparities and international trade patterns across countries with a focus on their microeconomic volatility differences. Supported by novel empirical evidence at both the firm and country levels, the theory bridges two standing puzzles in the literature: the observed negative correlation between firm-level sales volatility and trade participation (Alessandria et al., 2015; Alessandria et al., 2021b; Baley et al., 2020), and the unexplained low trade engagement of developing economies (Blum et al., 2019; de Sousa et al., 2012; Fernandes et al., 2015; Fieler, 2011; Waugh, 2010) revealing a previously unseen link between them. My findings reveal that higher microeconomic volatility, prevalent in developing economies, reduces exports, thus explaining their lower trade participation. Since standard models fail to account for microeconomic volatility's negative impact on total trade, they overestimate trade costs for these economies.

I show that volatility dampens exports due to two crucial factors, generally absent in standard models but present in the micro-level data: variable price elasticity of demand and dynamic export decisions. I find that when price elasticity increases with firm prices, profit reductions during downturns outweigh potential gains during upswings. This generates a negative impact of microeconomic volatility on overall trade, reversing the "Oi-

Hartman-Abel" effect present in standard models. [1] Additionally, dynamic export decisions amplify this negative relationship. High domestic volatility discourages firms from expanding abroad, hindering their growth and resilience and ultimately resulting in lower overall exports and national income.

The intuition follows from the predictions of a general equilibrium model where firms face time-varying productivity, self-select into exporting as in Melitz (2003), and invest in building customer capital abroad, as in Fitzgerald et al. (2021) and Steinberg (2021). However, unlike these previous works, I introduce variable price elasticity, akin to Klenow et al. (2016). I derive three key results from the model. First, volatility reduces exports if firms' revenue functions are concave in productivity. Second, price elasticity varying with firm productivity generates concave revenue functions in firms' productivity. Third, dynamic export decisions amplify the effect of volatility on total trade.

I use the general equilibrium model to assess the impact of the proposed mechanism quantitatively. The results strongly support the relevance of the proposed mechanism. First, the model predicts a negative correlation between firm sales volatility, GDP per capita and total trade, driven by variations in microeconomic volatility. Notably, the model suggests that low-volatility countries (at the bottom 10%) export 103% more than high-volatility ones (at the top 10%) due solely to this difference in volatility. Second, when the proposed features are absent in the model, the model predicts that trade increases with volatility and that GDP per capita falls with trade, contrary to the observed patterns in the data.

These results imply that existing trade cost estimates partially reflect the negative impact of microeconomic volatility on exports. Because many models implicitly predict a positive volatility-trade correlation, this leads to overestimating trade costs for countries with high volatility to fit observed data, such as the case for developing economies. In fact, my calculations suggest that these results can explain up to two-thirds of the variation in estimated trade cost differences across development documented by de Sousa et al. (2012).

[1] 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.

Finally, my empirical findings, both at the cross-country and firm level, support the model's predictions. At the aggregate level, three key results emerge from cross-country data: (1) developing countries exhibit higher firm sales volatility; (2) countries with higher firm sales volatility tend to export less, even after accounting for standard trade determinants; and (3) the influence of development on trade substantially diminishes after controlling for the observed firm sales volatility. The model explains roughly 75% of the observed volatility-trade link and slightly overestimates the observed income-trade correlation.

At the firm level, I focus on testing the existence of the two key proposed features and their predicted impact on exporter growth. The results also support the proposed mechanism and its predictions. First, similar to Fitzgerald et al. (2021) and Steinberg (2021), I find that shifts in exporters' demand intercept drive their growth trajectories in foreign markets. Second, I find exporters' markup response to cost shocks increases with their size consistent with the existence of variable price elasticity. Third, as predicted by the theory, the results confirm that exporters facing higher volatility experience slower growth throughout their life cycle.

In essence, this paper identifies a novel mechanism through which microeconomic volatility and uncertainty discourage firms' investment in expanding over their life-cycle. When applied to exporters, domestic volatility creates significant trade barriers that negatively correlate with income and are distinct from traditional, trade policy-driven barriers. The findings have two important policy implications. First, they challenge the traditional view that gains from international trade solely depend on trade-policy changes as they show that non-trade policies reducing microeconomic volatility can foster trade and development. Second, they highlight the challenges developing nations might encounter in reducing these non-policy trade barriers driven by volatility, as history suggests that reducing economic volatility has been particularly challenging for them.

Literature. The paper relates to several strands of literature at the intersection of macroeconomics, international trade, firm dynamics, and development, making several contributions to them.

To the best of my knowledge, this paper is the first to show that higher domestic microeconomic volatility in developing economies explains their low international trade engagement. Unlike prior studies (e.g. Blum et al., 2019; de Sousa et al., 2012; Fieler, 2011; Limão et al., 2001; Rodrik, 1998; Waugh, 2010), my model incorporates dynamic exporter behavior and variable markups - backed up but my micro-level findings- and find that micro volatility differences generate a trade income relationship consistent with the one observed in the data. Using this framework, I expose the underlying assumptions that lead standard models to neglect the dampening effect of volatility on export-oriented investments and overestimate trade costs for developing economies.

This paper also contributes to the literature on exporter and firm dynamics (Eaton et al., 2007; Fitzgerald et al., 2021; Foda et al., 2024; Kohn et al., 2016; Ruhl et al., 2017; Steinberg, 2021; Vaziri, 2021) by documenting the negative impact of domestic volatility on new exporter growth. I propose a novel theoretical framework that aligns with these findings. My framework builds upon exporter investment decisions explored in Fitzgerald et al. (2021) and Steinberg (2021) but crucially incorporates the influence of variable price elasticity of demand.

To integrate exporter dynamics and variable price elasticity, I propose a novel indirect utility function based on the work of Kimball (1995) and Klenow et al. (2016). This function nests the one in Klenow et al. (2016) and allows for tractable incorporation of endogenous demand shifters, crucial for generating new exporter dynamics. This addition allows the model to capture exporter life-cycle patterns in prices and quantities, heterogeneous markup responses to firm cost changes, and the negative relationship between exporter growth and domestic volatility. Finally, embedding this framework in a general equilibrium small open economy allows me to test the aggregate relevance of these micro-level features.

My findings also contribute to the literature on firm-level uncertainty and trade. Traditional models struggle to explain the observed negative correlation between firm uncertainty and total trade (e.g. Alessandria et al., 2015; Alessandria et al., 2021b; Baley et al., 2020; Handley et al., 2022). While recent studies address this by assuming risk-averse firms (e.g.

Esposito, 2020; Gervais, 2021; Handley et al., 2022; Limão et al., 2015), this paper offers a novel, micro-founded mechanism that solves this puzzle. Furthermore, the applicability of this mechanism extends beyond firm-level uncertainty. It can analyze the impact of trade policy uncertainty (or other macro or microeconomic uncertainties) on welfare and total trade, addressing key feature gaps in existing literature (e.g. Handley et al., 2017; Handley et al., 2022; Martin et al., 2020; Merga, 2020; Steinberg, 2019).

Lastly, and beyond its focus on trade, this paper contributes to the literature on investment under uncertainty in three ways. First, I provide both empirical and theoretical evidence for the importance of firm-level variable price elasticity. This novel mechanism sheds light on how uncertainty discourages firm investment, complementing existing frameworks that focus on investment frictions with real-option effects (e.g. Alessandria et al., 2019; Bloom, 2009; Handley et al., 2017; Novy et al., 2020; Pindyck, 1982) or default risk (e.g. Arellano et al., 2019; Merga, 2020). Second, aligned with my empirical findings, the proposed mechanism generates a negative relationship between investment intensity and firm-level uncertainty, which arises not only due to the investment extensive margin decision. Third, I examine the impact of uncertainty on a crucial investment for firm growth: demand-shifting investments, showing how higher uncertainty depresses this type of investment.[2]

Layout. The paper starts with a simplified model to highlight the mechanism intuition in Section 2. Section 3 presents data. Sections 4 and 5 document the aggregate and firm-level empirical facts, respectively. Section 6 introduces the general equilibrium model, and section 7 the quantitative predictions. Section 8 concludes.

2 The mechanism in a simple example

Before exploring the empirical results and quantitative predictions of the general equilibrium model, I start by developing a simple example model to highlight the intuition of the primary mechanism. I focus on how the assumption of variable or constant price elasticity

[2] See (Einav et al., 2021; Fitzgerald et al., 2018; Fitzgerald et al., 2021; Ruhl et al., 2017; Steinberg, 2021) for the relevance of this type of investment for firms growth.

can reshape the relationship between microeconomic volatility, total exports, and exporters' growth. For this, I start by showing how the influence of microeconomic volatility on total exports hinges on the curvature of the revenue function to firms' productivity. Then, I emphasize that allowing or not the price elasticity of demand to vary affects the curvature of revenue function to firms' productivity.

The model consists of a continuum of exporters that solves a two-period problem. Firms initiate their life with a certain amount of customer capital, denoted as A, and their export status is determined exogenously. They produce the varieties quantities, q, using a linear technology in labor l and productivity z. Firms optimize their value by allocating labor to the production of varieties and customer capital investment. The dynamic problem they face is determining how much to invest in their customer capital for the upcoming period, all before the idiosyncratic productivity shock z_i is realized and before knowing if they will export ($m = 1$) or not ($m = 0$). The productivity shocks are drawn from a continuous distribution, $F(z)$, and exhibit a standard deviation denoted as σ_z. The exporting condition, m, follows a Bernoulli distribution (with probability ι). The demand for a firm's product is given by

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

A^{α} is the part of the demand shifter 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 a price to maximize its profits, $\pi(A,z,m)$, after observing 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 the following:

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

s.t.

$$A' \geq 0$$

If firms do not export, $m = 0$, then $\hat{\pi}(z,0) = 0$. If firms decide to invest, the optimal condition for tomorrow's customer capital is given by

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

The above equation shows how the curvature of operational profits to firms' productivity plays a pivotal role in determining the microeconomic uncertainties' impact on investment choices. When profits are convex in firms' productivity, a mean-preserving spread over firms' productivity leads to higher investments in customer capital and, hence, higher exports tomorrow. In contrast, a mean-preserving spread reduces investment if profits exhibit concavity. The intuition is as follows: heightened uncertainty increases the likelihood of better and worse productivity outcomes. When profits are concave, the expected profit reductions from worse outcomes outweigh the expected profit gains from better outcomes, resulting in a lower expected return for acquiring an additional customer. Conversely, the opposite holds when profits are convex in firms' productivity.

The previous result depends on the shape of the revenue function. This follows because differences in the profit function curvature arise from variations in the curvature of the revenue function, as the production function is linear in firms' productivity. To highlight the core behavior of the mechanism and its aggregate implication, let's assume that firms' productivity follows an independently and identically distributed (iid) pattern. We can express the next period's total exports as

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

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

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

Export reaction to increased microeconomic volatility depends on the interaction of two responses. These are the dynamic and static responses, as described in the first and second terms of the right-hand side equation (3). The dynamic response captures how increased uncertainty impacts firms' investment in customer capital, which is tied to the curvature of the firm's profit function, as previously discussed. Meanwhile, the static response reflects shifts in total sales due to changes in the productivity distribution. To note this, observe that conditional on a firm's productivity, the static sales component - $p\hat{q}$ - remains the same for different distributions.

Proposition 1. *If the production function is linear in inputs and productivity, and the curvature of the revenue function is concave on firms' productivity, then a mean preserving spread over firms' productivity reduces total exports.*

Proof: *See appendix C.1*

Proposition 1 implies that inaccuracies in specifying the revenue function can significantly impact the estimation of trade determinants, particularly regarding the importance of microeconomic volatility and estimated trade costs. This is because in a scenario where the data-generating process results in revenue being concave in the firm's productivity, if we employ a model with a convex revenue function, the latter model will predict increased exports as firms' volatility rises, whereas, in the actual data-generating process, greater volatility reduces total exports. To match the data, we will estimate higher trade costs for exports to all destinations from the origin country as volatility increases to compensate for the model misspecification. Proposition 2 formalizes this statement.

Proposition 2. *Under monopolistic competition and linear production function, if the curvature of the revenue function in the model is miss-specified assuming convexity instead of* *concavity, ceteris paribus, then the model will estimate higher iceberg trade costs to export for an economy with mean preserving spread on firms' productivity.*

Proof: *See appendix C.1*

Similarly, if we overlook the dynamic nature of exporters' decisions, we will bias the estimated effects of volatility on total trade. Even if we accurately account for the curvature of the revenue function but use a static model while the data-generating process presents exporters' dynamics decision as described previously, we will obtain bias estimates as it follows from equation (3). Later, using a general equilibrium version of the model, I explore the quantitative relevance of each of these components.

Let's now explore how the assumptions over the price elasticity of demand can impact the curvature of the revenue function. I formalize this outcome in Proposition 3, showing that if the price elasticity of demand increases with firms' productivity, the revenue function can become concave on productivity.

Before showing the formal result, let's gain some economic intuition by dissecting how productivity changes translate into revenue into two primary components: a direct effect and an indirect effect. The direct effect relates to how changes in marginal costs affect prices, while the indirect effect relates to how price changes impact quantities sold. In the context of constant price elasticity and monopolistic competition, if firms' productivity increases, firms will fully transmit the cost reduction into lower prices, the direct effect. Yet, the price decline is more than offset by the increased quantities sold due to the movement along the demand curve; this is the indirect effect.[3] Consequently, revenues rise in a manner that exceeds the proportionality to firms' productivity change due to the strong response of quantities to price changes, and the full pass-through of cost changes to prices.[4]

The previous result, however, does not necessarily hold when the price elasticity of demand varies with quantities sold or firms' productivity, as this case results in a weakening of both the direct and indirect effects. In this case, as firms' productivity increases, they reduce prices less than in the previous scenarios due to markup increases that follow from a

[3] Assuming the price elasticity of demand is above 1.

[4] Assuming the price elasticity of demand is above 2.

reduction in the price elasticity the firm faces. This mitigates the price reduction, reducing the direct effect. Additionally, as firms decrease their prices, quantities become less responsive to price changes, damping the indirect effect. This mitigates the movement along the demand curve, conditionally on the same price movement. Consequently, if the price elasticity of demand is sufficiently responsive, revenues will increase with firms' productivity, albeit in a concave manner.

Proposition 3 . *Under monopolistic competition and linear production function, if the price elasticity is sensitive enough to firms' prices, then revenues can become a concave function of firms' productivity.*

Proof: *See appendix C.1*

Proposition 3 explains why the standard model with firm heterogeneity fails to generate a negative relationship between microeconomic volatility - or uncertainty- and total sales or trade. These models generally assume constant elasticity of substitution, leading to convex revenue function on firms' productivity. In the final section, I employ a general equilibrium model to quantify how assuming (CES) affects the microeconomic volatility of the total trade relationship and the estimated trade costs.

Having established the relevance of allowing for exporters' dynamic decision-making and variable price elasticity, in the next three sections, I will proceed to test the models' main predictions and the validity of the main assumptions underlying these predictions. Then, I will extend the presented model to a general equilibrium framework, calibrate it using the firm-level estimates, and use it to test the macroeconomic relevance of the proposed mechanism and estimate the macroeconomic effects of microeconomic volatility.

3 Data

In this section, I briefly discuss the data used for the cross-country and firm-level empirical analyses. To document the aggregate facts, I use several data sources: the Penn World table database, the Dynamic Exporter Database from the World Bank, the Enterprise Survey from the World Bank, and the CEPII database. Appendix A.1 contains the details of the cross-country data.

For the firm-level data and model estimation, I use two primary data sources: (1) Administrative data from Colombian customs and (2) Administrative data from "Superintendencia de Sociedades" from Colombia containing the firm's balance sheet information. 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 at the firm-product-destination level yearly to avoid the usual problems with lumpiness in international trade.

I merge the custom data with firm-level data from "Superintendencia de Sociedades", which reports the variables firms declare in their balance sheet information. This dataset provides information on firms' total income, operational income, operational cost, total costs, profits, and operational profits. These variables are in nominal Colombian Pesos, which I deflate with the production price index when needed. The data sets cover a subsample of 20,000 firms a year. These firms are the most prominent, 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. However, since the paper focuses 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.

4 Cross-country evidence

In this section, I document three facts at the cross-country level on the relationship between firm sales volatility, total trade, and development. The first fact shows that there exists a positive relationship between aggregate exports and level of development (consistently with findings of Blum et al., 2019; de Sousa et al., 2012; Fernandes et al., 2015; Fieler, 2011; Waugh, 2010). The second fact shows that, conditional on a country's firm's sales volatility, the relationship between aggregate exports and GDP per capita reduces substantially. The third fact shows a negative relationship between firm sales volatility and total exports, even after conditioning on countries' level of development. These three results suggest that, on average, higher volatility in firms' sales is negatively associated with export performance and that GDP per capita is negatively associated with this volatility, as shown in Figure 1. Importantly, these empirical relationships are consistent with the predictions of the simplified model with variable price-demand elasticity, as it predicts that as microeconomic volatility increases, total trade and GDP per capita reduce.

Firm-level sales volatility measurement. I use enterprise survey data from the World Bank to compute the cross-country measure of microeconomic volatility. Ideally, I should use pure firms' productivity shocks to pin down the microeconomic volatility measure. However, given the data limitations, this is not plausible. Hence, I focus on changes in domestic sales, and I will treat the model consistently with this empirical exercise, looking at the same statistics. To rely on a measure that completely purged out the common effects on firms due to aggregate or sectoral changes, I compute the firm-level shocks by incorporating country-industry-year fixed (as in Di Giovanni et al., 2020; Yeh, 2021). For this, I estimate:

$$\Delta\text{Domestic Sales}_{i,j(i),c,t} = \gamma_{j(i),c,t} + e_{i,j(i),c,t}$$

where $\Delta\text{Domestic Sales}_{i,j(i),c,t}$ is the percentage change in domestic sales of firm i, belonging to main industry, $j(i)$, in-country origin c, during year t. $\gamma_{j(i),c,t}$ denotes country-industry-year fixed effects so that $e_{i,c,t}$ can be interpreted as pure firm-level shocks to domestic sales. Because, as suggested by Vannoorenberghe (2012), these changes can be related to foreign demand or supply shocks, I restrict the sample to those firms that do not declare any direct or indirect export or import in the database. Once I have computed the firm-level shock, I compute the country's volatility of sales shocks as the average observed standard deviation across time for each country i of the pure firm-level shocks to domestic sales:

$$\sigma_c := \sum_{t=1}^{T} \frac{\sqrt{\sum_{i \in N_{c,t}} \frac{\left(\hat{e}_{i,c,t}\right)^2}{|N_{i,t}|-1}}}{T} \tag{4}$$

where $|N_{i,t}|$ represents the total number of firms in the country c.[5]

Exports, volatility, and income differences: Estimation. To empirically understand the relevance of micro volatility on international trade, I estimate a gravity equation expanded with this measure. I decompose the logarithm of the country c's exports to destination country d (denoted by $\ln(x_{cdt})$) in origin and a destination-time fixed effect (denoted by α_c, γ_{dt} respectively), and a vector of bilateral variables ($\boldsymbol{y}_{cdt}$), and variables for the domestic economy that varies over time ($\boldsymbol{h}_{ct}$),

$$\ln(x_{cdt}) = \alpha_c + \gamma_{dt} + \boldsymbol{\beta} \boldsymbol{y}_{cdt} + \boldsymbol{\beta}_2 \boldsymbol{h}_{ct} + \varepsilon_{cdt} \tag{5}$$

As in Head et al. (2014) and Eaton et al. (2002), I proceed in a two-step procedure to understand the variables that relate to the origin component of a country, α_c. Once I have estimated the vector $\hat{\alpha}_c$, I project it against a set of variables to understand how they relate to different country characteristics, as indicated below:

$$\hat{\alpha}_c = \beta_0^{\alpha} + \beta_1^{\theta} \ln \sigma_c + \beta_2^{\alpha} \ln \frac{GDP_c}{L_c} + \boldsymbol{\theta}_3 \bar{\boldsymbol{y}}_{cj} + \boldsymbol{\theta}_4 \bar{\boldsymbol{h}}_c + \boldsymbol{\theta}_5 \bar{\boldsymbol{Q}}_c + e_c \tag{6}$$

the two coefficients of interest are β_1^{α} and β_2^{α}. The former captures the relationship between the average exports of a country and its firm sales volatility, σ_c, and the latter captures the relationship between the average exports and the average level of GDP per capita of the country, $\frac{GDP_c}{L_c}$. I control for countries' institutions' quality, their level of financial development, and direct measures of exporting costs represented in the vector $\bar{\boldsymbol{Q}}_c$, using three indexes developed by the World Bank: the contract enforcement, the financial devel-

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

opment of the country, and the declared export costs that exporters face.[6] As suggested in Head et al. (2014), I control for the average of bilateral-time variables denoted by $\bar{y}_{cj}$, origin countries' time variables, $\bar{h}_c$, standard gravity equation, and countries' terms of trade (TOT) volatility (measured as the time-invariant standard deviation of it changes).

Aggregate Fact 1: Exports increase with GDP per capita. Table 1 presents the results for several estimations: the case without controlling by countries' volatility measures and when we control by its volatility. Columns (1), (2), and (4) show the estimates for equation (6) without controlling for the volatility measure. Column (1) shows the result when only controlling by country size. Column (2) includes all the gravity controls and the declared export costs. Column (4) adds the institutional variable for contract enforceability and the financial development index. Both results show significant and relevant relations between the level of development and the average export to each market, even after controlling for country size - measured by country population- and the country's institutional quality (column 4).

Aggregate Fact 2: Conditional on firm-level sales volatility, exports relationship with GDP per capita drops. Columns (3) and (5) of Table 1 are homologous to columns (2) and column (4), but adding the variable of interest, the firms' sales volatility measures. The estimated relationship between exports and the level of GDP per capita drops between 20% to 30% after controlling for the level of firms' sales volatility, suggesting that firms' sales volatility drives part of the positive relationship between average exports and GDP per capita.

Aggregate Fact 3: Exports decrease with firm-level sales volatility. Columns (3) and (5) of Table 1 show the existence of a negative relationship between average exports and countries' firm sales volatility. The estimates suggest that a country with a standard deviation higher level of firm sales volatility relative to the mean will export, on average, between 30% to 34% less. Or that moving from the first quartile to the top quartile of the

[6]The inclusion of these three indexes follows as they are likely to be correlated with the level of development and firm-level volatility of a country and have been found to be relevant for international trade Manova (2008), Manova (2013), Kohn et al. (2020), and Blum et al. (2019).

cross-sectional distribution of firms' sales volatility is associated with a decrease in total exports between 70% to 73%, conditional on the usual trade determinants.

Given the novelty of the aggregate fact 2 and 3, I perform several robustness checks for these results in appendix A.2. The results are robust when using different measures of microeconomic volatility, adding more controls, or changing the time frame.

These empirical findings are consistent with the previously discussed model, as discussed in Propositions 1 to 3. As we saw previously, in a standard model with form heterogeneity, if price elasticity is responsive enough and exporters grow slowly over their life cycle, higher volatility can decrease exports and total GDP per capita. Additionally, the aggregate results provide a new explanation of why estimated export costs are associated with variations in the level of development even after controlling for the standard determinants of international trade, as the standard benchmarks do not consider cross-country differences in firm sales volatility.

Nonetheless, these documented aggregate relationships are not necessarily causal. The cross-country nature of the exercise is prompt to suffer for a potential omitted-variable bias. This is why, in the following sections, I will proceed in the following way. First, I will focus on micro-level data from Colombia to test the empirical validity of the firm-level assumptions behind Propositions 1 to 3 and their firm-level predictions already discussed in section 2. Second, using my micro-level estimates, I will estimate a general equilibrium small open economy with heterogeneous firms and new exporters' dynamics to use it as a laboratory to estimate the effects of higher microeconomic volatility on total exports and GDP per capita.

5 Firm-level facts: Variable price elasticity and exporters dynamics

Having established the aggregate relevance of microeconomic volatility and that cross-country relationships are consistent with the predictions of a model with variable price-demand elasticity, I proceed to test the model's main assumptions. I present three facts supporting the assumptions and predictions of the simplified model described in section 2. First, I focus on how exporters adjust their prices to changes in their marginal cost of production; I document evidence supporting that firms' markups vary with firms' relative productivity, implying the existence of variable price-demand elasticity, and according to Proposition 3, the plausible existence of concave revenue functions.

Second, I test the first assumptions regarding exporters' growth and its implications. When exporters grow by expanding the intercept of their demand and their revenue is concave on firms' productivity, microeconomic volatility should discourage new exporter expansion according to the previously presented model. Empirically, I find this to be the case. Hence, allowing for the new exporters' dynamic margin might be of quantitative importance in measuring the effects of microeconomic volatility on total trade in the model.

5.1 Markups response vary with firms size

Estimating the markup elasticity in the data. The objective is to test whether relatively more productive firms respond by changing markups more to changes in their marginal cost, as this result translates into the existence of variable price-demand elasticity.

Firm i markup when selling product l to destination market d, $\mu_{i,d,l,t}$, are defined as the ratio between the product's price, p, and the product's marginal cost of being sold to the destination market ($Mc_{i,d,l,t}$). Assuming that firms' prices are set ultimately in the currency of the destination market, prices are given by the following equation:

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

where $\frac{Mc_{i,d,l,t}}{e_{d,t}}$ denotes the marginal cost of production in foreign currency, as $e_{d,t}$ is the bilateral exchange rate.

Two consequences follow from this definition if markups are constant, $\mu_{i,d,l,t} = \mu$. First, the exchange rate pass-through to prices should equal minus one. Second, exchange rate pass-through should not vary across destinations for a given firm, conditional on the same exchange rate movements. I find these implications to be rejected by the data.

To test if firms respond more by changing markups to changes in their marginal cost when they are more productive, I use firms' market share in the destination market as a proxy for the ratio of the exporters' relative productivity in that market. And, I follow Arkolakis et al. (2017) and use real exchange rate changes as changes in the marginal cost across for selling abroad. These decisions are based on the data constraints.

To avoid obtaining biased estimates of markup responses to shocks due to changes in the exchange rate depending on firms' relative productivity on destination markets, we need to control for the effects that exchange rate movements have on firms' cost of production.[7] 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 destinations, denoted as $Mc^{a}_{i,l,t}$, and (2) the cost of selling the product to a destination d, denoted by $Mc^{b}_{l,d,t}$; then we can control for the changes in the marginal cost of selling the product to destination d, by exploiting variation across destinations within firm-product-time and product-time-destination. This implies that we can recover the markup changes by observing the price responses to changes in cost, as shown in the following equation:

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

Suppose the markup responses vary across destinations within the exporter, depending on the exporter's relative productivity in that market. In that case, we can use exchange rate shocks interacting with the exporter's market share to recover the differential reaction

[7]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.

of firms' markup to changes in their marginal cost, dependent on their relative size. To test if markup changes vary with exporters' market share, we can then estimate

$$\Delta p_{i,d,l,t} = \beta_1 \Delta e_{i,d,l,t} \times \text{exp. share}_{i,d,l,t-1} + \boldsymbol{\beta} \text{exp. share}_{i,d,l,t-1} \times \boldsymbol{X} + \theta_{i,l,t} + \gamma^2_{i,l,d} + \gamma^3_{l,d,t} + e_{i,d,l,t} \tag{7}$$

where Δ denotes log differences of the variables over a year, and $\boldsymbol{X}$ represents a matrix with unit vectors, log changes in destination import prices, log changes of Colombian aggregate export prices, and log changes in destination real GDP. $\theta_{i,l,t}$ denotes the firm-product-time fixed effects, $\gamma^2_{i,l,d}$ firm-product-destination fixed effects, and $\gamma^3_{l,d,t}$ denotes the product-destination-time fixed effects. Under the previously mentioned assumptions, β_1 captures the differential markup responses to movements in the exchange rate due to firms' differences in their market share. Note that while this estimation procedure captures the markup responses to shocks depending on exporters' relative size with minimum assumption over the production function, it cannot be used to estimate the level of markups.

Lastly, a concern of directly estimating equation (7) is that exchange rate variation might reflect changes in the destination country, which can bias the estimate. I use an instrumental variable approach to solve this concern. In particular, 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. I relegate the detailed presentation and discussion on the instrumental variable approach and its implementation to the appendix B.1.

Firm-level fact 1: Markup response increases with firm's 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 80 for the case without control by destination changes in GDP (column 2) and around 101 when this control is added (column 4), showing the strong relevance of instruments. Second, as expected, when we compare the OLS results (columns 1 and 2) with the IV ones (columns 2 or 4), we find that the concern about the possible estimation bias triggered by shocks in the destination economy was valid; nonetheless, all estimates are positive. The results show that the markup response to shocks to firms' marginal cost is increasing in the exporter's market share. Particularly, a firm with a one percentage point higher market share will optimally decide to do an exchange rate pass-through between 0.82% and 0.65% lower, as shown by columns (2) and (4) of Panel 2, respectively.

As a validation exercise, panel 3 presents a similar estimate but considers quantities as the dependent variable. The estimation results provide insights into the soundness of the instrument. While the OLS estimates -columns 1 and 3- predict a quantity change inconsistent with predicted price changes in panel 2, the IV results -columns 2 and 4- show results consistent with the predicted price changes in panel 1. After using the IV, not only do quantities respond relatively less, as firms that have higher market share reduce prices less, but the results are also consistent with price elasticity being higher than 1, as we would expect. A back-of-the-envelope calculation shows that estimates suggest an average demand price elasticity of around 3.96 (column 2) and 3.5 (column 4).

Appendix B.1 discusses the IV strategy in more detail and presents several robustness results as shown in Table A.4. The results are robust to dropping the firm-destination-product fixed effects, conditioning only to exporters that continue exporting the following year, and repeating the analyses conditional on years after 2012.

5.2 Exporters' growth and domestic volatility

I now turn to test the models' assumption regarding new exporters' dynamics and its implication over new exporter growth under uncertainty highlighted in section 2.

To identify the evolution of customer capital, which is unobserved in the data, I focus on the evolution of export intensity over exporters' life cycles. To understand this, note that according to the model presented in section 2, exporters' growth over their life cycle in a particular market can be decomposed by two components: (1) the growth driving the demand shifter - the customer capital accumulation, A-, and (2) by the differential evolution of prices across markets.[8] This result follows from the following equation:

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

and consequently, the log difference over time is given by:

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

Now, suppose that price dynamics do not evolve differently over exporters' life cycles in each market, as will be the case in the coming results and as was found for other countries (Fitzgerald et al., 2021; Steinberg, 2021). In that case, common shocks to the firm will affect similarly the static component across markets -$\hat{q}(.)$-, and hence $\Delta \frac{\hat{q}(p_{i,l,d,t})}{\hat{q}(p_{i,l,\text{dom},t})} \approx 0$. Therefore, $\Delta \exp \text{int}_{i,l,d,t}$ captures the evolution of the unobservable component $\Delta A_{i,l,d,t}$ over exporters' life cycle.

Firm-level fact 2: New exporters grow by shifting their demand. Panel (a) of Figure 2 presents the estimates of the evolution of exporters' export intensity -conditional on prices - over their life cycle after entering a new market. Panel (b) shows the same evolution but for relative prices. Since the results and estimations procedures are similar to the ones presented by Fitzgerald et al. (2021) and Steinberg (2021), I relegate the details of the estimation procedure to appendix B.2. Consistent with their findings, the results show that the differential evolution of exporters' prices across markets is constant over their life cycle. Still, the export intensity grows over the exporters' life cycle, even conditional on exporters' prices. Consequently, exporters grow into markets by shifting the intercept of the demand they face 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 simplified model in section 2: the existence of variable markups and exporters that grow by shifting the intercept of their

[8]Note that here I am abstracting from the market aggregate variables changes, as destination time fixed effects take care of them.

demand. Under these assumptions, one of the model's predictions highlighted in section 2 was that if price elasticity is responsive enough, volatility will reduce exporters' growth over their life cycle. Let's now proceed to test this implication.

I follow a strategy similar to the previous section to compute firms' exposure to domestic volatility. However, now I can exploit a leave-one-out strategy using Colombian firm-level data. As before, I start by taking out the common shocks to firms in the same industry by regressing the change of the log change of domestic sales against the main product of export-year fixed effects, as follows

$$\Delta\text{Domestic sales}_{i,j(i),t} = \gamma_{j(i),t} + \Delta\hat{s}^{D}_{i,j(i),t}. \tag{8}$$

where ΔDomestic sales$_{i,t}$ denotes the log difference of domestic sales over time, $\gamma_{j(i),t}$ is the main-product time fixed effects - $j(i)$ is firm's i main product of export-, and $\Delta\hat{s}^{D}_{i,t}$ is the residual component that captures the firm-level shocks.

Then, I use the shocks to other firms within the same main product of exports, $j(i)$, to compute firms' exposure to domestic volatility. The focus on domestic sales shocks 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. I compute the average cross-sectional standard deviation of firm-level shocks $\Delta\hat{s}^{D}_{i,t}$, at time t, for all the firms besides the firm i, whose main export product, at the sixth digit level is $l^{6d}(i)$ as,

$$\sigma_{i,t} = \sqrt{\frac{\sum_{j\neq i \in N_{l^{6d}(i)}} \left(\Delta\hat{s}^{D}_{j(i),t}\right)^2}{|N_{l^{6d}(i),t}| - 1}} \tag{9}$$

where $|N_{l^{6d},t}|$ denotes the number of firms whose main export product at the sixth digit product is l^{6d}. $\sigma_{i,t}$, hence measures the average volatility of the firm-level domestic shocks to the firms other than i that share its main product of export $l^{6d}(i)$, which I will use as my benchmark measure of firm's i exposure to volatility.

To assess how domestic volatility relates to exporters' evolution over their life-cycle, I estimate the following equation:

$$\Delta_h \left(\frac{\exp\ \mathrm{int}_{i,l,d,t+h}}{\exp\ \mathrm{int}_{i,l,d,1}} \right) = \sum_{j=1}^{6} \beta_j^1 \ln \sigma_{i,t} \mathbb{I}_{\{\mathrm{age}=j\}} + \sum_{j=1}^{6} \beta_h^2 \mathbb{I}_{\{\mathrm{age}=j\}} + \gamma_{i,l,t}^a + \gamma_{d,t}^b + \gamma_{cohort_i,l,d,t}^c + controls_{i,l,d,t} + e_{i,l,d,t} \tag{10}$$

where exp $\mathrm{int}_{i,l,d,t}$ denotes the export intensity of product l - at the sixth digit-, that firm i, at time t, sells to destination d, defined as the exports divided by the firm's total domestic sales. $\mathbb{I}_{h=j}$ is a dummy variable equal to one if the firm's age in that particular market is h. $\gamma_{i,l,t}^a$ and $\gamma_{d,t}^b$ represent firm-product-time and destination-time fixed effects, capturing those variations in export intensity common to the destination or firm-product for each period. Additionally, results are conditional on the cohort of entry to that market γ_{cohort}^c, representing fixed effects by the year and month of entry.

Firm-level fact 3: New exporters grow less when exposed more to domestic volatility. Higher exposure to domestic volatility reduces firms' incentive to grow in their foreign markets. The estimation results are presented in Figure 3. The figure shows the estimated differences in the cumulative change of exports over the exporters' life cycle. It plots the estimated coefficients, $\{\beta_j^1\}$, and its confidence interval for all new exporters with a tenure of at least six years on each market. The estimated coefficients are presented in column (6) of Table A.3 of the appendix.

Several robustness checks are also presented and discussed in the appendix B.3. In particular, results are robust to (1) use less strict fixed effects, (2) allow the sample to contain firms with smaller or larger tenure in the market, (3) use change in export quantities as dependent variables instead of export intensity; (4) use different measures of exposure to domestic volatility.

6 The model

Now, I turn to the general equilibrium model incorporating the proposed mechanism to assess the quantitative relevance of microeconomic volatility in explaining the observed macroeconomic relationship between firms' sales volatility, total trade, and GDP per capita. The model consists of a small open general equilibrium economy model incorporating variable markups, extensive and intensive margin decisions into exporting, and persistent firm-level shocks.

6.1 Model structure

The economy consists of 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 operate in a competitive market. Consumption production uses a technology that converts domestic and imported bundles of intermediate goods into final consumption goods. The intermediate goods firms can sell to the domestic and foreign markets, both of which are monopolistic competitive markets. There are no aggregate shocks.

The timing in the model is as follows. At the beginning of the period, idiosyncratic shocks are realized. Intermediate goods firms decide prices to sell domestically and in the foreign markets, how much labor to hire, and how much to invest in foreign customer capital for the next period. 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 owns the firms and holds risk-free bonds in zero net supply. Every period, she observes her bond holdings, b, and the aggregate state of the economy $\mathbb{S}$, decides how much to consume and save, and provides labor inelastically, L^s. Her problem is given by:

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

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, and the interest rate adjusts 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 consumption good is produced using two goods as inputs: a bundle of imported goods, M, and a bundle of domestic goods, D; these bundles are combined in the following way to produce the final good C,

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

where ν represents the home bias. The price of each of these bundles is given by P^m and P^D, respectively. P^m is, from now on, normalized to be 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:

$$D = M\left(\frac{\nu}{1-\nu}\right)^{-\gamma}\left(P^D\right)^{-\gamma} \tag{12}$$

Domestic bundle. The production for the domestic bundle, D, uses intermediate differentiated goods and is given by the following condition

$$\int_{\omega\in\Omega^d} \Upsilon\left(\frac{q^d(\omega)}{D}\right) d\omega = 1, \tag{13}$$

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

$$\Upsilon(x) = 1 + (\theta - 1)e^{\frac{1}{\eta}}\eta^{\frac{\theta}{\eta}-1}\left(\Gamma(\frac{\theta}{\eta}, \frac{1}{\eta}) - \Gamma(\frac{\theta}{\eta}, \frac{x^{\frac{\eta}{\theta}}}{\eta})\right), \ \theta > 1;\ \eta > 0 \tag{14}$$

where $\Gamma(a, b)$ represents the incomplete gamma function, I call θ the price elasticity parameter, and η the super-elasticity parameter - note that both the price elasticity and super-elasticity are not constant. As it will be clear later, conditional on θ, η shapes the firm's markup responses to changes in the intermediate good price. The producer of the domestic bundle will observe intermediate good prices $\{p^d(\omega)\}_{\omega\in\Omega}$ and choose the intermediate quantities $\{q^d(\omega)\}_{\omega\in\Omega}$ to solve the following problem

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

subject to equations (14), and (13). The solution to this problem yields the following demand for variety ω,

$$\log q(\omega) = \frac{\theta}{\eta}\log\left(-\eta\log\left(\frac{p^d(\omega)}{p_c^d}\right)\right) + \log D \quad \text{if } p^d < p_c^d \tag{16}$$

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

$$p^c = e^{\frac{1}{\eta}}\frac{\theta - 1}{\theta}\frac{P}{\tilde{D}} \tag{17}$$

where P is the price index for the intermediate goods, defined as $P := \int_\Omega \frac{q(\omega)}{D}p(\omega)d\omega$, and $\tilde{D} := \int_\Omega \Upsilon'(\frac{q(\omega)}{D})\frac{q(\omega)}{D}d\omega$.[9]

Foreign consumer's problem. Intermediate firms can sell to a foreign importer. The importer takes aggregate demand, Q^*, and foreign prices, P^*, as given.[10] The importer ob-

[9] See Arkolakis et al. (2017) to see why when $\eta \to 0$ the model converges to CES, and $p^c \to \infty$.

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

serves the prices of the intermediate goods and solves,

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

s.t.

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

where $\Upsilon(x)$ denotes the indirect utility function of the representative consumer and is given by (14); $A(\omega)$ 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; as shows the following foreign demand function for each variety

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

note that $A(\omega)$ 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. However, because the domestic economy is a small open economy, p^{c*} is assumed to be constant, unlike p^c, which is an equilibrium object.

Also, note that the equation shows how both cross-sectional variable markups are consistent with new exporters that grow by shifting the intercept of their demand. While the evolution of A dictates the new exporters' dynamic, the cross-sectional markups depend on the ratio between the firm's price and the choke price of the destination economy. In particular, if $\alpha \to 0$, firms face no benefit from investing in customer capital; hence, there will be no new exporters' dynamics, and the model will behave as a model with static exporters' decisions.

Intermediate good firms. Each intermediate a variety using a linear production function with time-varying labor productivity. The firms' productivity is a random variable that follows a Markov process governed by the transition probability $f(z',z)$. 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 last two state variables. Furthermore, the joint distribution of productivity and customer capital will be enough to characterize the distribution of intermediate firms, denoted by $\Psi(z,A)$.

The intermediate good firms make static and dynamic decisions. The timing is as follows. At the beginning of time t, firm i observes its productivity z_i and the foreign market level of customer capital A_i. It 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 - the static decision-. At the end of the period, it decides how much to invest in customer capital to sell in the foreign market - the dynamic decision-. When selling to the domestic market, they can reach all the available customers, so there are no gains from 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, $\tau > 1$. 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.

Firms' static problem. Now, I turn to characterize the firms' static problems when selling to the international market. Nevertheless, if we set $\alpha = 0$ and $\tau = 1$, the coming equations characterize the static problem when selling to the domestic economy. The firm's static problem consists of choosing the optimal price such that it maximizes its operational profits, given its production technology, the economy choke price, p^c, wages, and the aggregate quantities, as in

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

subject to its production technology, $q_i^* = \frac{l_i z_i}{\tau}$, and demand equation (18). Given the demand function firms face, note that by choosing the price to maximize their profits, firms implicitly choose their products' price elasticity. 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,

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

An important implication follows from the above equation: markups are decreasing with firms' prices. 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 firm-level facts documented in the previous section and the findings by De Loecker et al. (2016) and Berman et al. (2012). Additionally, the price elasticity equation and the markup equation imply boundaries for the optimal prices such that $\mu(p) \geq 1$, and $\xi(p) \geq 1$for all $p \leq p^{c*}$.

As discussed in Section 2, the behavior of price elasticity and, consequently, the firm's markup is essential to determine the shape of the revenue function in terms of the firms' productivity. In this case, the average 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 relationships.

Firm's dynamic problem. Firms make two dynamic decisions directly related to the exporters' extensive and intensive margin. These decisions are the exporting decision, denoted by m, and the investment decision to accumulate more customers, denoted by i_d. As firms can't sell their customer capital, they can't make negative investments. To invest i_d in customer capital, the amount of labor required is given by:

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

note that 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 for all firms exporting paying the exporting fixed cost, and k_i that is where firms can invest and accumulate customer capital, which evolves according to the following law of motion,

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

when firms do not export ($m = 0$), they lose all the accumulated customer capital, and hence, tomorrow's customer capital will be given by $A' = A^{min}$. Denoting with an apostrophe the variables next period, and by $\mathbb{S}$ the vector of aggregate state variables, the firm dynamic problem is to solve

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

subject to (20), (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, wf_e. When they decide not to export ($m = 0$), firms will only collect the profits for selling to the domestic market, $\pi^d(z_i, 1)$, for which the domestic customer capital of the economy is normalized to one.

Firm's optimal dynamic behavior. Two main equations characterize the firms' exporter behavior: the customer capital investment governing the exporters' intensive margin evolution and the export decision governing the exporters' extensive margin. The optimal customer capital the firm decides to have in the next period is given by:

$$\frac{\partial wc(i_d,A)}{\partial A'} \geq \Lambda \underbrace{(1-Pr(z_i^{'*}|z_i))}_{\text{export probability}} \overbrace{\mathbb{E}_{z_i}\left\{\frac{\partial V(A',z')}{\partial A^{'}}\ |z_i^{'} > z_i^{'*}\right\}}^{\text{Expected marginal return if export}}$$

The above condition holds with equality when firms decide to invest in customer capital, $i_d > 0$. In this case, firms invest until they equalize the marginal cost of investment, the left-hand side of the last equation, to the expected marginal return on investment, the right-hand side of the same equation. Using Leibniz's rule, we get that two components determine the expected marginal return on investment. The first is the expected probability that in the next period - $(1-Pr(z_i^{'*}|z_i)$- where denotes z^* the minimum level of productivity at which the firm is willing to export. 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 concerning their future productivity. As we saw in the simplified model, uncertainty can reduce the marginal return conditional on exporting if price elasticity is sensitive enough to firms' productivity. Similarly, as uncertainty increases, the firms' expected probability of exporting in the next period can be reduced.

Firms will export if productivity is higher than the productivity threshold $z^*(A,\mathbb{S})$. They will decide the contrary when their productivity is below that threshold. The firm productivity threshold is characterized by the productivity level that makes the firm indifferent between exporting or not, given by:

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

The marginal firm is indifferent between staying in the export market or not if the operational profits of doing so plus the option value of not losing the customer capital it had accumulated is equal to the investment cost plus the exporting fixed cost. Firms will not face any option value in a static case or in an economy where customer capital is unaffected by the exporter's decision. The existence of the option value generates the well-known effects of hysteresis on international trade, given 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 Baldwin et al. (1989). The existence of the option value and hysteresis is a vital margin to be present in the model, as its absence will upward bias the absolute values effects of uncertainty on total trade. This is because the option value tends to increase under higher uncertainty delaying exit (see for example Dixit, 1989; Merga, 2020).

6.2 Equilibrium

Let's now specify the conditions for equilibrium in 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,

$$\int l(z,A)d\Psi(z,A) = L^s \quad , \tag{24}$$

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

$$Y = wL^s + \int (\pi^d(z_i,1) + m(\pi(z_i,A_i) - wf_e))d\Psi(z,A) \quad , \tag{25}$$

and total exports are given by

$$Exp = \int p^*(z,A)q^*(z,A)d\Psi(z,A) \quad , \tag{26}$$

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

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

where I make use of the fact 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 conditions,

$$\int \Upsilon\left(\frac{q(z,1)}{D}\right) d\Psi(z,A) = 1 \tag{27}$$

characterizing the equilibrium domestic choke price, p^c defined in equation (17). The evolution of the firm productivity and customer capital joint distribution, $\Psi(z,A)$, is given by,

$$H(z,A;\mathbb{S}_t) = \int f(z_t, z_{t-1})\phi(A_t, A_{t-1}, z_{t-1}; \mathbb{S}_{t-1}) d\Psi(z_{t-1}, A_{t-1}) \tag{28}$$

where $H(.)$ is the transition function for the measure of firms $\Psi_t = H(\mathbb{S}_{t-1})$. $\mathbb{S}_t$ denotes the aggregate state of the economy, and hence the measure of firms that will transition from (A_{t-1}, z_{t-1}) to (A_t, z_t) is denoted by $f(z_t, z_{t-1})\phi(A_t, A_{t-1}, z_{t-1}; \mathbb{S}_{t-1})$.

Given the initial measure Φ_0; an equilibrium consists of policy and value functions of intermediate goods firms $\{V(z,A,\mathbb{S}_t), A'(z,A,\mathbb{S}_t), q^s(z_t,\mathbb{S}_t), q^{*s}(z,A,\mathbb{S}_t), m(z,A,\mathbb{S}_t)\}$; of consumers $\{V^C, (b,\mathbb{S}_t), b'(b_t,\mathbb{S}_t), C(b_t,\mathbb{S}_t)\}$; of final good producers $\{M(\mathbb{S}_t), D(\mathbb{S}_t)\}$; of domestic bundle producers $\{D(\mathbb{S}_t), q^d(\mathbb{S}_t)\}$; the price of the export and domestically sold intermediate goods $\{p^s(z,\mathbb{S}_t), p^{*s}(z,\mathbb{S}_t)\}$; the domestic choke price $\{p^c(\mathbb{S}_t)\}$; the price of labor units $\{w(\mathbb{S}_t)\}$; the price of the bonds $\{r(\mathbb{S}_t)\}$; the price of the consumption good and the domestic bundle, $\{P^c(\mathbb{S}_t), P^D(\mathbb{S}_t)\}$; and the evolution of the aggregate states Ψ_t governed by the function $H(\mathbb{S}_t)$, 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 and goods markets clear, and (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

Now, I proceed to perform the quantitative exercises. The aim is to test the model's ability to capture the firm-level facts and the observed patterns between total exports, microeconomic volatility, and GDP per capita. Because the model nests, static models, or models with constant markups, I will use these features to test the relevance of each mechanism in explaining the aggregate patterns.

I begin by discussing the model's parameterization. Since the model is highly nonlinear, I solved it using global methods. I explain the algorithm to solve for its equilibrium in Appendix D. I then explore the models' implications at the firm and aggregate levels, starting at the firm level. I begin by studying the model's prediction of exporters' dynamics under different levels of micro-volatility. Finally, I test the four models' predictions for the aggregate relationships of interest.

7.1 Model calibration

Because the model is highly nonlinear, all parameters affect all the moments, and all are set to match the moments together. Nevertheless, some parameters have a clear empirical moment counterpart based on the model's prediction. Two parameters are externally calibrated: the consumer's discount rate, β, and the Armington elasticity, γ, set to 0.98 and 2.5, 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

$$u(c) = ln(c),$$

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

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

where $\varepsilon_{i,t}$ is assumed to be normally distributed, with standard deviation σ_z. Both ρ and σ_z are set to match the AR(1) process estimates for domestic sales in Colombia, following the same estimation as in the data.

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 export intensity of all exporters and of the new exporters', while f^e is set to match the share of exporters over the total active firms. The parameters α, ϕ, δ are set to match the exporters' export intensity evolution over their life cycle.

Finally, the parameters governing the price elasticity, θ, and η, are set to lie within the markup range estimated for Colombia, and the empirical results are presented in Table 2. To match these estimates in the model, I perform the same exercise as in the data, but with two exceptions. First, I can directly observe the markups in the model, so I run the exact estimates as in the data but use markups as dependent variables. This prevents me from using the fixed effects used to control for the marginal cost changes, as explained in the empirical section. Second, I use wage reductions as the change in the marginal cost of production following the literature. 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 a parameter consistent with the foreign demand and the estimated parameters for the price elasticity.[11] 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.

7.2 Model implications

Now, we can test the different models' ability to generate the empirical relations documented in the data section. To achieve this, I simulate four model combinations: with or without exporter dynamics and with or without variable markups. I want to simulate different economies that vary only in their conditional domestic sales volatility for each model.

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

To estimate the relevance of different levels of microeconomic volatility, I change the microeconomic volatility parameter, σ_z, solve for the new policy functions and the general equilibrium for each change. To only change the conditional variance of the domestic sales changes, I need to adjust the mean, μ, and the persistence of the shocks ρ, such that the changes in the volatility parameter, σ_z, do not affect the average productivity and the unconditional variance distribution of firms' productivity. Without these adjustments, the shocks will affect the average firm productivity and the share of firms on the right tail of the distribution as volatility increases by construction. This would contradict the empirical evidence regarding the "missing" middle literature.

Quantitative result 1: Higher micro-volatility reduces new exporters' growth. I now test the model's ability to replicate the firm-level fact 3, where exporters more exposed to domestic volatility grow less over the export markets. To do this, I compare the estimated differential growth due to this higher exposure in the data and the model. Figure 3 presents the results. The benchmark model can adequately predict the qualitative relation regarding the higher domestic volatility and the differential growth of the new exporter, as shown by the yellow dotted line - model prediction- against the solid black line - empirical estimates-. Quantitatively, the model predicts a slightly bigger drop in export intensity for the initial years of the exporters' lives. However, the model also seems to underpredict the drop in export intensity growth once firms reach six years of tenure. These results are successful if we compare them to models without the variable price elasticity since these other models will predict a null or contrary relationship to the one in the data, as discussed in Section 2.

Aggregate predictions: Model vs data. Now, I turn to the models' prediction regarding the aggregate variables. To understand the relevance of volatility and the proposed mechanism, let's re-write the total exports as in section two, but now without assuming that shocks productivity are i.i.d, in this case, we can re-write total exports as

$$Exp_t = \bar{A}\int_{z^*(A)} \frac{A_i^{\alpha}}{\bar{A}} r\hat{e}v^*(z)d\Psi(z,A)$$

where $\hat{rev}^*(z) := p^*(z)q^*(z,1)$ is the static component of exports, and $\bar{A} := \int_{z^*(A)} A_i^\alpha d\Psi(z,A)$ denotes the average effective demand shifter over active exporters. Using the covariance definition and the Leibniz rule, we have that the total export response to a marginal change in a generic variable x is given by,

$$\frac{\partial \ln Exp_t}{\partial x} = \underbrace{\frac{\partial \ln \bar{A}}{\partial x}}_{\textit{dynamic margin}} + \frac{1}{\Theta} \ln \left(\overbrace{\partial \frac{\mathbb{E}(rev_i^*(z)|z \geq z^*)}{\partial x}}^{\textit{static margin}} + \overbrace{\partial \frac{\mathbb{C}\mathbf{ov}\left(\frac{A_i^\alpha}{\bar{A}}; rev_i^*(z)|z \geq z^*\right)}{\partial x}}^{\textit{misallocation margin}} \right) - \frac{1}{\Theta} \underbrace{\int_A \frac{\partial z^*(A)}{\partial x} \frac{A_i^\alpha}{\bar{A}} rev^*(z^*) \psi_z(z^*,A) d\Psi_A(A)}_{\textit{extensive margin}}$$

where $\Theta := \mathbb{E}(rev_i^*(z)|z \geq z^*) + \mathbb{C}\mathbf{ov}\left(\frac{A_i^\alpha}{\bar{A}}; rev_i^*(z)|z \geq z^*\right)$, $\psi_z(z^*,A)$ denotes the conditional probability density function of firms productivity, given their value of customer capital, and $d\Psi_A(A)$ is the marginal density function of customer capital.

The previous result shows that in the dynamic model with customer capital, there are, as usual, two main margins of adjustment: an intensive and extensive margin. However, in this case, unlike the case for static models or new exporters' dynamics models with iid shocks, the intensive margin is determined by three sub-margins. The three sub-margins of the intensive margin are (i) the dynamic margin, which captures the effect on the average level of customer capital; (ii) the static margin, which captures the effect of firms' changes in their export static decision-equal to the total intensive margin on static models-; and (iii) the misallocation margin - absent in models with iid shocks-, which captures the changes on the covariance between firms' revenues per customer and firm's relative level of customer capital, a higher covariance increases export as it means that firms that obtain higher revenues per customer are reaching relative more customers.

Quantitative result 2: Higher micro-volatility reduces total exports. Panel (a) of Figure 4 shows the models' quantitative prediction regarding total exports and the volatility of domestic sales changes when we change σ_z as previously described. The models' predictions are striking. Both models with variable markups are qualitatively consistent with the documented empirical relationships between microeconomic volatility and total exports, while the model without variable markups predicts the opposite relationship. Within the models with variable markups, the model with new exporters' dynamics generates a quantitative relationship similar to the empirical relationship in the data, as it predicts an elasticity between the domestic microeconomic volatility and total exports of around 1.09, which is 76% of the point estimates found in the empirical section - column (3) of Table 1, and is 60% higher than the model without the new exporter's dynamics.

To put this result in context, if we compare the top and bottom 10% countries on the microeconomic volatility distribution, the former would increase their exports by 103% if they could reduce their microeconomic volatility to the level of those countries in the bottom 10% of the distribution. Also, for example, the results imply that if Colombia faced the microeconomic volatility levels of Belgium or Sweden, their export would grow by 55% and 69% higher, respectively.

Besides these quantitative predictions, two crucial additional outcomes emerge from the exercise. First, it implies that abstracting from the existence of variable markups to simplify the analyses comes at the cost of missing the negative relationship between microeconomic volatility and total trade. Second, abstracting from the existence of new exporting dynamics comes at the cost of quantitatively biasing down the negative relationship between microeconomic volatility and international trade. Therefore, these results present a solution and explanation to the puzzle documented in (Alessandria et al., 2015; Alessandria et al., 2021a), and a new micro-foundation for those models that need to assume firm risk aversion for higher uncertainty to affect international trade flows (Esposito, 2020; Gervais, 2021; Handley et al., 2022).

Quantitative result 3: Micro-volatility differences generate a positive relationship between exports and GDP per capita. Panel (b) of Figure 4 shows the four models predicted relationship between total trade and GDP per capita that emerges by changing the standard deviation of firms' tfp shocks as previously explained. The models with constant elasticity of substitution predict a negative relationship between total exports and GDP per capita as we vary the microeconomic volatility, consistent with the puzzling prediction by standard international trade models discussed in Waugh (2010), Fieler (2011), de Sousa et al. (2012), Alessandria et al. (2015) and Blum et al. (2019); unlike these models, the ones with variable markups predict a positive relationship quantitatively consistent with the data.

These differences in the predictions between models with constant elasticity and variable markups imply that the former models will need higher iceberg costs to export to match the empirical relationships as microeconomic volatility increases. This is because, in the data, as microeconomic volatility decreases, the GDP per capita and total exports increase. However, standard models with CES cannot capture these relationships and predict that microeconomic volatility increases exports and will need higher iceberg costs to export to compensate for this result. A back-of-the-envelope calculation implies that in the new exporter dynamic model with the CES, the estimated iceberg export cost should decrease by 0.73% for each percentage point increase in GDP per capita - assuming a trade elasticity of 2.5 - to match the export patterns observed in the data.

For the countries in my sample, the previous result implies that the estimated iceberg cost to export by the CES model will be 67% higher in developing economies than in developed ones.[12] While seemingly a considerable number, this is in line with the quantitative cost differences found in Waugh (2010), and with the estimates by de Sousa et al. (2012), who found that exports non-tariff barriers difference among development can be up to 90%.[13] Hence, according to our model prediction, cross-country microeconomic volatility differ-

[12]The result follows by assuming a trade elasticity of 2.5. If we assume a trade elasticity in the range between 2.0 and 3.5, the iceberg cost differences would be between 51% to 91%

[13]In the paper they argue that cost to export from developing economies are around 50% higher, but this is based on a trade elasticity of 8. Suppose we adjust it to 2.5 to be consistent with our exercise. In that case, we get 90% additional iceberg costs

ences account for around 70% of the higher estimated export iceberg costs that developing economies face.

8 Conclusion

In this paper, I showed that domestic microeconomic volatility is a significant barrier to international trade and development. This finding emerges from a general equilibrium model incorporating two key empirically validated microeconomic features: variable demand elasticity and dynamic export investment decisions. By doing so, my findings provide a new explanation for two puzzling features of the data: the observed negative relationship between exports and firms' sales volatility and the lack of involvement in international trade by developing economies.

These results follow from the fact that adding the two features reverses the "Oi-Hartman-Abel" effect generally present in standard frameworks. Higher volatility discourages exporter investment in foreign markets, hindering exporters' size and growth and, ultimately, reducing total exports and income. The model replicates the negative correlation between firm-level sales volatility and trade/income across countries, explaining a substantial portion of previously unexplained variation in trade costs across development.

These findings suggest that policies promoting domestic microeconomic stability can be of first-order importance in promoting international trade and development. Furthermore, the model results and its tractability open promising avenues for future research. Compared to traditional frameworks, it suggests a more prominent role for foreign trade policy uncertainty in suppressing trade and welfare. Additionally, the proposed framework can be used to investigate how these frictions explain observed differences in firm distribution and growth across development.

References

Alessandria, G., Choi, H., Kaboski, J. P., & Midrigan, V. (2015). Microeconomic Uncertainty, International Trade, and Aggregate Fluctuations, 42.

Alessandria, G., Khan, S. Y., & Khederlarian, A. (2019). Taking Stock of Trade Policy Uncertainty: Evidence from China's Pre-WTO Accession. *National Bureau of Economic Research*, *No. 25965*, 55.

Alessandria, G., Arkolakis, C., & Ruhl, K. J. (2021a). Firm dynamics and trade. *Annual Review of Economics*, *13*, 253–280.

Alessandria, G., Johnson, R., & Yi, K.-M. (2021b). *Perspectives on Trade and Structural Transformation* (tech. rep. w28720). National Bureau of Economic Research. Cambridge, MA. https://doi.org/10.3386/w28720

Amiti, M., Itskhoki, O., & Konings, J. (2014). Importers, Exporters, and Exchange Rate Disconnect. *American Economic Review*, *104*(7), 1942–1978.

Arellano, C., Bai, Y., & Kehoe, P. J. (2019). Financial frictions and fluctuations in volatility. *Journal of Political Economy*, *5*(127), 2049–2103.

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

Baldwin, R., & Krugman, P. (1989). Persistent trade effects of large exchange rate shocks. *The Quarterly Journal of Economics*, *104*(4), 635–654.

Baley, I., Veldkamp, L., & Waugh, M. (2020). Can global uncertainty promote international trade? *Journal of International Economics*, *126*, 103347.

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

Besedeš, T. (2011). Export differentiation in transition economies. *Economic Systems*, *35*(1), 25–44.

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

Bloom, N. (2013). Fluctuations in uncertainty. *Journal of Economic Perspectives*, *28*(2), 153–176.

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

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

De Sousa, J., Mayer, T., & Zignago, S. (2012). Market access in global and regional trade. *Regional Science and Urban Economics*, *42*(6), 1037–1052.

de Sousa, J., Mayer, T., & Zignago, S. (2012). Market access in global and regional trade. *Regional Science and Urban Economics*, *42*(6), 1037–1052.

Di Giovanni, J., Levchenko, A. A., & Mejean, I. (2020). Foreign Shocks as Granular Fluctuations. *National Bureau of Economic Research*, *No. w28123*, 49.

Dixit, A. (1989). Entry and exit decisions under uncertainty. *Journal of political Economy*, *97*(3), 620–638.

Eaton, J., & Kortum, S. (2002). Technology, Geography, and Trade. *Econometrica*, *70*(5), 1741–1779.

Eaton, J., Eslava, M., Kugler, M., & Tybout, J. R. (2007). Export dynamics in colombia: Firm-level evidence. National Bureau of Economic Research Cambridge, Mass., USA.

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

Esposito, F. (2020). Demand Risk and Diversification through International Trade. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3617802

Feenstra, R. C., Inklaar, R., & Marcel, P. T. (2015). The next generation of the penn world table. *American Economic Review*, *105*(10), 3150–3182.

Fernandes, A. M., Freund, C., & Pierola, M. D. (2015). Exporter behavior, country size and stage of development: Evidence from the exporter dynamics database. *Journal of Development Economics*, *119*, 121–137.

Fieler, C. (2011). Nonhomotheticity and Bilateral Trade: Evidence and a Quantitative Explanation. *Econometrica*, *79*(4), 1069–1101.

Fitzgerald, D., & Priolo, A. (2018). How do firms build market share? *National Bureau of Economic Research, No. w24794*, 2037–2073.

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

Foda, K., Shi, Y., & Vaziri, M. (2024). Financial constraints, firm dynamics and productivity. *Applied Economics Letters*, 1–9.

Gervais, A. (2021). Global sourcing under uncertainty. *Canadian Journal of Economics/Revue canadienne d'économique*, *54*(3), 1103–1135.

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

Handley, K., & Limão, N. (2022). Trade policy uncertainty. *Annual Review of Economics*, *14*(1), 363–395.

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

Head, K., & Mayer, T. (2014). Gravity Equations: Workhorse,Toolkit, and Cookbook, In *Handbook of International Economics*. Elsevier.

Hummels, D., & Klenow, P. J. (2005). The Variety and Quality of a Nation's Exports. *American Economic Review*, *95*(3), 704–723. https://doi.org/10.1257/0002828054201396

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

Klenow, P. J., & Willis, J. L. (2016). Real Rigidities and Nominal Price Changes. *Economica*, *83*(331), 443–472.

Kohn, D., Leibovici, F., & Szkup, M. (2016). Financial frictions and new exporter dynamics. *International economic review*, *57*(2), 453–486.

Kohn, D., Leibovici, F., & Szkup, M. (2020). Financial frictions and export dynamics in large devaluations. *Journal of International Economics*, *122*, 103257.

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

Limão, N., & Maggi, G. (2015). Uncertainty and trade agreements. *American Economic Journal: Microeconomics*, *7*(4), 1–42.

Limão, N., & Venables, A. J. (2001). Infrastructure, geographical disadvantage, transport costs, and trade. *The World Bank Economic Review*, *15*(3), 451–479.

Mandelman, F. S. (2013). Monetary and exchange rate policy under Remittance Fluctuations. *Journal of Development Economics*, *102*, 128–147.

Mandelman, F. S., & Vilán, D. (2020). Remittances and COVID-19: A Tale of Two Countries. *FEDS Notes*, *2020*(2803).

Manova, K. (2008). Credit constraints, equity market liberalizations and international trade. *Journal of International Economics*, *76*(1), 33–47.

Manova, K. (2013). Credit Constraints, Heterogeneous Firms, and International Trade. *The Review of Economic Studies*, *80*(2), 711–744.

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

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

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

Novy, D., & Taylor, A. M. (2020). Trade and Uncertainty. *The Review of Economics and Statistics*, *102*(4), 749–765.

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

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

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

Steinberg, J. B. (2019). Brexit and the macroeconomic impact of trade policy uncertainty. *Journal of International Economics*, *117*, 175–195. https://doi.org/https://doi.org/10.1016/j.jinteco.2019.01.009

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

Vannoorenberghe, G. (2012). Firm-level volatility and exports. *Journal of International Economics*, *86*(1), 57–67. https://doi.org/https://doi.org/10.1016/j.jinteco.2011.08.013

Vaziri, M. (2021). *International trade, financial constraints and firm dynamics* (tech. rep.). University of Cambridge Working Paper.

Waugh, M. E. (2010). International Trade and Income Differences. *American Economic Review*, *100*(5), 2093–2124.

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

Figures and Tables

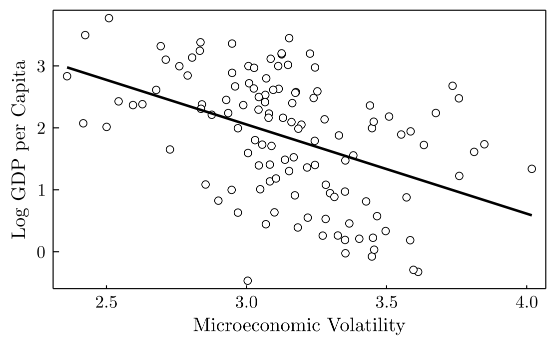
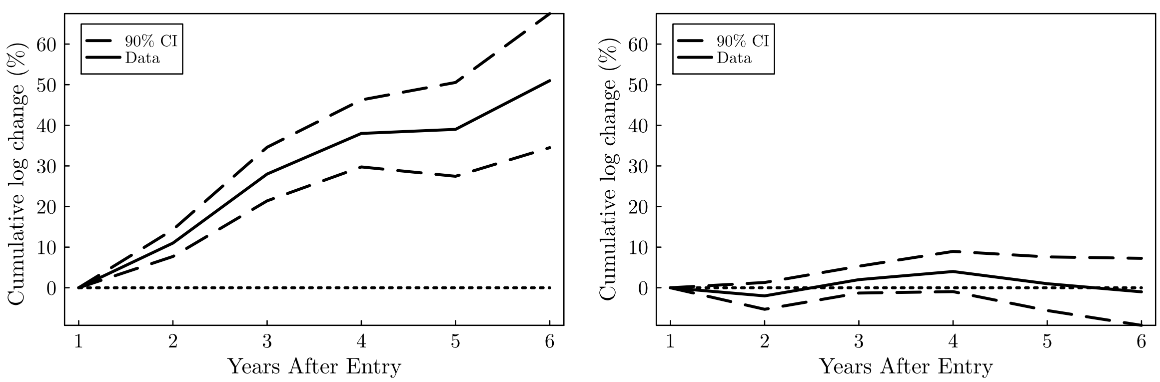


Figure 1: Volatility and GDP per Capita

Note: The Y-axis represents the log average real GDP per capita during my sample period. The x-axis denotes the measure of firms' sales volatility as defined in equation (4).



(a) Export intensity dynamics

(b) Price dynamics

Figure 2: New Exporters' Dynamics

Note: Panel (a) shows the estimated log cumulative change in export intensity relative to total sales 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, destination-time, and cohort fixed effects. Results in Panel (a) are presented in column 7 of Table A.2, and results from Panel (b) are from column 10 of the same table. 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 at least three years of not exporting to the market. Standard errors in brackets. Error cluster at the firm level.

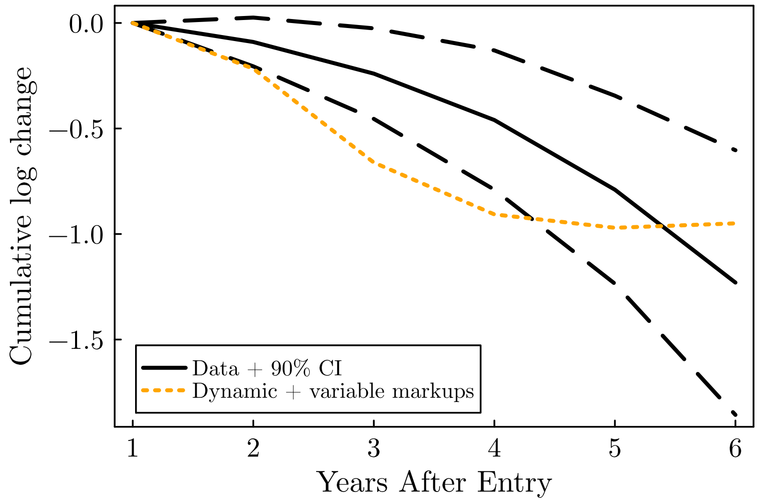
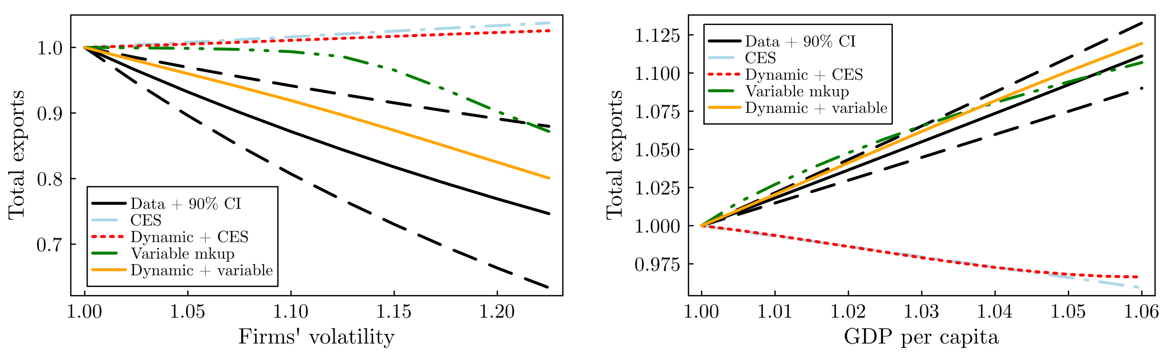


Figure 3: New Exporters Growth and Volatility: Model & Data

Note: The data results are based on the estimates for Colombian firm-level data presented in column 6 of Table A.3. The orange dotted line shows the cumulative export intensity response elasticity predicted by the model with new exporters' dynamics and variable markups when the average firm domestic sales volatility changes by 1%. Both estimates from the model and data are based on the export intensity cumulative change conditional on those exporters with at least six years of tenure in the market.



(a) Firms' sales volatility and total exports

(b) GDP per capita and total exports

Figure 4: volatility, GDP per capita, Exports

Note: The data results are based on Table 1. Firms' volatility refers to the standard deviation of firms' changes in domestic sales both in the model and in the data.

Table 1: Microeconomic Volatility and Average Exports

	Dependent variable: Av. Exp				
	(1)	(2)	(3)	(4)	(5)
ln(GDP per capita)	1.81***	1.27***	0.92***	1.23***	0.98***
	[0.20]	[0.15]	[0.16]	[0.16]	[0.15]
ln(Micro Volatility)			-1.44**		-1.62***
			[0.62]		[0.49]
Observations	35211	35211	35211	35211	35211
R^2	0.75	0.85	0.91	0.89	0.93
Number of countries	38	38	38	38	38
Gravity Controls	Only Size	All	All	All	All
Doing Business	-	Exp	Exp	All	All

Note: Av. Exports denote the estimated value α_i from equation (5). Trade flows are yearly at frequency. First Stage-Observation denotes the amount of observations used to estimate equation (5). The number of countries equals the observations for the second stage. Exp denotes controls for the doing business declared export cost. All add to the declared export costs, the contract enforceability index, and the financial development index. 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

	(OLS)	(IV)	(OLS)	(IV)
Panel 1: First Stage				
	Dependent variable: Δex. rate$_{d,t}$ $\times$ $share_{i,l,d,t-1}$			
Δremittances$_{\neq d,t}$ $\times$ $share_{i,l,d,07}$	-	0.28***	-	0.65***
	-	[0.03]	-	[0.29]
Panel 2: Second Stage (Prices)				
	Dependent variable: $\Delta \log p_{i,l,d,t}$			
Δexchange rate$_{d,t}$ $\times$ $share_{i,l,d,t-1}$	0.11	0.82***	0.09	0.65**
	[0.08]	[0.29]	[0.10]	[0.29]
Panel 3: Second Stage (Quantities)				
	Dependent variable: $\Delta \log q_{i,l,d,t}$			
Δexchange rate$_{d,t}$ $\times$ $share_{i,l,d,t-1}$	0.77***	-3.21***	0.25	-2.09***
	[0.21]	[0.70]	[0.21]	[0.62]
Observations	62,357	62,357	58,781	58,781
F-statistic		80.68		101.81
Firm-product-time FE	✓	✓	✓	✓
Destination-product-time FE	✓	✓	✓	✓
Firm-product-Destination FE			✓	✓
Controls $\times$ $share_{i,l,d,t}$	Agg. prices	Agg. prices	All	All

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 $\times$ $share_{i,l,d,t}$ denotes the addition of controls of firms' sales share among total Colombian exports and its intersection with the log change of real GDP, Colombia export price to that destination, and import price index. "Agg. prices" denote when only aggregate price changes are used, and "All" denotes the case, including GDP changes. Standard errors in brackets. Error cluster at the destination country. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Calibrated Parameters

Parameters	Variable markups + Dynamics	CES + Dynamics	Variable markups + Static	CES + Static	Rationale
β	0.96	0.96	0.96	0.96	Yearly frequency discount rate
γ	2.5	2.5	2.5	2.5	Armington elasticity
Parameters estimated within model					
θ	2.90	3.80	2.90	3.80	"Average" price elasticity
η	4.20	-	5.60	-	Super elasticity
σ^{ω}	0.48	0.48	0.48	0.48	Firms' labor productivity s.d.
ρ^{ω}	0.61	0.61	0.61	0.61	Firms' labor productivity persistence
ν	0.71	-	0.71	-	Home bias
f_e	0.08	0.043	1.5	0.10	Exporter fixed costs
α	0.70	0.74	-	-	Customer capital: curvature
ϕ	3.72	14.30	-	-	Investment adjustment cost
δ	0.24	0.42	-	-	Customer capital: depreciation
A^{min}	0.01	0.02	1.00	1.00	Customer capital: Initial value
τ	0.44	0.2	0.38	0.61	Iceberg cost

Table 4: Target Moments

Moment	Data	Variable markups + Dynamics	CES + Dynamics	Variable markups + Static	CES + Static
Average markup	0.45	0.44	0.35	0.45	0.35
Markup sensitivity estimates	0.65	0.63	-	0.66	-
Share of exporters	0.19	0.19	0.20	0.23	0.20
Trade openness	0.37	0.37	-	0.37	-
Av export intensity new exporters	0.40	0.40	0.16	-	-
Av. export intensity	0.45	0.50	0.23	0.46	0.25
S.d. domestic sales shocks	0.36	0.30	0.58	0.30	0.58
Persistence domestic sale shocks	0.47	0.49	0.57	0.46	0.58
Cum. growth 2nd year	0.11	0.18	0.18	-	-
Cum. growth 3rd year	0.28	0.30	0.31	-	-
Cum. growth 4th year	0.38	0.39	0.40	-	-
Cum. growth 5th year	0.39	0.45	0.47	-	-
Cum. growth 6th year	0.51	0.50	0.52	-	-

Note: Firms' cumulative growth shows the evolution of new exporters' export intensity over their life cycle; its values correspond to the estimated results shown in column 7 of Table A.2 of the appendix. Average export intensity is calculated using weighted by firm-level exports. The standard deviation of domestic sales shocks and their persistence shows the standard deviation of the estimated residual and the estimated coefficient from an ar(1) estimate for firm-level real domestic sales.

Appendix

A Appendix: Cross country Data and Estimation Robustness

Here, I present more details about the data used for the cross-country analyses and the robustness of the cross-country estimates.

A.1 Cross country Data

Penn World Tables. This data covers 183 countries between 1950 and 2019. I use this data for the country's total factor productivity and other aggregate variables such as GDP, as well as export and import prices.[14]

CEPII. I use two datasets from the CEPII foundation, the "Gravity" data set and the "TradeProd" data set.[15] 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 trade margins for different exporters.

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.

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

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

A.2 Cross-Country Estimation

Measurement of microeconomic volatility. There are some potential concerns about using the cross-sectional standard deviation of the changes in firm-level domestic sales to measure volatility. To test for different measures, I use three measures and present the results in Table A.1. One measure is constructed using the firm-level labor productivity for those that do not export or import, denoted as $\textit{Micro Volatility}^{tfp}_{NonExpo}$, the other is using the labor productivity but for all firms, denoted as $\textit{Micro Volatility}^{tfp}_{All}$. The final measure, denoted by $\textit{Micro Volatility}^{Common}$, uses the common component of the three measures constructed using the principal component method.

B Appendix: Firm-level Estimation

B.1 Estimation of Markup response: Instrumental variable approach

In this appendix section, I present more details of the estimation procedure to estimate how markups respond to exchange rate changes depending on their firm's sale shares and some additional robustness checks.

As already mentioned in the main text, to test if markup changes vary with exporters' market share, we can estimate

$$\Delta p_{i,d,l,t} = \beta_1 \Delta e_{i,d,l,t} \times \text{exp. share}_{i,d,l,t-1} + \beta \text{exp. share}_{i,d,l,t-1} \times \mathbf{X} + \gamma^1_{i,l,t} + \gamma^2_{i,l,d} + \gamma^3_{l,d,t} + e_{i,d,l,t} \tag{29}$$

To estimate β without bias, we need to abstract from the exchange rate variation that might reflect changes in the average productivity of the destination country, as this can bias the estimate. I use an instrumental variable approach that solves 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 that destination. The first stage is then given by

$$\begin{aligned}\Delta e_{i,d,l,t-1} \times \text{exp. share}_{i,d,l,t-1} = \Delta remittances_{d,t} \times \text{exp. share}_{i,d,l,07} + \\ + \beta \text{exp. share}_{i,d,l,t-1} \times \mathbf{X} + \gamma^1_{i,l,t} + \gamma^2_{i,l,d} + \gamma^3_{l,d,t} + e_{i,d,l,t}\end{aligned}$$

Two assumptions are needed to validate this procedure. First, remittance flows to Colombia need to 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.[16]

[16] 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

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 after controlling for the common shocks that may hit all the destination countries. This is conditional on global destination market shocks and the firm's common marginal cost at the product level; the changes in remittance flows from a third country cannot be generated by shocks affecting the relative differences in firms' prices to destinations.

For example, imagine 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, conditional on the aggregate shocks affecting each country and firms' product marginal costs.

Results comparing the Iv and the OLS estimation are presented in Table A.4. Columns 1 and 3 show the OLS results, while the rest of the column presents the results using the IV strategies. As can be seen, the F-statistic range between 65.15 to 108.22 for different specifications. Relative to Table 2 presented in the main text, the current one adds four additional results in Columns 5 to 7. Column 5 presents the results of dropping the firm-destination-product fixed effects. Column 6 shows that results hold if we condition the exporter's sample to those exporters that continue exporting the following period. Column 7 presents the findings after re-estimating the IV strategy, fixing the exporter's share in 2012, and using data between 2013 and 2019 to re-do the estimates. The three columns show that results are invariant to these changes and that if something, the benchmark case (column 4) used to calibrate the model is on the conversation side of the estimates.

B.2 New exporters' dynamics

I revisit the facts documented in Fitzgerald et al. (2021) and Steinberg (2021) to understand how Colombian exporters grow over their life cycle after entering a new destination. Consistent with their findings, exporters increase their exports over their life cycle conditional on prices. Furthermore, I find relative prices that do not change over exporters' life cycles. 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:

$$\Delta_h y_{i,d,l,t} = \sum_{h=1}^{6} \beta_h \mathbb{I}^h_{\{age=h\}} + \ln p_{i,d,l,t} + \gamma^a_{i,l,t} + \gamma^b_{d,l,t} + \gamma^c_{\text{cohorts}} + \varepsilon_{i,d,l,t}$$

where $\Delta_h y$ represents the log differences between the initial value of the variable y and its value "h" years after, I estimate the above equation for two possible dependent variables: one $\text{export}^q_{i,d,l,t}$ representing the total export quantities that firm i is selling of product l to destination d in year t; the other is $\frac{\text{export}_{i,d,l,t}}{\text{Tot. sales}_{i,t}}$, representing nominal exports from firm i to each market at time t over total sales - ideally, I would want to divide by the total domestic product sales for the same product l, but that data is unavailable. I project variable y 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 $\gamma^b_{d,t}$ in my benchmark specification, $\gamma^c_{\text{cohorts}}$ represents the first month of entry I observed. Adding these fixed effects allows me to purge out the common variation in sales from firm i of product l at time t to all markets; 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:

$$\ln p_{i,d,l,t} = \sum_{h=1}^{6} \beta^p_h \mathbb{I}^h_{\{age=h\}} + \gamma^a_{i,l,t} + \gamma^b_{d,l,t} + \gamma^c_{\text{cohorts}} + \varepsilon^p_{i,d,l,t}$$

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_1 and β_1 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 one, are defined as those exporters that did not export any positive amount to that product-destination market in the last three years.[17]

Results are presented in table A.2. Columns 1 to 4 show the estimation results using changes in quantities exported, columns 5 to 8 present the cumulative changes in export intensity, and columns 9 to 10 show the cumulative changes in prices over the exporters' life cycle. Results show that exporters tend to increase their exports and export intensity slowly, conditional on prices, while they do not seem to adjust relative prices across destinations. Consequently, exporters grow by shifting the intercept of their demand.

B.3 Volatility and exporter life cycle

Table A.3 presents the estimation of equation (10). Column 1 to 7 presents the results using the measure of domestic sales volatility as described by equation (9). Columns 5 to 7 estimate equation (10) conditional on those exporters with at least five and sixth years of tenure. Column 7 presents the results using the cumulative changes in total exported quantities instead of export intensity. Columns 8 and 10 use different measures of domestic volatility, as detailed below.

Robustness measure 2: A product weighted measure of firm's volatility exposure. - used in Column (8) - 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 for those firms with the same main export products at the sixth digit belonging 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 6-digit product export share over the correspondingly 4-digit products for each firm i.

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

4. Compute the 6-digit product average share as the average share between 2006-2009 for all the firms selling that 6-product product.

5. Use the 6-digit product average computed in the previous step to weight the volatility computed in step 2 for each firm-4-digit product.

Robustness measure 3: Firm-level common shocks to construct volatility measure. The measure of volatility used in Column (9) is constructed as follows:

1. Restrict the sample to those exporters with at least two products and two countries of destination.

2. First compute the common changes in the exports of a firm i in time t, $\gamma_{i,t}$, to all its products and destination it's selling to by estimating:

$$\Delta exp_{i,l,d,t} = \gamma_{i,t} + \theta_{d,l,t} + e_{i,l,d,t} \tag{30}$$

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

Robustness measure 4: Product-specific shocks to construct volatility measure. The measure of volatility used in Column (10) is constructed as follows:

1. Restrict the sample to those exporters with at least two products and two countries of destination.

2. First compute the export firm-destination-product shocks, $\Delta e\hat{x}p_{i,l,d,t}$ by estimating:

$$\Delta exp_{i,l,d,t} = \theta_{d,l,t} + \Delta e\hat{x}p_{i,l,d,t} \tag{31}$$

3. Compute the cross-section standard deviation of $\Delta e\hat{x}p_{i,l,d,t}$ for all the firms other than i selling that 6-digit product.

4. Use the volatility in the previous step to take the firm-level average volatility.

The similar patterns documented suggest that the results are not driven by the possible selection due to firms' exit, neither by the measure of volatility used nor by the dependent variable. When I test for all these cases, the documented patterns are similar, and I can't reject the model's main predictions regarding the effects of volatility over exporters' life cycle evolution.

C Model

C.1 Proofs

Proposition 1. *If the production function is linear in inputs and productivity, and the curvature of the revenue function is concave on firms' productivity, then a mean preserving spread over firms' productivity reduces total exports.* Total exports can be written as:

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

This is enough to prove that both $p(z)\hat{q}(z)$ and A^{α} are decreasing in volatility. So, let's start with the last term of the equation, where the argument follows Jensen's' inequality. Note that if revenues are concave on a firm's productivity, then $p(z)\hat{q}(z)$ is concave as A is given at any point in time. Define $g(z) := p(z)\hat{q}(z)$, then $\mathbb{E}_z[g(z)] = (\int p(z)\hat{q}(z)dz)$. Assume that Y is a random variable with a mean zero and independent of X. We can then define $X = Z + Y$ so that X is a mean preserving spread over Z. Now note that

$$\mathbb{E}_X[g(X)] = \mathbb{E}_Z[\mathbb{E}_Y[g(Z+Y)|_Z]] \leq \mathbb{E}_Z[g(Z+\mathbb{E}_Y[Y|_Z)]] = \mathbb{E}_Z[g(Z)]]$$

The inequality follows from Jensen's inequality.

I will show that A decreases volatility if revenues are concave. Note that because production is linear in labor and revenues concave, profits are concave in productivity, too. Note that by equation (2), A is proportional to $\left\{\mathbb{E}_{F'}\left\{\hat{\pi}(z',1)|_{z=z}\right\}\right\}^{\frac{1}{1-\alpha}}$. By the same argument as above, $\mathbb{E}_{F'}\left\{\hat{\pi}(z',1)|_{z=z}\right\}$, will decreased under a mean preserving spread.

Proposition 2. *Under monopolistic competition and linear production function, if the curvature of the revenue function in the model is miss-specified assuming convexity instead of concavity, ceteris paribus, then the model will estimate higher iceberg trade costs to export for an economy with mean preserving spread on firms' productivity.*

Let Exp^{e1} denote the total export from the data-generating process from Economy 1, and Exp^{e2} the data on total exports for Economy 2. For simplicity, assume the structural parameters of these economies are the same, except that for Economy 2, firms face a higher conditional volatility than Economy 1. By Proposition 1, then we have that $Exp^{e1} > Exp^{e2}$.

Denote the log differences between these economies by $\Delta Exp = \ln Exp^{e1} - Exp^{e2}$. By Proposition 1, this implies that in the actual data generating process $\Delta Exp > 0$.

Now, let's denote the predicted export change of the model with convex revenue function when we have a mean preserving spread over firms productivity as $\Delta Exp^{\text{convex model}}$. By Proposition 1, a model with a convex revenue function predicts $\Delta Exp^{\text{convex model}} < 0; asamean, preservingsprea$

Now, let's define $\ln\hat{\tau}$ as the difference between the prediction of the convex model and the actual data-generating process where profits are concave. Hence, we have that,

$$\ln\hat{\tau} := \Delta Exp - \Delta Exp^{\text{convex model}} > 0$$

By definition, then, we have

$$\ln\hat{\tau} = \ln(\frac{Exp^{e1}}{Exp^{e2}}) - \ln(\frac{Exp^{\text{convex model},e1}}{Exp^{\text{convex model},e2}}) > 0$$

So we get that,

$$\ln(\frac{Exp^{e1}}{Exp^{e2}}) = \ln(\frac{Exp^{convex,e1}}{Exp^{convex,e2}}) + \ln\hat{\tau}$$

Such that

$$\frac{Exp^{e1}}{Exp^{e2}} = \frac{Exp^{convex,e1}}{Exp^{convex,e2}\ \hat{\tau}^{-1}}$$

This implies that if the model revenue function is miss specified, using convex revenue functions, when the data generating process is concave, we will need the predicted exports by the convex model to be reduced by $\hat{\tau} > 1$ when we increase firms' productivity volatility to match the total export variation observed in the data. The adjustment must compensate for the predicted model increase in ΔExp^{convex} due to the revenue miss-specification.

Now, I show that conditional on all the structural parameters of the economy, except for those shaping the mean preserving spread, exists a marginal cost $\hat{mgc}$ that is higher than the actual marginal cost of production denoted by mgc for all firms, such that:

$$\int rev(\hat{mgc})dF = Exp^{\text{convex model},e2}\ \hat{\tau}^{-1}$$

Hence is sufficient to show that there exists an $\hat{mgc}$, such that,

$$rev(\hat{mgc}) = \frac{rev(mgc)}{\hat{\tau}}$$

where mgc, is such that,

$$\int rev(mgc)dF = Exp^{\text{e2}}$$

It is sufficient to show that there exists an $\hat{mgc}$, such that,

$$rev(\hat{mgc}) = \frac{rev(mgc)}{\hat{\tau}}$$

To prove it, assume the contrary. We have two cases. The first case is $\hat{mgc} \leq mgc$ for some firms, and the previous equalities hold. Let's start with the case of equality for all firms since $\tau > 1$; this is a contradiction by Proposition 1.

Now assume $\hat{mgc} < mgc$ for some firms and that for the rest of the firms, it holds with equality. Since $\hat{\tau} > 1$, this implies that revenues are increasing in the marginal cost- a contradiction.

The second case is that for every possible marginal cost higher than the benchmark one, we have that $\int rev(\hat{mgc})dF > Exp^{convex,e2}\ \hat{\tau}^{-1}$This implies that the revenue function is bounded below and above zero, as $\infty > \tau > 1$, and $Exp^{convex,e2} > Exp^{convex,e1} > 0$ by Proposition 1.

But by firms' problem if $\hat{mgc} \to \infty$ it implies that $p \to \infty$. Now we have two options. The first option is that as prices converge to infinity, revenues converge to infinity, but this implies revenues increase with the marginal cost of production, a contradiction. The second one is that revenues converge to zero as prices converge to infinity. This latter case implies that $Exp^{convex,e2}\ \hat{\tau}^{-1} < 0$— another contradiction by Proposition 1. Now that we know that $\hat{mgc} > mgc$, such that $\int rev(\hat{mgc})dF(z) = Exp^{convex,e2}\ \hat{\tau}^{-1}$, we can define the firm-level iceberg costs

$$\tau := \frac{\hat{mgc}}{mgc} > 1$$

This is the common firm-level iceberg cost needed by the convex revenue model to match the data after a mean-preserving spread.

Proposition 3. *Under monopolistic competition and linear production function, if the price elasticity is sensitive enough to firms' prices, then revenues can become a concave function of firms' productivity.*

without loss of generality abstract from customer capital to facilitate the notation. Hence, revenues will be written as $rev(z) = p(z)q(p(z))$. We need to show that if price elasticity is sensitive enough, then we can have that, $\frac{\partial^2 rev(z)}{\partial^2 z} \leq 0$ Let's start by writing the revenue change relative to the firm's productivity as follows

$$\frac{drev(z)}{dz} = \frac{dp}{dz}\left[q + p\frac{\partial q}{\partial p}\right]$$

Now take the second difference,

$$\frac{d^2 rev(z)}{dz^2} = \frac{d^2 p}{dz^2}\left[q + p\frac{\partial q(p)}{\partial p}\frac{\partial p}{\partial z}\right] + \frac{dp}{dz}\left[2\frac{\partial q(p)}{\partial p}\frac{dp}{dz} + p\frac{\partial^2 q(p)}{\partial p^2}\frac{dp}{dz}\right]$$

Which we can group as

$$\frac{d^2 rev(z)}{dz^2} = \frac{d^2 p}{dz^2}\left[q + p\frac{\partial q(p)}{\partial p}\right] + \left(\frac{dp}{dz}\right)^2\left[2\frac{\partial q(p)}{\partial p} + p\frac{\partial q(p)}{\partial p} + p\frac{\partial^2 q(p)}{\partial p^2}\right]$$

Now, we know that $\frac{d^2 p}{dz^2} \geq 0$, as we assume the price elasticity decreases with firms' productivity, in constant with the; we also know that price elasticity is negative $\frac{\partial q}{\partial p} < 0$. Note that $\frac{\partial q}{\partial p} = \theta\frac{q}{p}$, where $\theta < -1$. Now let's denote the elasticity of the price elasticity to the firm's price as $\eta_{-\theta,p}$, and note that the second derivative of quantities with respect to prices is,

$$\frac{\partial^2 q}{\partial p^2} = \left[\eta_{-\theta,p} - 1 + \theta\right] \frac{\theta q}{p^2}$$

Then, we can rewrite the second derivative of the revenue function as

$$\frac{d^2 rev(z)}{dz^2} = \underbrace{\frac{d^2 p}{dz^2}\left[q(1+\theta)\right]}_{<0} + \left(\frac{dp}{dz}\right)^2 \left[2\frac{\theta q}{p} + \left[\eta_{-\theta,p} - 1 + \theta\right] p \frac{\theta q}{p^2}\right]$$

So we have that,

$$\frac{d^2 rev(z)}{dz^2} = \underbrace{\frac{d^2 p}{dz^2}\left[q(1+\theta)\right]}_{<0} + \left(\frac{dp}{dz}\right)^2 \frac{\theta q}{p}\left[1 + \eta_{-\theta,p} + \theta\right]$$

Note that in the case of constant price elasticity, we have $\eta_{-\theta,p} = 0$; hence, the second term is positive. But, when the price elasticity is not constant $\eta_{-\theta,p} > 0$. Furthermore, if $\eta_{-\theta,p} > -\theta - 1 > 0 \forall z$, then the second term is negative, and we have that $\frac{d^2 rev(z)}{dz^2} < 0$.

D Algorithm

The model only needs to solve for the economy's steady state given different parameters for σ and its counterpart adjustment in μ and ρ, such that we only do a mean preserving spread over the conditional volatility of firms' productivity.

Given the high non-linearities of the firm's problem, I solve the model using global methods. First, the firms' domestic decisions are static, and we only need to solve them for optimal prices. To solve the export decision, firms need to know their customer capital level A, their productivity z_i, and domestic wages, w, with which they need to make a proper forecast for z_i', and w'. In principle, firms need to know the firm's distribution to solve for w and w'. But because I will solve for the steady distribution, instead of using the firms' distribution as a state variable, which is infeasible, or using the Krussel-Smith method, I will use wage prices as a state variable, which is sufficient to characterize the firm's decision, given the assumption of the small open economy.

To solve for the economy's aggregate equilibrium, I proceed as follows: When calibrating the model, I set the wage equal to one. This allows me to set wages equal to one in the baseline economy without any changes. For each change in the volatility parameters, I solve for the whole value function, policy functions, and aggregate economy again.

For each parameter value, the solution is computed as follows:

1. Fix the parameter values of the problem. and pre-set ε to small value.
2. Set a grid space of $(20X85X10)$ for firms' productivity, customer capital, and wages. Solve for the optimal value function and optimal policy function using global methods.
3. Pre-set wages to w^n
4. Use the obtained optimal policy function to expand the grid space to $(100X120)$ possible grid points for state variable. Compute a Markov transition matrix for the firms' measure for state variable, $H(.)$ conditional on wages w^n
5. Pre-set a non-degenerate aggregate distribution Ψ^j, conditional on wage w^n
6. Update Ψ using the Markov transition matrix until $|\Psi^{j+1} - \Psi^j| \leq \varepsilon$
7. Using Ψ, compute the aggregate variable and the domestic choke price p_d^c
8. Compute the excess labor demand $\Delta L = L^d - L^s$.
9. If the labor excess demand $|\Delta L| > \varepsilon$, update $w^n = w^{n+1}$ and start from 3 again.

I fix a wage level, and using the expanded space, I compute the Markov transition matrix for each firm state based on the firms' optimal decision, conditional on the pre-set wage. Using the transition matrix, I can update the aggregate distribution until it converges, given a wage. Then, after solving for all the equilibrium objects, I can construct a labor demand and supply and check if the labor market is clear. If it is not, I adjust wages and start the process again.

E Appendix Tables

Table A.1: Robustness Microeconomic Volatility and Exports

	Dependent variable: Av. Exp							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln(GDP per capita)	1.81***	1.27***	0.92***	1.23***	0.98***	0.92***	0.94***	0.93***
	[0.20]	[0.15]	[0.16]	[0.16]	[0.15]	[0.17]	[0.16]	[0.16]
ln(Micro Volatility)			-1.44**		-1.62***			
			[0.62]		[0.49]			
$ln(\text{Micro Volatility}^{tfp}_{NonExpo})$						-0.96**		
						[0.46]		
$ln(\text{Micro Volatility}^{\text{tfp}}_{All})$							-0.84*	
							[0.46]	
$ln(\text{Micro Volatility}^{\text{Common}})$								-0.14**
								[0.07]
Observations	35211	35211	35211	35211	35211	35211	35211	35211
R^2	0.75	0.85	0.91	0.89	0.93	0.93	0.92	0.93
Number of countries	38	38	38	38	38	38	38	38
Gravity Controls	Size	All	All	All	All	All	All	All
Doing Business	-	Exp	Exp	All	All	All	All	All

Note: The table replicates the results of Table 1 using different ways of computing firm sales volatility.

Standard errors are in brackets and are clustered at the origin country level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.2: Exporters Life Cycle

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	$\exp^q$	$\exp^q$	$\exp^q$	$\exp^q$	$\frac{exp}{\text{Tot. sales}}$	$\frac{exp}{\text{Tot. sales}}$	$\frac{exp}{\text{Tot. sales}}$	$\frac{exp}{\text{Tot. sales}}$	$\ln(p)$	$\ln(p)$
$\mathbb{I}_{\{age_{ildt}=2\}}$	0.11***	0.13***	0.16***	0.21***	0.06***	0.08***	0.11***	0.17***	-0.02	-0.02
	[0.02]	[0.02]	[0.02]	[0.04]	[0.02]	[0.02]	[0.02]	[0.04]	[0.01]	[0.02]
$\mathbb{I}_{\{age_{ildt}=3\}}$	0.25***	0.31***	0.39***	0.59***	0.17***	0.20***	0.28***	0.42***	0.01	0.02
	[0.03]	[0.03]	[0.04]	[0.06]	[0.03]	[0.03]	[0.04]	[0.08]	[0.02]	[0.02]
$\mathbb{I}_{\{age_{ildt}=4\}}$	0.35***	0.43***	0.55***	0.68***	0.22***	0.26***	0.38***	0.48***	0.00	0.04
	[0.03]	[0.04]	[0.05]	[0.09]	[0.03]	[0.04]	[0.05]	[0.09]	[0.02]	[0.03]
$\mathbb{I}_{\{age_{ildt}=5\}}$	0.37***	0.48***	0.59***	0.60***	0.22***	0.29***	0.39***	0.34**	0.02	0.01
	[0.05]	[0.06]	[0.07]	[0.14]	[0.04]	[0.05]	[0.07]	[0.15]	[0.03]	[0.04]
$\mathbb{I}_{\{age_{ildt}=6\}}$	0.43***	0.50***	0.72***	0.65***	0.29***	0.32***	0.51***	0.46**	-0.00	-0.01
	[0.07]	[0.08]	[0.09]	[0.15]	[0.06]	[0.08]	[0.10]	[0.18]	[0.04]	[0.05]
$\mathbb{I}_{\{age_{ildt}=7\}}$	0.45***	0.49***	0.73***	0.90***	0.39***	0.43***	0.63***	1.17***	-0.01	-0.03
	[0.13]	[0.14]	[0.17]	[0.32]	[0.14]	[0.14]	[0.18]	[0.41]	[0.06]	[0.09]
Observations	55,315	51,950	37,061	17,254	52,446	49,129	34,650	51,950	17,254	15,381
R^2	0.18	0.31	0.41	0.58	0.15	0.25	0.36	0.88	0.97	0.53
Year × Dest. FE	✓	✓	✓	-	✓	✓	✓	-	✓	-
Year × Product FE	✓	✓	-	-	✓	✓	-	-	-	-
Year × Firm FE	-	✓	-	-	-	✓	-	✓	-	-
Year × Firm × Product FE	-	-	✓	✓	-	-	✓	✓	✓	✓
Year × Product × Dest. FE	-	-	-	✓	-	-	-	✓	-	✓

Note: New exporters entered the export market and have not exported that 6-digit product to that destination in at least the past three years. All exporters are continuing exporters until each year. Error cluster at the destination country. $exp.^q$ denotes the use of quantities cumulative change as dependent variable (columns 1 to 4), $\frac{exp}{\text{Tot. Sales}}$ use the ratio of nominal exports to domestic sales instead (columns 5 to 8). Columns 9 and 10 use prices as the dependent variable. Error cluster at the 6-digit product. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.3: Volatility and Exporters Life Cycle

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	$\Delta\frac{\text{exp}}{\text{Tot. sales}}$	$\Delta\frac{\text{exp}}{\text{Tot. sales}}$	$\Delta\frac{\text{exp}}{\text{Tot. sales}}$	$\Delta\frac{\text{exp}}{\text{Tot. sales}}$	$\Delta\frac{\text{exp}}{\text{Tot. sales}}$	$\Delta\frac{\text{exp}}{\text{Tot. sales}}$	Δexp^q	$\Delta\frac{\text{exp}}{\text{Tot. sales}}$	$\Delta\frac{\text{exp}}{\text{Tot. sales}}$	$\Delta\frac{\text{exp}}{\text{Tot. sales}}$
$\mathbb{I}_{\{age_{ildt}=2\}} \times \ln \text{Vol.}$	0.01	-0.01	0.00	0.00	-0.01	-0.09	-0.05	0.01	-0.09*	0.06
	[0.03]	[0.03]	[0.04]	[0.04]	[0.06]	[0.07]	[0.06]	[0.02]	[0.05]	[0.09]
$\mathbb{I}_{\{age_{ildt}=3\}} \times \ln \text{Vol.}$	0.00	0.00	-0.00	-0.02	-0.11	-0.24*	-0.19**	-0.01	-0.07	-0.03
	[0.04]	[0.04]	[0.05]	[0.06]	[0.09]	[0.13]	[0.09]	[0.03]	[0.07]	[0.13]
$\mathbb{I}_{\{age_{ildt}=4\}} \times \ln \text{Vol.}$	-0.08	-0.08	-0.10	-0.09	-0.25*	-0.46**	-0.27**	-0.06	-0.11	-0.14
	[0.05]	[0.05]	[0.07]	[0.09]	[0.13]	[0.20]	[0.12]	[0.04]	[0.10]	[0.17]
$\mathbb{I}_{\{age_{ildt}=5\}} \times \ln \text{Vol.}$	-0.21***	-0.21***	-0.26***	-0.34***	-0.56***	-0.79***	-0.63***	-0.18***	-0.35**	-0.79***
	[0.08]	[0.08]	[0.10]	[0.12]	[0.18]	[0.27]	[0.20]	[0.06]	[0.17]	[0.26]
$\mathbb{I}_{\{age_{ildt}=6\}} \times \ln \text{Vol.}$	-0.41***	-0.46***	-0.54***	-0.66***	-0.82***	-1.23***	-0.74***	-0.21***	-0.88***	-0.88**
	[0.14]	[0.14]	[0.17]	[0.19]	[0.29]	[0.38]	[0.28]	[0.08]	[0.30]	[0.42]
$\mathbb{I}_{\{age_{ildt}=7\}} \times \ln \text{Vol.}$	-	-	-	-	-	-	-0.86**	-	-	-
	-	-	-	-	-	-	[0.35]	-	-	-
Observations	24,038	23,930	23,349	17,496	11,364	8,326	13,141	17,513	17,502	18,789
Year × Dest. FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year × Product FE	-	✓	✓	✓	✓	✓	✓	✓	✓	✓
Year × Firm FE	-	-	Only Firm	✓	✓	✓	✓	✓	✓	✓
Year × Firm × Product FE	-	-	-	✓	✓	✓	✓	✓	✓	✓
Total tenure	≥ 3	≥ 3	≥ 3	≥ 3	≥ 5	≥ 6	≥ 5	≥ 3	≥ 3	≥ 3
Measure	Bench.	Bench.	Bench.	Bench.	Bench.	Bench.	Bench.	Measure 2	Measure 3	Measure 4

Note: The table presents the estimation of equation (10). Columns 1 to 7 use the benchmark measures of domestic exposure to volatility. Column 7 uses the change in export quantities, denoted by $\Delta exp.^q$, instead of the changes in export intensity. Columns 8 to 10 use the other measures of volatility described in B.3. Total tenure denotes the minimum years exporters continuously export to each market in the sample. Error cluster at the firm level. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.4: Robustness for Markups Estimates

	(OLS)	(IV)	(OLS)	(IV)	(IV)	(IV)	(IV)
Panel 1: First Stage							
	Dependent variable: Δex. rate$_{d,t}$ $\times$ $share_{i,l,d,t-1}$						
	-	$\Delta e \times share$	-	$\Delta e \times share$	$\Delta e \times share$	$\Delta e \times share$	$\Delta e \times share$
Δremit$_{\cdot \neq d,t}$ $\times$ $share_{\cdot,07}$		0.28***		0.28***	0.29***	0.28***	0.36***
		[0.03]		[0.03]	[0.03]	[0.03]	[0.04]
Panel 2: Second Stage (Prices)							
	Dependent variable: $\Delta \log p$						
Δexchange rate $\times$ *share*	0.11	0.82***	0.09	0.65**	0.59**	0.69**	1.15**
	[0.08]	[0.29]	[0.10]	[0.29]	[0.28]	[0.30]	[0.56]
Panel 3: Second Stage (Quantities)							
	Dependent variable: $\Delta \log q$						
Δexchange rate $\times$ *share*	0.77***	-3.21***	0.25	-2.09***	-3.21***	-2.17***	-3.34***
	[0.21]	[0.70]	[0.21]	[0.62]	[0.70]	[0.62]	[0.80]
Observations	62,357	62,357	58,781	58,781	58,781	57,774	45,053
F-statistic	-	80.68	-	101.81	108.22	97.16	65.15
Firm-product-time FE	✓	✓	✓	✓	✓	✓	✓
Destination-product-time FE	✓	✓	✓	✓	✓	✓	✓
Firm-product-Destination FE	-	-	✓	✓	-	✓	✓
Controls $\times$ $share_{i,l,d,t}$	Agg. prices	Agg. prices	All	All	All	All	All
Continue exporting in $t+1$	-	-	-	-	-	✓	-
After year 2012	-	-	-	-	-	-	✓

Note: Columns 1 - 4 are the same as Table 2. Continue exporting denotes the case when the sample is restricted to exporters that export the following year. After the year 2012 denotes the robustness case when export shares are fixed in 2012, and the sample is taken after 2012. Standard errors are in brackets. Error cluster at the destination country. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$