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Abstract

We consider the canonical trade model with heterogeneous firms, love for variety and trade costs, and integrate it in the consumption CAPM model. This yields a structural gravity equation that includes an additional factor related to risk premia. Empirical evidence based on firm-level data confirms the importance of cross-sectional heterogeneity in risk and time-varying risk premia to shape bilateral trade flows. The structural gravity model augmented to account for fluctuations in risk premia offers a compelling explanation for trade collapses during abrupt economic downturns.

Keywords: Risk premia, Gravity equation, Trade collapse

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1 Introduction

Large and countercyclical risk premia are widely viewed as an important source of business cycle fluctuations and, in particular, play a predominant role during large economic downturns. At the same time, in the presence of abrupt negative economic shocks such as those experienced during the global financial and COVID-19 crises, international trade often contracts sharply leading to trade collapses. However, the models which are used to predict the size and direction of international trade flows do not include a role for risk and risk pricing since they are perfect foresight models. We claim this is an important omission, and propose a simple extension of the canonical structural gravity model (as developed by Chaney, 2008), to overcome it.

We consider the canonical trade model with heterogeneous firms, love for variety and trade costs, and integrate it in the consumption Capital Asset Pricing Model (CAPM) with risk-averse agents. Thus, investment opportunities must be priced using an equilibrium discount factor obtained from the intertemporal marginal rate of substitution of the representative consumer. Selecting into an export market is a risky investment. Since firms are owned by risk averse households, this risk must be priced using the household's stochastic discount factor. As a result, selecting into a new export destination is more attractive if the demand from that destination acts as a hedge for the household's aggregate consumption growth risk. Through the lens of an intertemporal asset pricing model, the choice to export to a new destination is influenced by the comovement between the domestic investor's consumption growth and the importer-country's demand.

The key novel theoretical prediction we establish is the following: an increase in the riskiness of a given export destination should lower the probability of exporting to that destination. Risk affects trade through a mechanism which is analogous to Chaney's (2008) extensive margin trade elasticity. In particular, the extensive margin "risk-elasticity" is (in absolute value) decreasing with the elasticity of substitution across differentiated varieties. Thus, sectors in which firms have a greater degree of market power (high mark-ups) feature more risk sensitive exporters. The intuition for this result is closely related to the extensive margin elasticity of trade in the deterministic model studied in Chaney (2008). If a firm can exert large market power in a given market, the market share it is able to capture is relatively insensitive to differences in productivity. Thus the contribution of that market to the overall profits of the representative investor's portfolio (who owns all the firms) is large. But if the demand originating from that same market is very risky (comoves strongly with the investor's stochastic discount factor), then that market contribution to the riskiness of the investor's portfolio will be large as well, and will be higher the larger the market's contribution to the firm's overall profits.

Our baseline model delivers predictions about how aggregate risk affects bilateral trade flows in a homoskedastic world without time-varying risk premia. Subsequently, we extend the analysis to consider the role of time-varying risk premia in shaping bilateral trade flows over the business cycle and the cross-section of export destinations chosen by exporters. Heightened risk premia is found to discourage firms exports on the extensive margin and, as predicted by our model, this effect is stronger for riskier export destinations.

Risk affects directly the extensive margin of trade (the choice to export to a given destination), but not the intensive margin of trade. However, fluctuations in risk premia affect the intensive margin of trade indirectly, through the heterogeneous effect of risk premia shocks across different sized firms. An increase in risk premia will discourage exports in high "risk-elasticity" sectors. These are the sectors in which firms enjoy greater markups and market-shares. If those sectors are associated with larger firms, the upshot is that the extensive margin response to the increase in risk premia will, indirectly, also lower the average value of export conditional on exporting (intensive margin) due to the heterogeneous effect of heightened risk premia across firms. Therefore, when decomposing trade into its extensive and intensive margins, it is important to recognise that the two margins are intertwined.

To test the model predictions we rely on Argentinean firm-level export data. For each transaction between 2002 and 2009 we observe the name of the exporting firm, the Free on Board (FOB) export value (in US dollars), the date of the shipment, the country of destination, and the firms' Standard Industrial Classification (SIC). We compute the risk measure guided by our model, combining macroeconomic time series on aggregate consumption for each country in the global economy, and the corresponding bilateral trade flows. The measure obtained is based on imposing a factor structure to firm-destination sales growth rates (following an approach similar to Di Giovanni et al., 2014), and computing the covariance between the systemic component of aggregate sales growth and the aggregate Argentinean consumption growth rate. The resulting risk factor varies across sectors and import destinations. Thus, its inclusion still allows us to set up a baseline econometric specification containing both destination-specific and firm-specific time-effects to account for time-varying multilateral resistance (Anderson and Van Wincoop, 2003, and Head and Mayer, 2014).

Consistent with the theoretical predictions, risk is found to affect directly the extensive margin of trade but not the intensive margin. The probability of exporting to a given destination decreases with risk. The probability of exporting to riskier markets (in the top-quartile of the risk distribution) is, depending on the empirical specification, estimated to be 0.4 to 1.4 percentage points lower compared to less risky markets (in the bottom-quartile of the risk distribution). These effects are economically substantial, since only a small subset of firms are exporters and, conditional on having exported at least once between 2002 and 2009, the probability of exporting to a given destination in a given year is around 32 percent. Thus, moving a market (defined by the sector and the importing country) from the bottom quartile to the top quartile of the risk distribution lowers the probability of market selection by the typical exporting firm by around 1.25 and 4.37 percent.

Turning to the intensive margin, the model predicts there should be no direct relation between the FOB value of exports (intensive margin) and risk. However, testing this proposition is fraught with selection bias problems. For instance, firms selecting into distant export markets are likely to have high variable profits to justify the large fixed costs. Indeed, the average export value per firm/product is typically found to increase with distance (Bernard et al., 2009). But if distant markets are also more risky, this will lead to a positive association between risk and the intensive margin. To resolve this selection problem, we follow the procedure proposed by Fitzgerald and Haller (2018) who argue that the intensive margin elasticities should be estimated on a restricted sample of firms which, based on their exporting histories, have a very high probability of serving the corresponding market. Consistent with the model's predictions, on this selected subsample, the intensive margin of bilateral trade is shown not to be directly affected by risk.

Finally, to test the predictions regarding the impact of risk premium shocks on bilateral trade flows over the business cycle, we consider the 2008 Great Recession and concurrent trade collapse (Baldwin, 2009). This business cycle episode is widely recognised as a period of heightened uncertainty and elevated risk premia. Hence, we set-up a difference-in-difference specification to investigate the impact of time-varying risk premia on the extensive and intensive margins of trade. We find that during the trade collapse (which affected Argentinean exporting firms strongly) the cross-section of export destinations served by Argentinean exporters was tilted away from the most risky destinations, consistent with the model's prediction. Moreover, the resulting reconfiguration in the cross-section of export destination served by Argentinean firms is shown to have also affected the average exports conditional on market selection (intensive margin), consistent with the heterogeneous risk-elasticities across sectors discussed above.

Our paper contributes to the literature that investigates the importance of risk and uncertainty for shaping the internationalization of the firm and, in particular, international trade and foreign direct investment (FDI). Early work in this area focused on FDI and the firm's choice of production location. For example, Ramondo and Rappoport (2010) study how production location affects risk diversification in an environment with complete markets but risk averse consumers who require compensation for holding aggregate consumption risk. They show that it is optimal for firms owned by risk averse consumers to open affiliates in economies least correlated with world risk. Ramondo et al. (2013) study the firm's choice between serving a foreign market through exports or through FDI, in an environment with risk neutral agents and complete financial markets. They show that even under risk neutrality, the covariances of the country specific shocks affect the international strategies of firms: the firm's choice between exporting and FDI aims to achieve high market shares in states of the world in which local demand in those markets is high. The focus of the paper by Ramondo et al. (2013) is on production and sales efficiency in a risk neutral environment.

There is some recent work examining how international trade affects aggregate risk. For example, Caselli et al. (2020) establish the importance of international trade as a vehicle to diversify the sources of demand and supply faced by firms in the global economy, when shocks are both country and sector specific. Conversely, Giovanni and Levchenko (2009) establish empirically the role of trade specialization as an amplifier of volatility. There is also a large literature investigating the association between bilateral trade and business cycle comovement (for example, Clark and Van Wincoop, 2001, and Kose and Yi, 2006, and Juvenal and Santos Monteiro, 2017). However, these papers do not study how risk affects the internationalisation of the firm.

A related strand of the literature (see, Handley and Limão, 2015), investigates directly how uncertainty affects the internationalisation strategy of the firm, in a set-up in which serving foreign markets requires a sunk investment that generates an option value of waiting. Their study differs substantially from ours, in its focus on domestic trade policy uncertainty and their assumption that the exporting country is large, such that changes in trade policy uncertainty confronting the exporting firms affects the importer's price index generating additional welfare gains from trade integration. Handley and Limão (2015) argue that the Chinese membership of the World Trade Organization boosted Chinese firms' investment and exports to the United States not so much by lowering the level of barriers confronting exporters but, instead, by lowering the trade policy uncertainty confronted by firms.

Our analysis is related to recent studies by Esposito (2020) and De Sousa et al. (2020), who study the problem faced by firms having to choose where to export before the realization of the destination specific demand uncertainty. Like us, Esposito (2020) considers firms confronted with sunk entry costs into export markets, but in his framework firms are owned by entrepreneurs who do not have access to capital markets and do not hold a well diversified portfolio. Therefore, in his model firm specific risk must be priced, whilst in well functioning capital markets this risk is purely idiosyncratic and does not carry a return. Similarly, using French firm-level data De Sousa et al. (2020) show that uncertainty about foreign sales affects the exports decision of firms, both in the intensive and the extensive margin. Uncertainty is measured using the volatility of the growth rate of expenditure for each industry and destination. More productive firms are found to be more affected, and the uncertainty channel affects mostly the extensive margin (consistent with results in this paper). But like Esposito (2020), the measure of risk used by De Sousa et al. (2020) does not distinguish between diversifiable and non-diversifiable risk resulting from assuming well functioning financial markets. Instead, we assume well functioning markets and firms owned by a risk-averse representative investor holding a well diversified portfolio. Firms are priced using the state-contingent stochastic discount factor of the representative agent which is determined by the growth rate of aggregate consumption. The upshot is that in our set-up fluctuations in the capital markets risk premia affect the cross-sectional profile of bilateral trade flows. This allows us to investigate how periods of high uncertainty and elevated risk premia are associated with trade collapses.

Finally, our paper is related to the literature on the Great Trade Collapse (Baldwin, 2009). One of the striking features of the Great Recession was the magnitude of the trade decline, and its synchronisation across the world. Several studies have analyzed the collapse in trade through different angles (Bems et al., 2013, provide a comprehensive survey). These studies have typically focused either on the import demand adjustments or, like us, the behavior of exporting firms. Examples of the latter, include Behrens et al. (2013) who looks at exporting firms in Belgium and assign a predominant role to the intensive margin of trade, and Bricongne et al. (2012) who study French exporters, and find that very large exporters adjusted mostly the intensive margin (the top 1% largest firms contributed to 75% of the overall intensive margin fall), but small exporters adjusted mostly the extensive margin (serving fewer products, to fewer destinations). Chen and Juvenal (2018) study how Argentinean wine exporters adjusted during the trade collapse, and in particular look for heterogeneous effects across exporters of different quality products (for wine it is possible to assign and measure quality using experts wine ratings). They find that volumes, prices, but also markups of higher quality wine exports all contracted more sharply during the crisis. Looking specifically at the extensive margin, Chen and Juvenal (2018) also find that during the crisis, higher quality wines were more likely to exit from exports. Because high quality wine exporters charge higher mark-ups (Chen and Juvenal, 2020), their finding is consistent with our prediction that the risk elasticity of trade is larger for high mark-up sectors. Other important contributions include Amiti and Weinstein (2011) and Chor and Manova (2012), who emphasize the role of financial frictions and the decline of trade credit.

Uncertainty has been shown to affect sharply the behavior of the firm over the business cycle. Bloom (2009) shows how temporary uncertainty shock generates a rapid drop, rebound, and overshoot in the hiring and investment choices made by the firm. At any rate, the internationalization strategy of firms should therefore be affected by such uncertainty shocks. But despite the massive spike in uncertainty coinciding with the trade collapse, little attention has been paid to heightened risk premia and uncertainty shocks as a contributing factor to the collapse. One important exception is offered by Novy and Taylor (2020), who propose a model in which uncertainly shocks magnify the response of trade, as importers adopt a "wait-and-see" approach, in particular, in relation to their inventory demand. This mechanism is shown to explain a significant portion of the shortfall in global import demand, particularly for the durable goods sector. Our paper differs from their study in that we focus on the supply side effects of uncertainty shocks.

The rest of this paper is organized as follows. In Section 2 we introduce the model of trade and the stochastic discount factor. Section 3 derives the structural gravity equation with risk. Section 4 describes the data used in the empirical work. Section 5 presents empirical results on the impact of risk on the extensive and intensive margins of exports. The possible role of time-varying risk premia to help explain the 2008 trade collapse is examined in Section 6. Finally, conclusions are presented in Section 7.

2 Exporters and risk

We consider a world economy with $N+1$ countries: Home, and N foreign countries, indexed $i = 1, \ldots, N$. Consumers in each country derive utility from the consumption of differentiated varieties of goods from S different sectors, indexed $s = 1, \ldots S$. Within each sector there is a continuum of differentiated varieties, each produced by a single monopolistic firm. Firms in each country have heterogeneous productivity levels and must choose which countries to sell their products to. This choice is made before the demand conditions in the destination countries are known, and thus constitutes and investment decision under risk. In the sequel, our focus is on the partial equilibrium in Home, with equilibrium foreign demands and factor prices taken as given.

2.1 Stand-in household

Home's stand-in household is endowed with one unit of labor which is inelastically supplied in the labor market, and has preferences at date t given by the following expected utility function

$$\begin{aligned} \mathcal{U}_t &= \mathbf{E}_t \sum_{i=0}^{\infty} \beta^i u\left(\mathcal{C}_{t+i}\right), \qquad \text{with} \\ \mathcal{C}_t &= \prod_{s=1}^{S} \left(\int_{\Omega_{st}} c_{st}\left(v\right)^{1-1/\epsilon_s} dv \right)^{\mu_s \epsilon_s / (\epsilon_s - 1)}, \end{aligned} \tag{1}$$

where $\mathcal{C}_t$ is the composite consumption basket, $c_{st}(v)$ is the consumption of the differentiated variety v of good s, and Ω_{st} is the set of varieties of good s available to consumers in Home at date t, and is endogenously determined in equilibrium; $\epsilon_s > 1$ is the elasticity of substitution across differentiated varieties in sector s, μ_s is the share of total expenditure in sector s goods, with $\sum_s \mu_s = 1$, and $\beta \in (0,1)$ is the discount factor. We set the composite consumption basket in Home to be the numéraire good, implying that the ideal price index satisfies the condition

$$\prod_{s=1}^{S} \left(\int_{\Omega_{st}} p_{st}(v)^{1-\epsilon_s} \, dv \right)^{\mu_s/(1-\epsilon_s)} = 1, \tag{2}$$

with $p_{st}(v)$ denoting the price of variety v in sector s. The budget constraint of the stand-in household is

$$\mathcal{C}_t + (\mathcal{B}_t/\mathcal{R}_t) + \int_j \mathcal{Q}_{jt}\xi_{jt} dj = WL_t + \mathcal{B}_{t-1} + \int_j (\pi_{jt} + \mathcal{Q}_{jt})\, \xi_{jt-1} dj, \tag{3}$$

where $\mathcal{B}_t$ are one-period real bonds purchased at date t at discount price $(1/\mathcal{R}_t)$; ξ_{jt} are the shares of the domestic firm $j \in \mathcal{J}$ purchased at date t, $\mathcal{Q}_{jt}$ is the *ex*-dividend price of each share, π_{jt} are the profits distributed by firm j, and W is the real wage rate which we assume is constant over time.

There is financial autarky, so that domestic firms are entirely owned by domestic investors and each country's net foreign asset position is zero. The standard asset pricing equations solving the household saving and portfolio allocation problem are given by

$$1/\mathcal{R}_t = \mathbf{E}_t \left[\frac{\beta u'(\mathcal{C}_{t+1})}{u'(\mathcal{C}_t)} \right], \tag{4}$$

$$\mathcal{Q}_{jt} = \mathbf{E}_t \left[\frac{\beta u'(\mathcal{C}_{t+1})(\pi_{jt+1} + \mathcal{Q}_{jt+1})}{u'(\mathcal{C}_t)} \right]. \tag{5}$$

Solving forward the asset pricing equation (5) and ruling out asset bubbles yields

$$\mathcal{Q}_{jt} = \mathbf{E}_t \left[\sum_{t=0}^{\infty} \frac{\beta u' \left(\mathcal{C}_{t+1} \right) \pi_{jt+1}}{u' \left(\mathcal{C}_t \right)} \right]. \tag{6}$$

Market clearing in financial markets requires $\xi_{jt} = 1$, for all domestic firms $j \in \mathcal{J}$, and $\mathcal{B}_t = 0$, at each date t.

2.2 Monopolistic firms pricing and market selection

We now turn to the problem solved by each domestic monopolistic firm $j \in \mathcal{J}$, whose objective is to maximize its share value (6). For that, we first need to characterize the firm's profit function. Each domestic monopolistic firm is characterized with the unit labor cost to produce output W/ϕ_j, with the efficiency parameter $\phi_j \geq 1$ heterogeneous across firms.

There are N possible markets Home firms can export to, but to be able to export at date t to country $i = 1, \ldots N$, the firm must invest in marketing at date $t-1$ the amount $f_i > 0$, expressed in units of the composite consumption basket. This investment is indivisible and sunk. Moreover, firms also face a variable "iceberg" transportation cost. For a Home firm to sell one unit of the differentiated product in country i, it must ship $\tau_i \geq 1$ units.

With isoelastic preferences, the optimal quantity demanded by country i for variety v in sector s is

$$q_{ist} \left(v \right) = Z_{ist} p_{jit} \left(v \right)^{-\epsilon_s}, \tag{7}$$

where Z_{ist} is an exogenous demand shifter for sector s goods in country i, and is assumed to follow a random walk in logs, such that

$$Z_{ist+1} = Z_{ist} \exp \left(\varepsilon_{ist+1} \right), \tag{8}$$

with ε_{ist} denoting an exogenous random variable with mean 0 and standard deviation σ_ε.[1] Optimal price setting by a Home producer j in sector s exporting to country i is

$$p_{jit} = \frac{\tau_i W}{\phi_j}\left(\frac{\epsilon_s}{\epsilon_s - 1}\right), \tag{9}$$

resulting in the following variable profit function by firm j in sector s exporting to country i

$$\tilde{\pi}_{jit} = \lambda_s Z_{ist}\left(\frac{\tau_i W}{\phi_j}\right)^{1-\epsilon_s}, \tag{10}$$

with $\lambda_s = \epsilon_s^{-\epsilon_s}\left(1 - \epsilon_s\right)^{\epsilon_s - 1}$. As in Chaney (2008), the firm's idiosyncratic efficiency parameter ϕ_j is randomly drawn from the Pareto distribution with support $[1, +\infty]$ and shape parameter $\alpha_s > \epsilon_s - 1$, and thus has cumulative density function

$$\mathbf{F}\left(\phi\right) = 1 - \phi^{-\alpha_s}. \tag{11}$$

The firm must decide at date $t-1$ if it will export to each country i at date t. In units of the domestic composite consumption basket, the total profits earned by the firm j at date $t+1$ from exporting to country i are given by

$$\pi_{jit+1} = \left(\tilde{\pi}_{jit+1} - \mathcal{R}_t f_i\right) d_{jit}, \tag{12}$$

with d_{jit} taking value 1 if at date t the firm j selects country i as an export destination, and 0 if not. Thus, the recursive form problem solved by a firm with technology level α_j choosing

[1] We abstract from general equilibrium considerations to focus on the role of demand risk for the exporting decisions made by the firms. However, in general equilibrium $Z_{ist} = \mu_s \mathcal{C}_{it} \mathcal{P}_{it}^{\epsilon_s - 1}$, with $\mathcal{P}_{it}$ the ideal price index in country i, and $\mathcal{C}_{it}$ aggregate consumption in country i at date t (Chaney, 2008). Thus, assuming $\ln Z_{ist}$ follows a random walk is a good approximations to the data, since there exists a long tradition of modeling consumption and the exchange rate (and terms of trade) as random walks (see, in turn, Hall, 1978, and Meese and Rogoff, 1983).

at date t which export destinations to serve at date $t+1$ is

$$\mathcal{Q}_{jt} = \max_{\{d_{jit}\}_{i=1}^{n}} \mathbf{E}_t \left[\mathcal{M}_{t+1} \left(\sum_{i=1}^{n} d_{jit} \pi_{jit+1} + \mathcal{Q}_{jt+1} \right) \right], \tag{13}$$

where $\mathcal{M}_{t+1} = \beta u'(\mathcal{C}_{t+1}) / u'(\mathcal{C}_t)$ is the stochastic discount factor (SDF). The solution to this problem is simple: firms choose to serve each market for which the expected discounted value of variable profits exceeds the fixed entry cost. This results in a destination specific threshold productivity level $\bar{\phi}_{ist}$, such that firms with productivity above it choose to export to destination i. The upshot is the following Bellman equation for the share price

$$\begin{aligned} \mathcal{Q}_{jt} = \sum_{i=1}^{n} \mathtt{I}\left(\phi_j \geq \bar{\phi}_{ist}\right) \Big[\mathbf{E}_t (\tilde{\pi}_{jit+1}) \mathbf{E}_t (\mathcal{M}_{t+1}) + \operatorname{cov}_t (\tilde{\pi}_{jit+1}, \mathcal{M}_{t+1}) - f_i \Big] \\ + \mathbf{E}_t (\mathcal{M}_{t+1} \mathcal{Q}_{jt+1}), \end{aligned} \tag{14}$$

where $\mathtt{I}\left(\phi_j \geq \bar{\phi}_{ist}\right)$ is an indicator function.[2]

3 Structural gravity equation and risk

In the sequel, we represent the stand-in household's preferences with the power utility function, $u(\mathcal{C}) = (\mathcal{C}^{1-\rho} - 1) / (1-\rho)$, with $\rho > 0$. Thus, the SDF admits the following linear Taylor expansion around the steady state equilibrium

$$\mathcal{M}_{t+1} \simeq (1 - \rho g_{t+1}) \beta, \tag{15}$$

where g_{t+1} denotes the net growth rate of domestic aggregate consumption at date $t+1$. We assume the growth rate of consumption is well represented by a serially uncorrelated stochastic process, with mean zero and standard deviation σ_g, with the upshot that $\mathbf{E}_t(\mathcal{M}_{t+1}) = \beta$.

[2]To obtain (14) we use the fact that $E(yz) = E(y)E(z) + \operatorname{cov}(y,z)$, and condition (4).

Given the exogenous stochastic processes assumed for the foreign aggregate demand shocks in (8), the variable profits by Home firms that export to country i also follow random walks in logs, given by

$$\begin{aligned}\tilde{\pi}_{jit+1} &= \tilde{\pi}_{jit} \exp\left(\varepsilon_{ist+1}\right), \\ &= \lambda_s Z_{ist} W^{1-\epsilon} \left(\frac{\phi_j}{\tau_i}\right)^{\epsilon_s - 1} \exp\left(\varepsilon_{ist+1}\right).\end{aligned} \tag{16}$$

Making use of (15) and (16) to substitute in (14), we are able to simplify the Bellman equation summarizing the firm's problem, as follows

$$\mathcal{Q}_{jt} = \sum_{i=1}^{n} \mathtt{I}\left(\phi_j \geq \bar{\phi}_{ist}\right) \left[\beta\lambda_s Z_{ist} W^{1-\epsilon_s} \left(\frac{\phi_j}{\tau_i}\right)^{\epsilon_s - 1} \left(1 - \sigma^{is}_{\varepsilon,g}\right) - f_i\right] + \mathbf{E}_t\left(\mathcal{M}_{t+1}\mathcal{Q}_{jt+1}\right), \tag{17}$$

with

$$\sigma^{is}_{\varepsilon,g} = \mathrm{cov}_t\left(\varepsilon_{ist}, g_{t+1}\right), \tag{18}$$

the conditional covariance between ε_{ist+1} and g_{t+1}, which is assumed to vary across sector s and export destination i.[3] It is optimal for firm j to export to country i if doing so increases its share price. Thus, it requires

$$\beta\lambda_s Z_{ist} W^{1-\epsilon_s} \left(\frac{\phi_j}{\tau_i}\right)^{\epsilon_s - 1} \geq \left(\frac{f_i}{1 - \sigma^{is}_{\varepsilon,g}}\right). \tag{19}$$

From (19), the threshold productivity level above which a sector s firm chooses to import to country i is given by

$$\bar{\phi}_{ist} = \left[\frac{f_i / \left(1 - \sigma^{is}_{\varepsilon,g}\right)}{\beta\lambda_s Z_{ist}}\right]^{1/(\epsilon_s - 1)} W\tau_i. \tag{20}$$

It is assumed that f_i is sufficiently large, so that $\bar{\phi}_{ist} > 1$, for all i and t. This formula is analogous to the threshold obtained in the perfect foresight canonical trade model (Chaney, 2008), except for the presence of the risk adjustment factor, $\sigma^{is}_{\varepsilon,g}$. Exporting to destinations

[3] To obtain (17) we use the fact that $\mathrm{cov}\left(ax, c + by\right) = ab\,\mathrm{cov}\left(x, y\right)$, with a and b and c constants and x, y two random variables, and also the fact that $\exp\left(x\right) \simeq 1 + x$ for small x.

delivering large profits when consumption is valued most by investors (negative risk factor, $\sigma^{is}_{\varepsilon,g}$) is attractive and, thus, requires a lower threshold productivity level.

Making use of equation (7), the value of exports by a firm with productivity ϕ conditional on exporting to destination i at date $t+1$ is given by

$$\begin{aligned} x_{jit+1} = p_{jit+1}q_{it} &= Z_{ist+1}p^{1-\epsilon_s}_{jit+1}, \\ &= \left(\frac{\epsilon_s}{\epsilon_s - 1}\right)^{1-\epsilon_s}\left(\frac{W\tau_i}{\phi_j}\right)^{1-\epsilon_s} Z_{ist}\exp\left(\varepsilon_{ist+1}\right), \\ &= x_{jist}\exp\left(\varepsilon_{ist+1}\right). \end{aligned} \tag{21}$$

Thus, the value of exports conditional on selecting a destination (the intensive margin of trade) follows a random walk in logs. Making use of (20) and the fact that ϕ_j has the Pareto distribution, yields sector s aggregate bilateral exports from Home to country i at date $t+1$, given by

$$\begin{aligned} X_{ist+1} &= \Lambda_s Z^{\alpha_s/(\epsilon_s-1)}_{ist}\left(W\tau_i\right)^{-\alpha_s}\left(\frac{1-\sigma^{is}_{\varepsilon,g}}{f_i}\right)^{\alpha_s/(\epsilon_s-1)-1}\exp\left(\varepsilon_{ist+1}\right), \\ &= X_{ist}\exp\left(\varepsilon_{ist+1}\right), \end{aligned} \tag{22}$$

with $\Lambda_s = \alpha_s\left(1-1/\epsilon_s\right)^{\epsilon_s-1}\left(1-\epsilon_s+\alpha_s\right)^{-1}\left(\beta\lambda_s\right)^{\alpha_s/(\epsilon_s-1)-1}$, a positive constant.[4] This formula is again analogous to the one for bilateral exports in Chaney (2008), only corrected for the risk factor. If the covariance between the investors discount factor and the foreign demand shock, $\sigma^{is}_{\varepsilon,g}$, is zero the model collapses to the Chaney (2008) perfect foresight gravity model.

The key novel insight from equation (22) is that aggregate exports between two countries is determined by the importer's risk factor, $\sigma^{is}_{\varepsilon,g}$. In particular, the elasticity of aggregate exports to changes in the risk factor is given by the extensive margin export elasticity, given by $\alpha_s/(\epsilon_s-1)-1$. As pointed out by Chaney (2008), this elasticity is larger if the degree of productivity dispersion is small (large α_s). Similarly, if the substitutability across products (measured by the elasticity of substitution, ϵ_s) is large, the elasticity of exports to risk will

[4] The detailed derivation of equation (22) is shown in Appendix A.

be lower. Thus, sectors in which firms have greater market power (high mark-up sectors) are associated with higher risk sensitivity of exports.

3.1 The extensive and intensive margins of trade under risk

It is noteworthy that the risk factor, $\sigma_{\varepsilon,g}^{is}$, does not appear in equation (21) and, thus, does not affect the intensive margin. Risk matters only because it affects the extensive margin of trade. Specifically, from (11) and (20), the probability that Home's firm j selects country i as an export destination is given by

$$\begin{aligned} \text{Prob}\left(d_{jit}=1\right) \equiv \mathbf{P}_{jit} &= 1-\mathbf{F}\left(\bar{\phi}_{ist}\right), \\ &= \left[\frac{\beta\lambda Z_{ist}}{f_i/\left(1-\sigma_{\varepsilon,g}^{is}\right)}\right]^{\alpha_s/(\epsilon_s-1)} \left(W\tau_i\right)^{-\alpha_s}. \end{aligned} \tag{23}$$

Taking logs yields

$$\ln \mathbf{P}_{jit} \simeq \text{constant} + \left(\frac{\alpha_s}{\epsilon_s-1}\right) Z_{ist} - \left(\frac{\alpha_s}{\epsilon_s-1}\right) f_i - \left(\frac{\alpha_s}{\epsilon_s-1}\right) \sigma_{\varepsilon,g}^{is} - \alpha_s W - \alpha_s \tau_i, \tag{24}$$

where we use the approximation $\ln\left(1-\sigma_{\varepsilon,g}^{is}\right) \simeq -\sigma_{\varepsilon,g}^{is}$, for small $\sigma_{\varepsilon,g}^{is}$. In what follows, Equation (24) provides the underpinnings for the risk adjusted structural gravity equation in Section 5. The upshot is that risk affects exports through the extensive margin.

Proposition 1 *The probability that a firm exports to a given destination (extensive margin) is decreasing in the destination's risk factor, $\sigma_{\varepsilon,g}^{is}$. The extensive margin risk elasticity is*

$$\textit{risk elasticity} = -\left(\frac{\alpha_s}{\epsilon_s-1}\right). \tag{25}$$

In absolute value, it increases with mark-ups (falls with ϵ_s), and falls with the productivity dispersion (increases in α_s). The intensive margin of trade in not affected by risk.

The Proposition 1 follows immediately from equation (24). It is our main theoretical prediction, and in what follows we test the prediction empirically. The first step is to develop a measure of risk.

3.2 Measuring risk

The risk factor is measured by $\sigma_{\varepsilon,g}^{is} = \text{cov}_t\left(\varepsilon_{ist+1}, g_{t+1}\right)$, and may in principle be time-varying. For our baseline analysis we assume homoskedasticity, and take $\sigma_{\varepsilon,g}^{is}$ to be constant over time. In Section 6 we allow for shocks to second order moments and, in particular, model the 2008 Great Recession as a shock to the volatility of the growth rate of consumption of the stand-in agent, to investigate if discount factor "risk shocks" contribute to explain the 2008-2009 trade collapse.

Risk varies across sectors and export destinations. In particular, we assume the innovations to export demand from country i faced by each domestic firm follows a simple factor structure with a sector specific component, ζ_s, and an importing country component, η_i, given by

$$\varepsilon_{ist+1} = \zeta_{st+1} + \eta_{it+1}, \tag{26}$$

where ζ_{st+1} and η_{it+1} are independent random variable with mean 0 and variance denoted, in turn, σ_ζ^2 and σ_η^2.[5] In addition we assume the following:

Assumption 1 *The sector specific shocks are uncorrelated with aggregate consumption and independently distributed across sectors $s \in S$, such that, for large S,*

$$(1/S)\sum_{s=1}^{S} X_{ist}\exp\left(\zeta_{st+1}\right) \simeq (1/S)\sum_{s=1}^{S} X_{ist}\left(1+\zeta_{st+1}\right) = \frac{\bar{X}_i t}{S},$$

with $\bar{X}_{it} = \sum_{s=1}^{S} X_{ist}$ denoting the total FOB exports from Home to country i, and where we use the approximation $\exp\left(\zeta_{st+1}\right) \simeq 1+\zeta_{st+1}$.

[5] Imposing a factor structure to the firm-destination sales growth rates follows an approach similar to Di Giovanni et al. (2014), who also use this method to identify macroeconomic and sector-specific shocks.

Given this assumption, and making use of equation (22) we obtain[6]

$$\varepsilon_{ist+1} = \ln\left(X_{ist+1}/X_{ist}\right), \tag{27}$$

$$\eta_{it+1} \simeq \ln\left(\bar{X}_{it+1}/\bar{X}_{it}\right). \tag{28}$$

We use (27) and (28) to obtain estimates of, in turn, ε_{ist} and η_{it}, denoted $\hat{\varepsilon}_{ist}$ and $\hat{\eta}_{it}$. Then the risk factor for sector s and export destination$i$, $\sigma_{\varepsilon,g}^{is}$, is estimated as follows

$$\sigma_{\varepsilon,g}^{is} = \text{std}\left(\hat{\epsilon}_{ist+1}\right)\text{std}\left(g_{t+1}\right)\rho\left(\hat{\eta}_{it+1}, g_{t+1}\right), \tag{29}$$

where $\rho\left(\hat{\eta}_{it+1}, g_{t+1}\right)$ is taken to be the correlation between aggregate consumption growth and the growth rate of aggregate FOB exports, and $\text{std}\left(\hat{\epsilon}_{ist+1}\right)$ is given by the standard deviation of export sales by sector.[7]

Finally, we normalize the standard deviation of aggregate consumption growth, $\text{std}\left(g_{t+1}\right)$, to unity. This is without loss of generality because aggregate volatility, $\text{std}\left(g_{t+1}\right)$, is common across all firms and all sectors. The normalization allows us to interpret the response of trade to changes in risk measured relative to the standard deviation of aggregate consumption. This is useful in Section 6, when we consider time-varying risk premia.

[6] To obtain equation (28) we consider a log linear approximation of (22), given by

$$X_{ist+1} \simeq X_{ist}\left(1 + \zeta_{s,t+1} + \eta_{it+1}\right),$$

and make use of Assumption 1 to obtain $\sum_{s=1}^{S} X_{ist}\left(1+\zeta_{s,t+1}\right) = \bar{X}_{it}$.

[7] We are able to estimate $\rho\left(\hat{\eta}_{it+1}, g_{t+1}\right)$ using annual time series for bilateral aggregate exports, without making use of the firm level data. This is important because it means that the measure of comovement is computed from relatively long time series. Using the firm level data instead, would restrict us to very short time series (the firm level data only spans the period 2002 – 2009). In Section 4 we provide more details on the data used for the construction of the risk measure.

4 Data and descriptive statistics

This Section discusses the different data sets we use in the empirical analysis, and explains how we combine information from firm-level customs data and aggregate macroeconomic time-series. We also present descriptive statistics for our main variables of interest.

4.1 Customs data

We use firm-level export data for Argentinean exporters collected by the Argentinean customs and provided to us by a private vendor named Nosis.[8] For each export flow between 2002 and 2009 we observe the name of the exporting firm, and the total value (in US dollars) of its FOB exports, and the destination country. Since exports are reported FOB they exclude transport costs, tariffs, and distribution costs in the importing country.

Nosis obtains firm level information such as the industry classification, the Tax Identification Number (CUIT), the date of creation and number of employees from the firm's tax returns which are administered by the Argentinean Tax Authority. Unfortunately, these information are not provided with the customs data but it was possible to obtain it by running web searches on the Nosis' website.[9] This allowed us to obtain each firm's average number of employees in the period analyzed, the industry classification according to the (4-digit) Standard Industrial Classification (SIC), and to calculate each firm's age.

[8]Due to confidentiality reasons the Argentinean National Statistics Office (INDEC) is not allowed to reveal data at the firm level (this is established in Law 17,622). Nosis buys the data directly from Argentinean customs and combines their own market knowledge with an algorithm that compares export transactions. When the exporter names are not available, they use earlier transactions that include the names in order to generate a "probable exporter". For instance, if an export transaction in 2007 had similar port, Harmonized Tariff Schedule (HTS), volume, and destination information as several of firm j's export transactions from a previous year, the algorithm would list firm j as the "probable exporter" in 2007.

[9]In the cases in which we could not obtain all information from Nosis website, we use the firm's Tax Identification Number and searched other sources of public information such as the Argentinean Tax Authority. Our main sample is composed of firms for which we have information on the level of employment and age of the firm. But we consider the robustness of our findings using an alternative sample of firms, that also includes the exporters for which we could not obtain these firm-level characteristics. To ensure the robustness of our findings we estimate our regression models using the entire sample of firms for which we have at least the sectoral classification. Our findings are robust and available in Appendix B.

4.2 Macroeconomic data and the estimation of risk

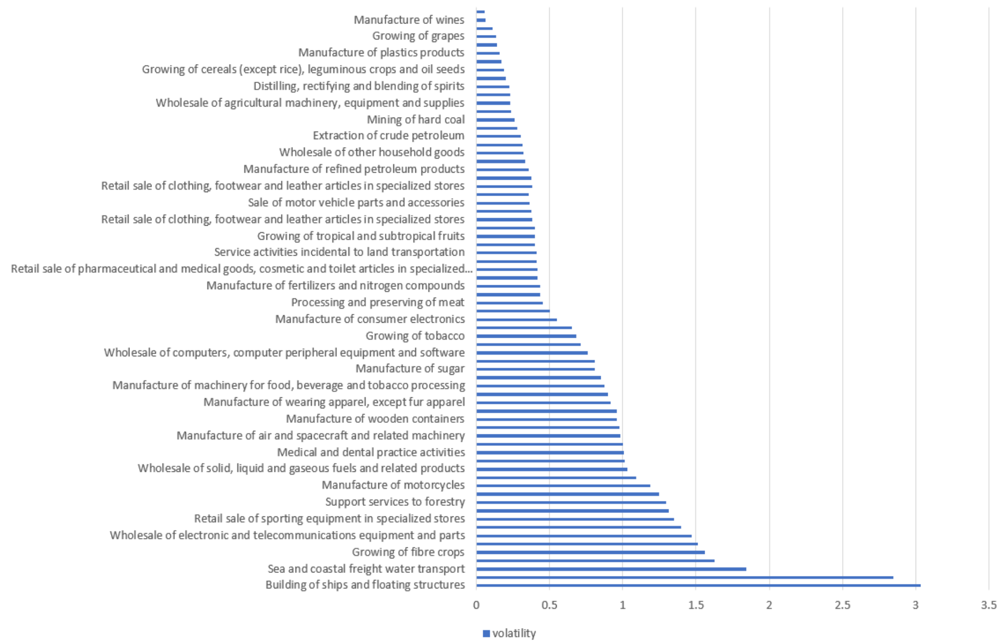
In order to obtain the measure of risk in equation (29) we combine the firm-level data described previously and macroeconomic time-series on aggregate consumption, using information from different sources.[10] To compute the comovement between the growth rate of consumption and the country specific demand shocks, $\rho\left(\hat{\eta}_{it+1}, g_{t+1}\right)$, we use annual time series for bilateral trade flows between Argentina and each trading partner, obtained from the Feenstra World Trade Flows (WTF) dataset. The bilateral trade flows data are used to get the time series for bilateral exports, $\bar{x}_{it}$, and we use the formula in (28) to calculate the estimated destination-specific demand shock, $\hat{\eta}_{it}$. To obtain an estimate of the demand shock in local currency and constant prices we adjust the nominal dollar bilateral trade flows using the Consumer Price Index (CPI) and the exchange rate obtained from the IMF International Financial Statistics. The growth rate of aggregate consumption in Argentina, g_t, is computed from the final consumption expenditure in constant local currency units (Peso), obtained from the World Bank's World Development Indicators database. The time-span for the calculation of the measure of risk is 1984 – 2015.[11]

Next, to compute the volatility of the sector specific demand shocks, $\operatorname{std}\left(\hat{\varepsilon}_{ist+1}\right)$, we use of the firm level data described above. For each sector s and destination i, we sum the FOB exports, x_{jit}, across all exporting firms j, to obtain the sector s exports to country i, X_{ist}. Then, making use of (27) we obtain the estimated demand shocks, $\hat{\varepsilon}_{ist+1}$, and compute the standard deviation of this shock for each sector sector, $\operatorname{std}\left(\hat{\varepsilon}_{ist+1}\right)$. For illustrative purposes, Figure 1 shows the computed volatility measure, $\operatorname{std}\left(\hat{\varepsilon}_{ist+1}\right)$, for a selection of sectors chosen

[10] The stochastic discount factor is given by the intertemporal marginal rate of substitution computed using the growth rate of aggregate consumption in Argentina. This approach is valid under either financial autarky or complete international capital markets. If the former is true, Argentina firms must be owned by domestic investors and, thus, the growth rate of domestic consumption delivers the appropriate stochastic discount factor. If, instead, we have complete markets, the marginal rates of substitutions are equal across countries and (with homothetic preferences) the domestic growth rate of aggregate consumption is again the correct way to recover the stochastic discount factor.

[11] The use of aggregate bilateral trade data allows us to extend the time dimension of our dataset for the calculation of correlations and standard deviations. The sample period spanned, 1984 – 2015, is determined by the availability of data on bilateral trade flows.

Figure 1: Volatility across sectors

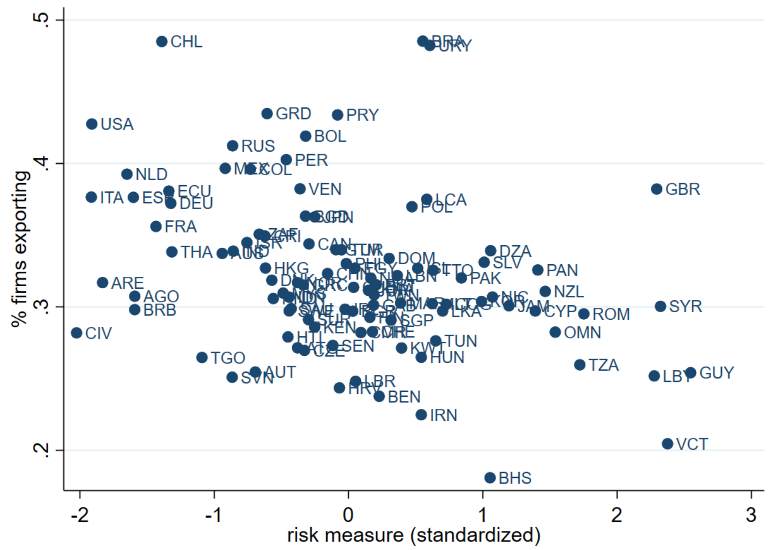


Notes: The graph shows how volatility varies across some selected sectors. The included sectors are chosen only for illustration purposes and cover some of the most volatile sectors and some of the least volatile sectors.

to include some of the most volatile and some of the least volatile sectors.

Multiplying together the sector specific volatility measure, std $(\hat{\varepsilon}_{ist+1})$, and the destination specific correlation measure $\rho\left(\hat{\eta}_{it+1}, g_{t+1}\right)$, yields a measure of risk that varies across sectors and destinations. In Figure 2 we show a scatter plot representing the risk measure averaged across sectors for each destination against the average (across sectors) percentage of firms exporting to the same destination (computed using the customs data described earlier). The graph suggests a negative association between risk and the probability that firms choose to export to a given market. Crucially, as the risk factor varies across sectors and import destinations, in our empirical investigation we are able to set up a baseline econometric specification containing both destination-specific and firm-specific time-effects to account for time-varying multilateral resistance (Anderson and Van Wincoop, 2003, and Head and Mayer, 2014), and destination and firm specific unobserved heterogeneity.

Figure 2: Risk and export selection



Notes: Scatter plot representing the risk measure averaged across sectors for each destination against the average (across sectors) percentage of firms exporting to the same destination.

Finally, other control variables in the gravity equation are obtained from standard sources. We obtain bilateral distances (in kilometers) from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). This measure is calculated following the great circle formula, which uses latitudes and longitudes of the most important cities (in terms of population). Annual nominal GDP denominated in current US dollars is obtained from the World Bank's World Development Indicators (measuring GDP adjusted for PPP yields very similar results).[12]

4.3 Descriptive statistics

Some descriptive statistics on the overall exports by the Argentinean firms and firm-level characteristics are reported, in Table 1 and Table 2. Our full sample includes 12,647 firms for which we observe their age, their business activity sectoral classification, the destination

[12]Due to missing data, GDP for Iraq and Syria are from the IMF World Economic Outlook database.

Table 1: Summary statistics on exports data by year

Year	# Exporters	Exports (Million $US)	# Destinations
		All firms	
2002	5,965	23,977	102
2003	6,748	26,676	102
2004	7,280	30,066	102
2005	7,664	24,912	102
2006	8,379	26,900	101
2007	9,591	36,014	100
2008	9,292	57,950	100
2009	8,546	44,730	100
		Manufacturing firms	
2002	3,565	15,617	102
2003	4,040	16,676	102
2004	4,348	20,018	102
2005	4,597	16,595	102
2006	4,912	17,390	101
2007	5,385	24,217	100
2008	5,314	38,847	100
2009	5,008	28,094	100

Notes: For each year in the sample, the table reports the number exporters, the value of FOB exports (in million US dollars), and the number of destinations. The top panel shows the information for the sample of all firms and the bottom panel for manufacturing firms.

countries to which they export, the value of their exports to each destination, and the firm's total number of employees over the period analyzed. Taken together, these firms export to a total of 102 countries. When we restrict our analysis to the manufacturing exporters, sample size is composed by 6,683 firms which export to a total of 102 destinations. Table 1 summarizes our trade data by year, and shows that the value of FOB exports included in our sample almost doubled between 2002 and 2009. In turn, the number of exporters increased by 44 percent. A similar pattern in observed when considering manufacturing firms only.

As shown in Table 2, in 2002 these firms (all sample) exported to an average of 11 different destinations, from a minimum of 1 to a maximum of 77 destinations with an associated average distance of 6,300 kilometers. In 2009 this increased to an average of 12 different destinations with a minimum of 1, a maximum of 74 and an average distance of 6402 kilometers. Interestingly, during this period the average value of FOB exports by firm increased 30 percent. When we look at manufacturing firms only, we observe that in 2002 they exported to an average of 12 destinations with a mean distance of 6,025 kilometers while in 2009 they exported to an average of 13 destinations and a mean distance of 6,079

Table 2: Descriptive statistics

Year	Mean exports	Mean destinations	Max. destinations	Min. destinations	Mean distance	Mean age	Mean employment
			All firms				
2002	4,019,618	11	77	1	6,300	34	140
2003	3,953,944	12	82	1	6,402	33	128
2004	4,130,444	12	82	1	6,444	32	120
2005	3,250,724	12	83	1	6,428	31	116
2006	3,210,814	11	79	1	6,356	30	110
2007	3,756,068	12	77	1	6,368	29	103
2008	6,237,628	12	77	1	6,424	29	103
2009	5,235,137	12	74	1	6,402	30	108
			Manufacturing firms				
2002	4,380,713	12	77	1	6,025	35	137
2003	4,127,660	12	82	1	6,127	34	126
2004	4,603,980	13	82	1	6,183	33	119
2005	3,609,898	12	83	1	6,166	33	113
2006	3,540,327	12	79	1	6,023	32	110
2007	4,497,093	12	77	1	6,080	31	103
2008	7,310,261	13	77	1	6,115	31	104
2009	5,609,863	13	74	1	6,079	31	109

Notes: For each year in the sample, the table reports the mean value of FOB exports; the mean, minimum and maximum number of destinations firms export to; the mean distance; the mean age of firms and the mean level of employment. The top panel shows the information for the sample of all firms and the bottom panel for manufacturing firms.

kilometers. Between 2002 and 2009 the average value of FOB exports by firm increased 28 percent. In terms of firm characteristics, the average age of the firm (all sample) is 34 years in 2002 and 30 years in 2009, with average employment going from 140 employees in 2002 to 108 in 2009. Similar figures are observed for the sample of manufacturing firms, with the average age going from 35 years in 2002 to 31 in 2009 and average employment dropping from 137 to 109 employees between 2002 and 2009.

5 Empirical results

In this section we test the main predictions of our model and, in particular, Proposition 1 establishing how risk affects the extensive and intensive margins of trade.

5.1 Risk and the extensive margin

Based on the theoretical model, our empirical specification is as follows

$$d_{jit} = \delta' \mathbf{F}_{jit} + \beta \mathbf{Risk}_{ji}^{(is)} + \varepsilon_{jit}, \tag{30}$$

where the unit of observation is given by firm j exporting to destination i across time, t. The dependent variable d_{jit} is an indicator variable, based on (24), and defined as

$$d_{jit} = \begin{cases} 1, & \text{if firm } j \text{ exports to country } i \text{ at date } t, \\ \\ 0, & \text{if not.} \end{cases} \tag{31}$$

The vector $\mathbf{F}_{jit}$ contains the set of control variables, including time-varying fixed effects. We consider two main specifications. The first one includes a set of control variables traditional in gravity models. These control variables are as follows. The log of the distance between Buenos Aires and the capital city of the export destination country (DIST_i), with higher distances associated with larger trade costs; the log of the gross domestic product of the destination county (GDP_{it}), predicted to raise the probability of positive selection. We also include firm-level control variables: the natural log of employment of the firm in the period analyzed (SIZE_j); and the log of the firm's age (AGE_{jt}). Both control variables are associated with higher productivity and experience, and so are predicted to raise the probability of selection. In this specification we also include sector-specific time effects.

In the second and main specification we consider a more stringent regression which includes firm-year fixed and destination-year fixed effects. The former control for firm's specific characteristics such as productivity and therefore firm's age and firm's size drop out of the regression. The destination-year fixed effects control for factors such as the time-varying demand or taste of a country. Thus, destination specific characteristics such as distance and GDP drop out of the regression. The destination-specific and firm-specific time-effects, also account for time-varying multilateral resistance (Anderson and Van Wincoop, 2003, and Head and Mayer, 2014). Finally, we estimate equatiuon (30) including the lagged dependent variable, to account for export histories and persistency in market selection widely documented in the literature to play an important role (see, for example, Fitzgerald and Haller, 2018).

Table 3: Extensive margin: All firms

	(1)	(2)	(3)	(4)
DIST	-0.077***	-0.044***		
	(0.001)	(0.001)		
GDP	0.025***	0.012***		
	(0.001)	(0.000)		
SIZE	0.029***	0.017***		
	(0.001)	(0.000)		
AGE	0.076***	0.019***		
	(0.002)	(0.002)		
Risk	-0.144***	-0.078***	-0.058***	-0.035***
	(0.010)	(0.007)	(0.014)	(0.010)
R-squared	0.085	0.240	0.305	0.394
Observations	667,185	583,660	644,564	563,857
Destination-Year FE	no	no	yes	yes
Firm-year FE	no	no	yes	yes
Sector-year FE	yes	yes	no	no
Lagged dependent variable	no	yes	no	yes

Notes: Robust standard errors adjusted for clustering at the firm-destination level are reported in parenthesis. In turn, * is used to denote significance at the 10% level, ** significance at the 5% level, and *** significance at the 1% level.

The risk measure is denoted $\mathbf{Risk}_{ji}^{(is)}$, to indicate that it varies across destination i and sector s. The model is specified as a linear probability model, following the approach made popular by Bernard and Jensen (2004). The linear specification allows us to estimate the model including destination-specific and firm-specific time-effects, without incurring the incidental parameter problem that affects non-linear models. For each set of regression coefficients, we compute robust standard errors adjusted for clustering at the firm-destination level.

Table 3 shows the baseline results. Column (1) includes distance, firm's size, firm's age, the destination country's GDP, sector-specific time effects, and our measure of risk. Consistent with the standard gravity model, the probability of exporting to a given destination increases with firm's size and age, increases with the importing country GDP and falls with distance. More importantly for us, the measure of risk is found to lower the probability of market selection, consistent with our main prediction. The coefficient β, capturing the extensive margin risk-elasticity, is negative and statistically significant. In column (2) we add the lagged dependent variable, and the main results hold. The estimated coefficient β is smaller (in absolute value) and statistically significant.

The results for the more stringent specifications, including destination and firm time effects are shown in columns (3) and (4). The coefficient on risk remains negative and significant. Once again, including the lagged dependent variable among the control variables lowers the estimated impact of risk. This finding suggests a hierarchy of risk in market selection, with less risky markets selected first. Ommiting the lagged dependent variable acts as confounding factor for risk, exacerbating the estimated negative effect of risk on market selection.

At any rate, the size of the β coefficient suggests a considerable role is played by risk. In particular, the interquartile range of the variable $\mathbf{Risk}_{ji}^{(is)}$ is around 10 percent. Overall, the value of the β coefficient suggests that the probability of exporting to a riskier market (top quartile) is between 0.4 and 1.14 percentage points less compared to that of exporting to a less risky market (bottom quartile). This is an important effect, given that only a small subset of firms are actually exporters and that the probability of market entry each year (conditional on exporting at some time in our sample) is about 32 percent. This implies that moving a market (defined by the sector and the importing country) from the bottom quartile to the top quartile of the risk distribution lowers by around 1.25 and 4.3 percent the probability of market selection by the typical exporting firm.

5.2 Risk and the intensive margin

In order to test the predictions of our model for the intensive margin, we estimate the regression equation

$$\ln(x_{jit}) = \omega' \mathbf{F}_{jit} + \gamma \mathbf{Risk}_{ji}^{(is)} + \varepsilon_{jit}, \tag{32}$$

where $\ln(x_{jit})$ is the log of the FOB value of exports of firm j exporting to destination i at time t. The vector $\mathbf{F}_{jit}$ is defined as before to contain the set of control variables, including time-varying fixed effects. From Proposition 1, risk should not affect the intensive margin of trade and, hence, we expect γ not to be statistically significant.

To test this prediction, we first include any destination-firm observations for which FOB exports are positive. However, this approach is likely to be vulnerable to selection bias, whereby we over sample firms that are close to the threshold for not exporting to certain destinations. This problem is described in Fitzgerald and Haller (2018). Some markets may be unattractive for all except the most productive firms. Thus, there will be certain markets for which exporting firms only export large amounts, as only high variable profits would justify the cost to serve those market. At the same time, there will be markets for which even the least productive firms are likely to export. These least productive firms will export small quantities, conditional on exporting. Thus, this could yield a spurious negative relation between the value of exports and the risk factor if the markets that are attractive even for the least productive firms are systematically less risky. To overcome this sample selection bias, Fitzgerald and Haller (2018) suggest estimating the regression equation for the intensive margin of trade on a sample that includes only the firm-destination pairs for which positive exports occur in every year of the sample (thus, underweighting those markets for which there is a high concentration of low productivity firms that are near the threshold bellow which they would not export).[13]

The baseline results for the intensive margin are reported in Table 4. We focus first on the least saturated specifications, which do not include the destination-specific and firm-specific time effects and, instead, include sector-specific time effects and the vector of control variables traditionally included in firm-level gravity equations: DIST_i, GDP_{it}, SIZE_j, and AGE_{jt}. Once again, we consider regression specifications both omitting and controlling for the lagged dependent variable, with the results reported, in turn, in columns (1) and (2) of Table 4.[14]

[13]As explained in Fitzgerald and Haller (2018), applying the Heckman selection correction (which is the conventional way to deal with sample selection bias in models with incidentally truncated dependent variables) is not feasible in our setting because there are no instruments available that would plausibly predict export participation, but not export revenue conditional on participation.

[14]Controlling for the lagged dependent variable in the intensive margin regressions should improve the model specification because positive serial correlation has been shown to be important in the dynamics of

Table 4: Intensive margin: All firms

	(1)	(2)	(3)	(4)	(5)	(6)
DIST	-0.212***	-0.055***				
	(0.007)	(0.003)				
GDP	0.199***	0.056***				
	(0.005)	(0.002)				
SIZE	0.302***	0.096***				
	(0.005)	(0.003)				
AGE	0.114***	-0.055***				
	(0.019)	(0.009)				
Risk	-0.098	-0.003	-0.435***	-0.220**	-0.837*	-0.177
	(0.089)	(0.049)	(0.137)	(0.094)	(0.495)	(0.146)
R-squared	0.272	0.697	0.518	0.774	0.658	0.858
Observations	260,124	155,381	236,772	136,763	52,792	46,193
Destination-Year FE	no	no	yes	yes	yes	yes
Firm-year FE	no	no	yes	yes	yes	yes
Sector-year FE	yes	yes	no	no	no	no
Lagged dependent variable	no	yes	no	yes	no	yes
Selection adjustment	no	no	no	no	yes	yes

Notes: Robust standard errors adjusted for clustering at the firm-destination level are reported in parenthesis. In turn, * is used to denote significance at the 10% level, ** significance at the 5% level, and *** significance at the 1% level.

All coefficients have the expected sign. More importantly, consistent with Proposition 1, the intensive margin "risk-elasticity" coefficient on $\mathbf{Risk}_{ji}^{(is)}$ is not statistically significant, and the point estimate is, in fact, very close to 0 when we control for serial correlation by including the lagged dependent variable.

Next, we consider the more stringent specification, that includes the destination-time and the firm-time fixed effects. In columns (3) and (4) of Table 4 we present the baseline results, without adjusting for sample selection. For these two specifications, risk is found to impact negatively on the intensive margin of trade, with the effect statistically significant at the 5% level if we control for the lagged dependent variable.

However, given our discussion above, this result could be driven by a selection bias whereby we over sample firms that are close to the threshold for not exporting to certain destinations. These firms are on average small firms that export small volumes (see, for example, Eaton

export market penetration (Albornoz et al., 2012).

Table 5: Extensive margin: Manufacturing Firms

	(1)	(2)	(3)	(4)
DIST	-0.092***	-0.052***		
	(0.001)	(0.001)		
GDP	0.026***	0.012***		
	(0.001)	(0.000)		
SIZE	0.037***	0.021***		
	(0.001)	(0.001)		
AGE	0.077***	0.020***		
	(0.003)	(0.002)		
Risk	-0.240***	-0.120***	-0.100***	-0.049**
	(0.019)	(0.012)	(0.031)	(0.020)
R-squared	0.292	0.398	0.087	0.263
Observations	396,615	346,955	406,094	355,257
Destination-Year FE	no	no	yes	yes
Firm-year FE	no	no	yes	yes
Sector-year FE	yes	yes	no	no
Lagged dependent variable	no	yes	no	yes

Notes: Robust standard errors adjusted for clustering at the firm-destination level are reported in parenthesis. In turn, * is used to denote significance at the 10% level, ** significance at the 5% level, and *** significance at the 1% level.

et al., 2007, and Albornoz et al., 2012). Therefore, to overcome this problem we estimate the same model on a restricted sample that includes only firm-destination pairs that always have positive exports. The results are in reported in columns (5) and (6) of Table (4). Once we adjust for sample selection and control for serial correlation (including the lagged dependent variable), there is no significant relationship between the value of FOB exports conditional on market selection and risk, consistent with Proposition 1.

5.3 Heterogeneous effects

In this section we include extensions and robustness checks to our baseline specifications, to investigate if there are heterogeneous effects across different firms. First, we consider the subsample that includes only manufacturing firms. Second, in order to understand the

Table 6: Intensive margin: Manufacturing firms

	(1)	(2)	(3)	(4)	(5)	(6)
DIST	-0.272***	-0.070***				
	(0.009)	(0.004)				
GDP	0.217***	0.061***				
	(0.006)	(0.003)				
SIZE	0.374***	0.114***				
	(0.007)	(0.003)				
AGE	0.046*	-0.071***				
	(0.024)	(0.010)				
Risk	-0.212	0.034	-0.727***	-0.209*	-0.830	-0.139
	(0.143)	(0.066)	(0.229)	(0.122)	(0.606)	(0.175)
R-squared	0.263	0.698	0.415	0.768	0.646	0.858
Observations	171,963	108,014	160,167	97,757	41,256	36,099
Destination-Year FE	no	no	yes	yes	yes	yes
Firm-year FE	no	no	yes	yes	yes	yes
Sector-year FE	yes	yes	no	no	no	no
Lagged dependent variable	no	yes	no	yes	no	yes
Selection adjustment	no	no	no	no	yes	yes

Notes: Robust standard errors adjusted for clustering at the firm-destination level are reported in parenthesis. In turn, * is used to denote significance at the 10% level, ** significance at the 5% level, and *** significance at the 1% level.

heterogeneity of our results across firms' size, we estimate our model by splitting firms into small, medium and large. The sample split is obtained by calculating the median and the 75^{th} percentile of employment. In order to avoid having a disproportionate number of observations for one group, we define small firms as those with an employment level lower than the median; medium firms are the ones with employment ranging between the median and the 75^{th} percentile and large firms are those with employment larger than the 75^{th} percentile.[15]

[15]We include all firms with employment below the median as small and firms with employment above the top quartile as large to avoid having a disproportionate number of observations for one group. This is needed, because large firms export to more destination on average, and our unit of observation is the firm-destination pair. The results are robust to different sample splits.

5.3.1 Manufacturing firms subsample

The result including manufacturing firms only are reported in Tables 5 and 6 for the extensive and intensive margins, respectively. Looking first at the extensive margin results reported in Table 5, the risk-elasticity coefficient, β, has the predicted negative sign, and is similar in magnitude compared to the baseline estimated coefficient in Table 3.

Table 6 reports the results for the intensive margin regression. Again the results for the manufacturing subsample are very similar to the baseline results. In the least saturated specifications that include the traditional control variables, the intensive margin risk elasticity is estimated to be very close to 0. Considering the most complete specification including destination-specific and firm-specific time effects, and after adjusting for sample selection and controlling for serial correlation (column 6 of Table 6), the intensive margin risk elasticity is also not found to be statistically significant, and the point estimate is indeed very close to 0. We conclude that our results are robust if we include only the manufacturing firms.

5.3.2 Risk elasticity and firm size

Next, we estimate our model separately for small, medium and large firms, to investigate if there is evidence of heterogeneous risk-elasticities. Recall that our model predicts that the extensive margin risk-elasticity should be larger for sectors in which the elasticity of substitution across differentiated varieties is smaller and, thus, where firms enjoy higher mark-ups. Direct evidence on the size of mark-ups suggests that in markets in which firms enjoy higher mark-ups (for example, markets for higher quality goods), firms are on average larger (see, for example, Atkin et al., 2015, and Chen and Juvenal, 2020).

We estimate the model for small, medium and large firms, using all our sample, and also using the subsample that includes only the manufacturing firms. Working with the entire sample, we classify firms as small, medium and large as follows: small firms are those with less than 18 employees, medium firms' number of employees range from 18 to 50, and large

Table 7: Extensive margin by firm size

	All firms											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	small				medium				large			
DIST	-0.046***	-0.031***			-0.074***	-0.044***			-0.110***	-0.057***		
	(0.0014)	(0.001)			(0.002)	(0.001)			(0.002)	(0.001)		
GDP	0.022***	0.013***			0.022***	0.010***			0.030***	0.014***		
	(0.001)	(0.001)			(0.001)	(0.001)			(0.001)	(0.001)		
AGE	0.076***	0.017***			0.070***	0.017***			0.098***	0.033***		
	(0.004)	(0.003)			(0.005)	(0.004)			(0.004)	(0.002)		
Risk	-0.046***	-0.024***	0.001	0.007	-0.105***	-0.061***	-0.031	-0.022	-0.174***	-0.090***	-0.082***	-0.049***
	(0.011)	(0.008)	(0.018)	(0.014)	(0.017)	(0.011)	(0.023)	(0.017)	(0.016)	(0.010)	(0.021)	(0.014)
R-squared	0.335	0.384	0.070	0.172	0.087	0.230	0.315	0.393	0.095	0.291	0.269	0.393
Observations	205,085	179,410	219,606	192,122	147,068	128,646	142,421	124,579	288,007	251,951	285,250	249,536
Destination-Year FE	no	no	yes	yes	no	no	yes	yes	no	no	yes	yes
Firm-year FE	no	no	yes	yes	no	no	yes	yes	no	no	yes	yes
Sector-year FE	yes	yes	no	no	yes	yes	no	no	yes	yes	no	no
Lagged dependent variable	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes

	Manufacturing firms											
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	small				medium				large			
DIST	-0.058***	-0.036***			-0.089***	-0.049***			-0.123***	-0.0614***		
	(0.002)	(0.001)			(0.003)	(0.002)			(0.002)	(0.001)		
GDP	0.0219***	0.0123***			0.023***	0.010***			0.030***	0.0121***		
	(0.001)	(0.001)			(0.002)	(0.001)			(0.001)	(0.001)		
AGE	0.088***	0.025***			0.072***	0.014***			0.099***	0.034***		
	(0.005)	(0.004)			(0.007)	(0.004)			(0.005)	(0.003)		
Risk	-0.090***	-0.043***	-0.019	0.001	-0.156***	-0.068***	0.018	0.011	-0.231***	-0.122***	-0.099**	-0.062**
	(0.020)	(0.014)	(0.031)	(0.023)	(0.038)	(0.024)	(0.057)	(0.042)	(0.027)	(0.015)	(0.041)	(0.026)
R-squared	0.071	0.192	0.325	0.388	0.088	0.260	0.299	0.401	192,169	168,112	191,147	167,216
Observations	125,964	110,194	119,275	104,335	87,801	76,811	86,073	75,299	0.094	0.305	0.266	0.399
Destination-Year FE	no	no	yes	yes	no	no	yes	yes	no	no	yes	yes
Firm-year FE	no	no	yes	yes	no	no	yes	yes	no	no	yes	yes
Sector-year FE	yes	yes	no	no	yes	yes	no	no	yes	yes	no	no
Lagged dependent variable	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes

Notes: Robust standard errors adjusted for clustering at the firm-destination level are reported in parenthesis. In turn, * is used to denote significance at the 10% level, ** significance at the 5% level, and *** significance at the 1% level.

Table 8: Intensive margin by firm size

All firms												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	small				medium				large			
Risk	0.359**	0.104	2.237	0.572	-0.0672	0.0780	0.790	0.115	-0.815***	-0.395***	-0.583	-0.0887
	(0.144)	(0.137)	(1.422)	(0.469)	(0.190)	(0.146)	(1.098)	(0.394)	(0.192)	(0.115)	(0.529)	(0.150)
R-squared	0.573	0.772	0.757	0.879	0.500	0.733	0.687	0.848	0.462	0.759	0.620	0.847
Observations	56,378	25,973	4,376	3,829	49,272	27,160	7,728	6,762	130,966	83,489	40,384	35,336
Destination-Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm-year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sector-year FE	no	no	no	no	no	no	no	no	no	no	no	no
Lagged dependent variable	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
Selection adjustment	no	no	yes	yes	no	no	yes	yes	no	no	yes	yes

Manufacturing Firms												
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	small				medium				large			
Risk	0.0628	-0.153	3.551**	1.113*	-0.129	-0.0218	1.387	0.680	-1.231***	-0.388**	-0.607	-0.0689
	(0.209)	(0.169)	(1.647)	(0.591)	(0.440)	(0.314)	(2.078)	(0.834)	(0.324)	(0.167)	(0.684)	(0.193)
R-squared	0.515	0.737	0.743	0.875	0.440	0.703	0.644	0.817	0.429	0.752	0.603	0.845
Observations	36,555	18,344	3,536	3,094	33,581	19,938	6,688	5,852	89,880	59,307	30,704	26,866
Destination-Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Firm-year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Sector-year FE	no	no	no	no	no	no	no	no	no	no	no	no
Lagged dependent variable	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
Selection adjustment	no	no	yes	yes	no	no	yes	yes	no	no	yes	yes

Notes: Robust standard errors adjusted for clustering at the firm-destination level are reported in parenthesis. In turn, * is used to denote significance at the 10% level, ** significance at the 5% level, and *** significance at the 1% level.

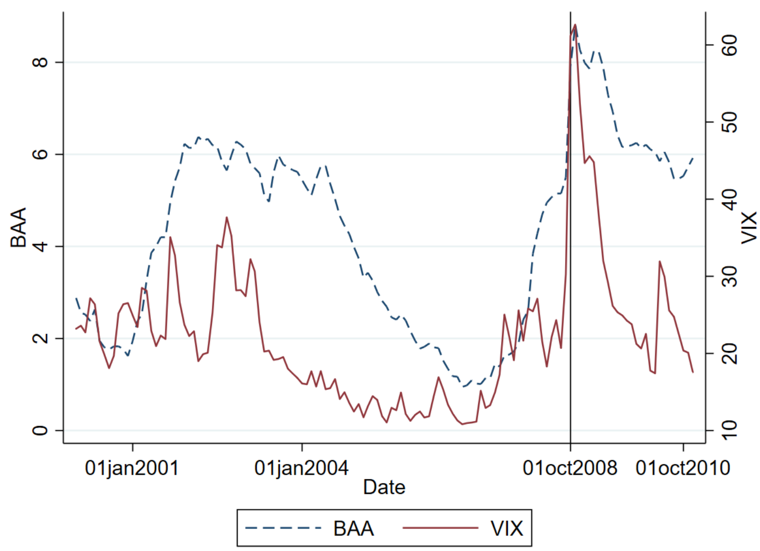
firms have more than 50 employees. For the sample of manufacturing firms, we define small firms as those with less than 25 employees, medium firms are the ones which have between 50 and 65 employees and large firms have more than 65 employees. As we did for our main analysis, we consider the extensive margin and the intensive margin risk-elasticities.

Table 7 reports the extensive margin results for the sample of all firms (top panel) and manufacturing firms (bottom panel). There is evidence of substantial heterogeneity across firms of different size. The extensive margin risk elasticities appear to be substantial for large firms and modest for small firms. The pattern of heterogeneity is the same for both the full sample and the subsample of manufacturing firms. Venturing outside the scope of our model, it is possible to argue that large firms are able to invest more in R&D and advertisement (Kugler and Verhoogen, 2011), and therefore are associated with higher quality products and higher product differentiation. Indeed, our model predicts larger elasticities in markets in which firms enjoy higher mark-ups and higher market shares on average, and large firms are associated with larger market-shares and greater mark-ups.

Next, we consider in Table 8 the results for the intensive margin trade elasticity, for small, medium and large firms.[16] The top panel displays the sample of all firms and the bottom the manufacturing firms sample. The first two columns for each firm category report the estimations for non-zero FOB values while the last two columns control for selection. Overall, the results are consistent with the prediction that risk does not affect directly the intensive margin of trade, especially after controlling for selection. Once again, the results are very similar when we consider the full sample of firms as well as the sample which includes manufacturing firms only. We conclude that the intensive margin is not directly affected by risk. However, given the evidence above, that the extensive margin risk elasticity is heterogeneous across firm size, risk will affect the intensive margin of trade indirectly. Our results indicate that large firms are more affected by risk in the extensive margin. Since large

[16] We only report the results based on the most stringent specification to preserve space but the ones based on the other specification are robust and available upon request.

Figure 3: Risk in the Great Recession



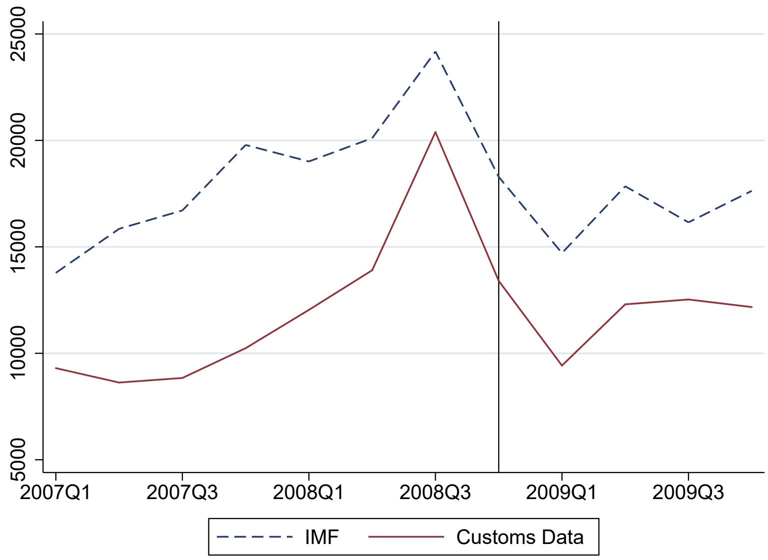
Notes: The Figure compares the monthly evolution of the Chicago Board Options Exchange Volatility Index (the VIX index), and the Moody's Seasoned Baa Corporate Bond spread vis-a-vis the US federal funds rate. Both measures are sourced from the Federal Reserve Bank of St. Louis Fred.

firms export more on average, conditional on serving a given market, the upshot is that an increase in risk will affect disproportionately large firms and indirectly will result in lower average exports conditional on exporting. Thus, the intensive margin is indirectly affected by the risk channel. We discuss this further in the following section, that looks at time-varying risk premium as a contributing factor to the 2008–2009 trade collapse.

6 Risky business cycles and the trade collapse

This section investigates the role of time-varying risk premia as a source of fluctuations in aggregate bilateral trade flows. We consider the global financial crisis to be a salient period of heightened volatility and risk premia. Thus, we introduce time-varying volatility and, in particular, consider variation in aggregate consumption growth risk, $\text{std}_t\left(g_{t+1}\right)$, as a factor contributing to the trade collapse during the 2008–2009 Great Recession.

Figure 4: Trade in the Great Recession



Notes: The Figure compares the evolution of Argentinean exports (million US dollars) between 2007Q1 and 2009Q4 using the International Financial Statistics of the IMF data (blue line) and the aggregate FOB from our customs data set (red line).

The crisis is typically dated between the forth quarter of 2008 and the third quarter of 2009 (see Chor and Manova, 2012). We corroborate the dates of the crisis by inspecting both volatility and trade data. Figure 3, shows two popular measures of uncertainty: the Chicago Board Options Exchange Volatility Index (the VIX index) and the Moody's Seasoned Baa Corporate Bond spread vis-à-vis the US federal funds rate.

From the Figure, it is clear that volatility peaked around the start of the crisis but remained high until the end of 2009. The timing of the heightened uncertainty is in line with the aggregate time series trends for the overall exports by Argentinean firms, which is plotted in Figure 4. It shows the evolution of exports at quarterly frequency between 2007 and 2009. For comparison, we show both the figures from the IMF International Financial Statistics (IFS) and the ones implied by our firm level data. Total exports reached a peak in the third quarter of 2008 (2008Q3), fell sharply until the third quarter of 2009 (2009Q3), after which

Table 9: Decomposition of margins

	Total exports	Extensive margin		Intensive margin
		Firms	Destinations	Sales
2007Q4-2008Q3	56,575	9,377	4	631,621
2008Q4-2009Q3	47,656	8,791	4	580,832
Growth	-16%	-6%	0%	-8%
Contribution		49%		51%

Notes: Destinations and Sales denote average destinations and average sales, respectively. Total exports are in million US dollars while average sales per firm-destination are in US dollars.

they began to slowly recover. In 2009Q3, total exports were 35 percent lower relative to their value in 2008Q3. The decline in exports between the last quarter of 2008 and the third quarter of 2009 (henceforth 2008Q4-2009Q3) is stark, and coincides with the period of heightened global uncertainty, We therefore select this date as the timing for the high uncertainty episode.

Starting in 2008Q4, because risk was greatly elevated compared to normal times, firm's decision to enter export markets was likely affected. In Table 9 we assess the contributions of the extensive and intensive margins to the dynamics of Argentinean exports during the crisis. In line with Behrens, Corcos, and Mion (2013), we decompose nominal exports X in a given time period as $X = j \times \bar{i} \times \bar{x}$, where j denotes the number of exporting firms, $\bar{i}$ the mean number of countries each firm exports to and $\bar{x} = X / \left(j \times \bar{i}\right)$ is the mean sales per firm-destination. Defining exports in the following period as, $\tilde{X}$, the change in exports from 2007Q4-2008Q3 and 2008Q4-2009Q3 can be written as $\Delta X = \tilde{X}/X$. Therefore, $\Delta X = \Delta j \times \Delta\bar{i} \times \Delta\bar{x}$. Note that Δj and $\Delta\bar{i}$ capture the changes at the extensive margin and $\Delta\bar{x}$ the changes at the intensive margin.

As shown in Table 9, exports contracted by 16 percent during the crisis. This fall was driven by a 6 percent reduction in the number of exporters, with no changes in the mean number of destinations per firm. Changes at the extensive margin therefore reduced exports by $(0.94 - 1) \times 100 = -6\%$. The reduction of exports at the intensive margin, given by the mean value of exports per firm-destination fell by 8 percent. Overall, the relative contributions of the intensive and extensive margins to the collapse of exports amounted to 51 and 49 percent, respectively. In the next subsection we analyze how the aggregate risk premia shock around the crisis affected the probability of exporting and the volume of exports.

6.1 Estimation

Our model predicts that the effect of heightened uncertainty is heterogeneous across export destinations and, in particular, is large for export destinations which are "risky" in the sense that they comove positively and strongly with the domestic households' growth rate of consumption. These are the countries for which our measure of comovement, $\rho\left(\hat{\eta}_{it+1}, g_{t+1}\right)$, is large and positive.

To test this prediction we obtain data at the quarterly frequency, spanning the period from 2007 until 2009. We estimate the following difference-in-difference (DID) specification

$$d_{jit} = \delta' \mathbf{F}_{jit} + \beta\, \mathbf{Crisis}_t \times \mathbf{Risk}_{ji}^{(si)} + \varepsilon_{jit}, \tag{33}$$

where the dependent variable, d_{jit}, is again a dummy variable taking value 1 if the firm j exports to destination i at time t. The covariate $\mathbf{Risk}_{ji}^{(si)}$ denotes the baseline measure of risk, varying across sector and destination, while $\mathbf{Crisis}_t$ is a dummy variable capturing the aggregate risk premium shock and, thus, takes value 1 for the period of elevated uncertainty during 2008-2009. In our baseline specification, $\mathbf{Crisis}_t$ is defined to take value 1 starting in 2008Q4 and until 2009Q3. For the pre-crisis period, we use data from 2007Q4-2008Q3. Our main specifications includes destination-firm fixed effect, and destination-specific and sector-specific time effects, collected in the vector $\mathbf{F}_{jit}$. Note that the inclusion of the time effects absorbs the individual effects (non-interacted) of the covariates $\mathbf{Crisis}_t$ and $\mathbf{Risk}_{ji}^{(si)}$,

Table 10: Time-varying risk premium and the trade collapse

	Extensive Margin		Intensive Margin	
	(1)	(2)	(3)	(4)
Crisis × Risk	-0.020**	-0.021**	-0.052	-0.088
	(0.008)	(0.009)	(0.080)	(0.134)
R-Squared	0.45	0.47	0.828	0.848
Observations	477,000	417,375	146,636	80,612
Destination/Time FE	yes	yes	yes	yes
Firm-Destination FE	yes	yes	yes	yes
Sector/Time FE	yes	yes	yes	yes
Lagged dependent variable	no	yes	no	yes

Notes: Robust standard errors adjusted for clustering at the firm-destination level are reported in parenthesis. In turn, * is used to denote significance at the 10% level, ** significance at the 5% level, and *** significance at the 1% level. The pre-crisis period corresponds to 2007Q4-2008Q3 and the crisis period corresponds to 2008Q4-2009Q3.

which are therefore not included in the regression specification. Our main prediction is that the coefficient β should be negative, implying that the heightened uncertainty has a more detrimental impact on the choice to export to risky destinations.

In addition to the extensive margin specification, we also estimate a similar model to (33) but for the intensive margin of trade. Thus, the dependent variable is the logarithm of FOB exports. When examining the intensive margin, to alleviate selection bias we restrict observations to the firm/destination pairs for which observed exports are always positive (as in Section 5). With regards to the intensive margin, the model's prediction is that fluctuations in risk premia should have no direct impact on the value of exports, regardless of the riskiness of the export destination. Results are shown in Table 10. Columns (1) and (2) of Table 10 report the results for the extensive margin while columns (3) and (4) include the ones for the intensive margin. For the extensive margin, the coefficient on the interaction

Table 11: Time-varying risk premium and the trade collapse by firm size

	Extensive Margin					
	small firms		medium firms		large firms	
	(1)	(2)	(3)	(4)	(5)	(6)
Crisis × Risk	-0.006	-0.013	-0.043***	-0.028	-0.033***	-0.029**
	(0.012)	(0.014)	(0.016)	(0.018)	(0.011)	(0.013)
R-Squared	0.348	0.374	0.417	0.437	0.501	0.515
Observations	151,504	132,566	104,584	91,511	220,128	192,612
	Intensive Margin					
	small firms		medium firms		large firms	
	(1)	(2)	(3)	(4)	(5)	(6)
Crisis × Risk	-0.047	0.054	-0.198*	-0.165	0.133	0.092
	(0.100)	(0.198)	(0.116)	(0.180)	(0.118)	(0.140)
R-Squared	0.801	0.825	0.779	0.798	0.824	0.845
Observations	31,684	13,448	29,632	14,836	85,111	52,122
Destination/Time FE	yes	yes	yes	yes	yes	yes
Firm-Destination FE	yes	yes	yes	yes	yes	yes
Sector/Time FE	yes	yes	yes	yes	yes	yes
Lagged dependent variable	no	yes	no	yes	no	yes

Notes: Robust standard errors adjusted for clustering at the firm-destination level are reported in parenthesis. In turn, * is used to denote significance at the 10% level, ** significance at the 5% level, and *** significance at the 1% level. The pre-crisis period corresponds to 2007Q4-2008Q3 and the crisis period corresponds to 2008Q4-2009Q3.

term, $\mathbf{Crisis}_t \times \mathbf{Risk}_{ji}^{(si)}$ is found to be negative and is statistically significant. Thus, the heightened risk premia is found to affect the cross-sectional profile of selected destinations, lowering the probability that firms select into the most risky destinations. consistent with the model's predictions. The two last columns of Table 10 consider the intensive margin response. Consistent with the model's prediction, the response is not statistically different from zero.

To be clear, our results do not imply that the intensive margin is not important. To the contrary, we know from the decomposition in Table 9, that the intensive margin is associated with 51% of the decline in Argentinean exports during the crisis. In relation to the risk channel, we find that risk premium shocks are not associated with greater declines in the intensive margin, consistent with Proposition 1. This inference is possible since more risky markets are not found to have a greater decline in the intensive margin during the crisis.

However, as discussed before, the finding that time-varying risk has no direct impact on the intensive margin of trade does not imply that the heightened uncertainty during the 2008 financial crisis did not affect the intensive margin. From the results by firm size reported in Section 5, we already know that the extensive margin risk channel is heterogeneous across firms and affects mostly large firms. Next we investigate if the effects of elevated risk premia are also heterogeneous across firms of different size. The results are reported in Table 11, and are consistent with our previous findings. Large firms suffer a larger decline in the extensive margin concentrated on the riskier markets, while the risk channel is unimportant for the small firms. The risk channel has no direct effect on the intensive margin. However, since large firms export more, the risk channel indirectly affects the intensive margin: the extensive margin response to the increase in risk leads, indirectly, to a lowering of the average value of exports conditional on exporting (intensive margin).

7 Conclusion

During large economic downturns, risk premia can play an important role in driving trade fluctuations, as it happened during the great trade collapse. However, workhorse models used to predict the direction and magnitude of trade do not include a role for risk premia. In this paper we propose an extension of the model by Chaney (2008) to include a role for risk, and we leverage data on bilateral trade flows and firm level data on Argentinean exporters to study how risk affects the behavior of exporters.

The model delivers testable predictions on how risk affects the extensive and intensive margins of trade. In particular, risk affects the extensive margin directly by discouraging exports to riskier destinations. There is no direct effect of risk on the average value of exports conditional on market selection. However, the extensive margin risk-elasticity of trade is larger in sectors in which there is greater product differentiation resulting in firms enjoying larger mark-ups. We find that the risk channel affects the extensive margin, and the effect is predominantly concentrated on large firms. Although risk does not affect the intensive margin directly, it does so indirectly. Higher risk results in a lower average value of export conditional on exporting (intensive margin), due to the heterogeneous effect across firm in the probability of selection into different export destinations.

We test the predictions of our model using firm-level Argentinean export data between 2002 and 2009. Consistent with the theoretical predictions, we find that risk affects directly the extensive margin of trade but not the intensive margin. The results are robust to different specifications. As an application, we investigate the impact of risk on bilateral trade flows during the Global Financial Crisis, since this is a typical example of a period of heightened risk premia. In line with the model predictions, during this period, we find that Argentinean exporters shifted away from more risky destinations.

One promising avenue for future research would be to use our framework to identify how risk shapes the composition of products exported in addition to the export destinations.

A Appendix Model

In this section we provide the detailed derivation of equation (22).

Conditional on exporting to destination i, the value of exports by a firm with productivity ϕ at date $t+1$ is given by

$$\begin{aligned} x_{jit+1} &= Z_{ist+1} p_{jit+1}^{1-\epsilon_s}, \\ &= \left(\frac{\epsilon_s}{\epsilon_s - 1}\right)^{1-\epsilon_s} \left(\frac{W\tau_i}{\phi_j}\right)^{1-\epsilon_s} Z_{ist+1}. \end{aligned} \tag{34}$$

But in sector s only firms with productivity $\phi_j \geq \bar{\phi}_{ist}$ export to country i at date $t+1$. Since ϕ_j has the Pareto distribution with shape parameter $\alpha > \epsilon_s - 1$, aggregate exports at date t from Home to country i are given by

$$\begin{aligned} X_{ist+1} &= \int_{\bar{\phi}_{ist}}^{\infty} x_{jit+1}(\phi)\, d\mathbf{F}(\phi), \\ &= \left(\frac{\epsilon_s}{\epsilon_s - 1}\right)^{1-\epsilon_s} \int_{\bar{\phi}_{ist}}^{\infty} Z_{ist+1} \left(\frac{W\tau_i}{\phi}\right)^{1-\epsilon_s} d\mathbf{F}(\phi), \\ &= \left(\frac{\epsilon_s}{\epsilon_s - 1}\right)^{1-\epsilon_s} Z_{ist+1} W^{1-\epsilon} \tau_i^{1-\epsilon} \int_{\bar{\phi}_{ist}}^{\infty} \alpha \phi^{(\epsilon-1)-\alpha-1} d\phi, \\ &= \left(\frac{\alpha}{1-\epsilon_s+\alpha}\right) \left(\frac{\epsilon_s}{\epsilon_s - 1}\right)^{1-\epsilon_s} Z_{ist+1} W^{1-\epsilon_s} \tau_i^{1-\epsilon_s} \bar{\phi}_{ist}^{(\epsilon_s-1)-\alpha}. \end{aligned} \tag{35}$$

Making use of equation (20) to substitute for $\bar{\phi}_{ist}$ in (35) yields

$$X_{ist+1} = \left(\frac{\alpha}{1-\epsilon_s+\alpha}\right) \left(\frac{\epsilon_s}{\epsilon_s - 1}\right)^{1-\epsilon_s} Z_{ist+1} (W\tau_i)^{-\alpha} \left[\beta \lambda_s Z_{ist} \left(\frac{1-\sigma_{\varepsilon,g}}{f_i}\right)\right]^{\alpha/(\epsilon_s-1)-1}. \tag{36}$$

Finally, making use of equation (8) yields the expression (22) in the main text.

B Appendix Robustness

Table B1: Robustness: All firms

	(1)	(2)	(3)	(4)
Risk	-0.058***	-0.034***	-0.822*	-0.159
	(0.015)	(0.010)	(0.495)	(0.145)
R-squared	0.310	0.398	0.658	0.859
Observations	666,855	583,366	53,104	46,466
Destination-Year FE	yes	yes	yes	yes
Firm-year FE	yes	yes	yes	yes
Sector-year FE	no	no	no	no
Lagged dependent variable	no	yes	no	yes
Selection adjustment	no	no	yes	yes

Notes: Columns (1) and (2) present the extensive margin results and columns (3) and (4) the intensive margin results. Robust standard errors adjusted for clustering at the firm-destination level are reported in parenthesis. In turn, * is used to denote significance at the 10% level, ** significance at the 5% level, and *** significance at the 1% level.

Table B2: Robustness: Manufacturing

	(1)	(2)	(3)	(4)
Risk	-0.096***	-0.048**	-0.847	-0.127
	(0.030)	(0.020)	(0.604)	(0.175)
R-squared	0.294	0.398	0.646	0.858
Observations	402,488	352,093	41,472	36,288
Destination-Year FE	yes	yes	yes	yes
Firm-year FE	yes	yes	yes	yes
Sector-year FE	no	no	no	no
Lagged dependent variable	no	yes	no	yes
Selection adjustment	no	no	yes	yes

Notes: Columns (1) and (2) present the extensive margin results and columns (3) and (4) the intensive margin results. Robust standard errors adjusted for clustering at the firm-destination level are reported in parenthesis. In turn, * is used to denote significance at the 10% level, ** significance at the 5% level, and *** significance at the 1% level.

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