Export Decision under Risk[*]

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Abstract

Does demand volatility matter for exports? How do exporting firms deal with skewed demand? A simple model of downside risk aversion shows that on average exporters increase export prices and reduce export volumes when demand volatility in destination markets increases. They behave the opposite way when demand skewness rises. We find that the moments of the demand distribution also affect the number of exporting firms and the industry supply. These adjustments may lead some firms to increase their exports when demand volatility increases. These theoretical predictions are put to the test by using French firm-level exports across destination markets with different levels of demand volatility and skewness. The firm-level results, over the period 2000-2009, are consistent with our predictions.

1 Introduction

Does demand volatility matter for exporters supply decisions? According to the Capgemini 2011 survey of large companies, 40% of respondents say that demand volatility is their number one business driver. Indeed, in numerous industries, sellers need to decide production levels or input procurements before the output is marketed or the market price

for output is known. Demand cannot be known for certain at the time the contracts with the importers are signed as expenditures for an industry are subject to random shocks. In this paper, we analyze how demand volatility affect the export decision at the firm level.

In most of the trade literature, the firm knows the state of demand function with certainty and only the *level* of foreign market size plays a key role in firm export performance. However, for a same level of demand (apparent absorption), we observe a significant demand *volatility* in destination markets. This point is illustrated in Figure (1) from data on world sectoral-level data. Under demand or price uncertainty, risk-averse firms have to

Figure 1: Demand (apparent consumption) level and demand volatility

Note: 82 countries, 62 sectors, 2005.
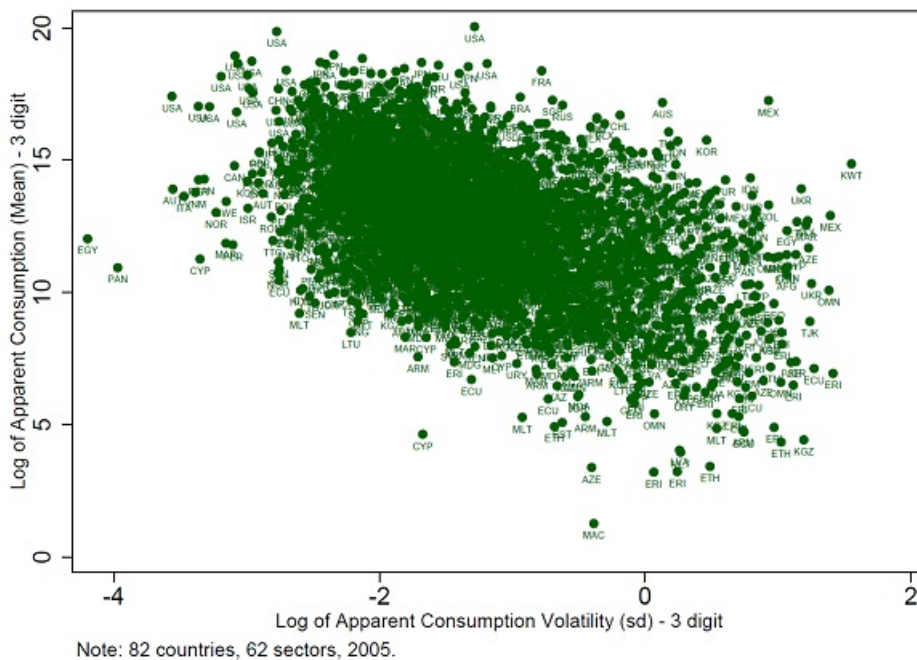
manage their risk exposure. Indeed, there exists some delay between the time an export decision is made and the time the corresponding output reaches the market. Hence, during this delay, the foreign demand or market price can change so that there is an uncertainty that the decision-maker has to handle. The literature on production decision under risk shows that an increase in risk (as measured by a higher volatility) has a negative effect on output size when the decision maker is averse to risk.

As a result, if firms are risk-averse, they should export less to a country with more volatile demand, *ceteris paribus*. In other words, a country with higher demand volatil-

ity should import less. Using the same database of world sectoral-level data, we find *prima facie* evidence of a negative relationship between demand volatility and imports, as depicted in Figure (2).[1]

Figure 2: Relationship between imports and demand volatility

Note: 100 countries, 63 sectors, 2000-09.
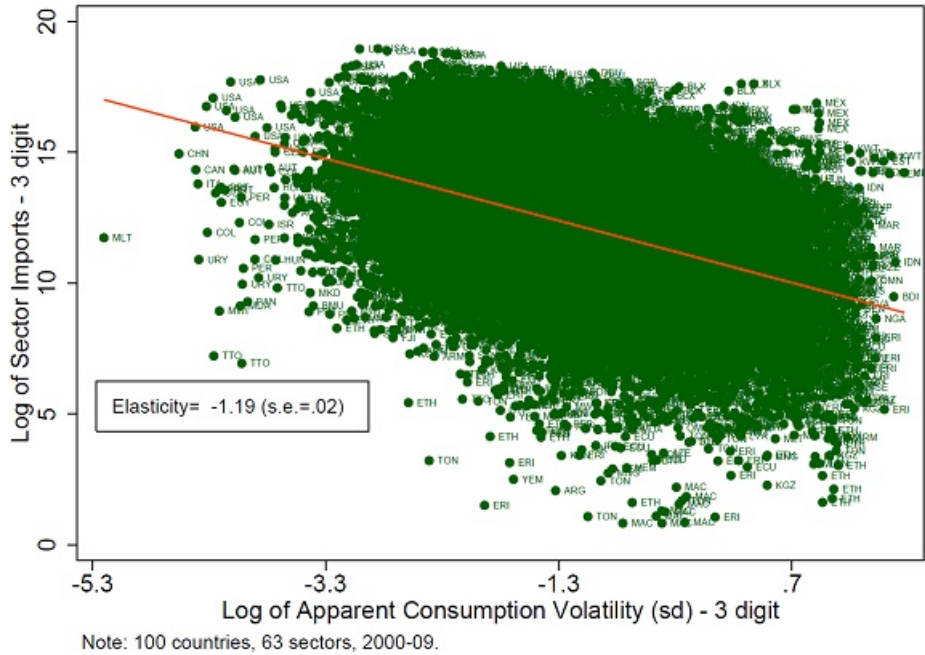
However, risk-averse firms react differently to uncertainty according to their characteristics. Indeed, demand fluctuation may force some producers to not enter the export market or to cease exporting and, in turn, the demand for the incumbent exporting firms may rise. Additionally, change in uncertainty may modify the relative prices among varieties supplied leading to a reallocation of market shares among the incumbent exporters. Hence, the effects of industry-specific uncertain demand on export performance at the firm level are not *a priori* clear.

Further, managers can be sensitive to downside losses, relatively to upside gains. It has been shown that macroeconomic fluctuations are skewed rather than symmetric (see e.g., Popov 2011). *Ceteris paribus*, managers might prefer to serve a country exhibiting a high probability of an extreme event associated with a high level of demand than a

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[1]This evidence is supported by an adjusted partial residual plot, controlling for year and country fixed effects. The corresponding elasticity of demand volatility is −0.17 (p<0.01) suggesting that an 1% increase in volatility in a destination country is associated with a 0.17% decrease in sectoral imports.

country with a high probability of an extreme event associated with a very low demand. Yet, the variance does not distinguish between upside risk versus downside risk. Skewness (the third central moment of a distribution) can be used as a measure of downside risk. Indeed, the sign of the skewness provides information on the asymmetry of the demand distribution, and thus on downside risk exposure. For a same mean and variance, countries with a demand distribution which is more skewed to the right can be viewed as providing better downside protection or smaller downside risk. A basic intuition is that an increase in skewness involves a smaller probability for low (or large negative) returns. A distribution exhibiting more downside risk than another is less skewed to the right.[2] For a same mean and variance, a decision-maker therefore prefer a distribution with the highest skewness.

To illustrate our point, consider the demand pattern of two hypothetical countries A and B. Each country exhibits a demand distribution with the same mean (6000 k€) and same variance $((6000)^2/3$ k€). Assume that, in country A, the level of demand is either 4000 k€ with a probability 3/4 or 12000 k€ with a probability 1/4 while, in country B, the level of demand is either 0 k€ with a probability 1/4 or 8000 k€ with a probability 3/4.[3] Despite an equal demand variance in each country, the manager may prefer to serve the country with a higher skewness (country A) because of a lower exposure to downside risk. In this case, the decision-maker is averse to downside risk. As a result, a manager prefers to serve a country with a large mean demand, a small variance and a large (unweighted) skewness.

In this paper, we study theoretically and empirically how firms adjust their intensive and extensive margins to a change in the variance and skewness of foreign demand. To achieve our goal, we first build a trade model where heterogeneous firms producing under imperfect competition face same industry-wide uncertainty over foreign demand. We adopt a mean-variance-skewness analysis so that firms are assumed to be averse both to risk and to downside losses. A comment is in order. By adopting this decomposition analysis, we consider a "small" risk. Indeed, export sales in a foreign country represent a low share in total sales of firms.

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[2]However, the converse is not necessarily true (Menezes, Geiss, and Tressler, 1980).

[3]A similar example can be found in Eeckhoudt, Gollier, and Schlesinger (2005) in a different context.

Our theory leads to the following predictions. A higher variance of foreign demand in a market raises the unit prices set by firms in this market through a change in their markup. The magnitude of this effect increases with the productivity of firms but decreases with trade costs. We also show that, even though a higher foreign demand volatility reduces the volume of industry export sales, its effect on the probability of exporting (extensive margin) and on the level of export sales at the firm level (intensive margin) is ambiguous. Indeed, a rise in demand volatility induces a reallocation of market share from most productive (and largest) firms to smaller firms. As a result, the probability of exporting may increase when fixed trade costs are not too high. Under this configuration, the export sales of medium-sized firms (or the smallest exporters) may grow. However, this effect is weakened when the skewness of foreign income increases.

To test our predictions, we use firm-level data from the French customs over the period 2000-2009. This database reports the volume (in tons) and value (in euros) of exports for each product (combined nomenclature) and destination, for each firm located on the French metropolitan territory. Our different estimations confirm our main predictions. Hence, decision-makers seem to act as if they were risk-averse and averse to downside losses. Our results are robust over different sized panels and to the inclusion of a plethora of fixed effects, and additional controls.

Our paper proceeds as follows. We present the related literature in Section 2. We then develop our multi-country model of trade with heteregeneous firms under imperfect competition in Section 3. Section 4 exposes the empirical strategy and the results. We conclude in Section 5.

2   Related literature

Although macroeconomic volatility plays a key role in a wide variety of economic outcomes (in long-run growth, investment and production decisions, welfare), rather little consideration has been given to its impact on export decision.

The determinants of macroeconomic volatility has received much attention. In particular, it has been argued that freer trade increases volatility at the country level. Industries

more open to international trade are more volatile even though the industries exporting in foreign countries or importing from different countries depend less on the domestic shocks (Giovanni and Levchenko 2009). On the one side, the industries exporting (or importing) a large fraction of their production (or their intermediate products) are vulnerable to world demand shocks (or supply shocks). On the other side, trade openness leads to a less diversified production structure, implying a greater specialization and, in turn, an increase in volatility. In addition, trade openness can exacerbate domestic volatility through a decline in the number of firms (Gabaix, 2011). Indeed, since lowering trade barriers induces an exit of small firms and boosts the size of large firms (Melitz, 2003), the economy becomes more and more dependent on the shocks at the firm level.

Besides, the macroeconomic volatility is a source of uncertainty which potentially influences the export decision. Indeed, trade decision are often made before the resolution of uncertainty. When an export commitment is made, the price received is unknown. The expected utility theory has been used to analyze international trade under risk and perfect competition (see Helpman and Razin 1978). More recently, the framework supplied by real option theory (Dixit and Pindyck 1994) has been introduced in trade model under imperfect competition. Given export sunk costs, the decision whether and when to export is very similar to an investment decision. For example, Baldwin and Krugman (1989) explain trade hysteresis despite large exchange rate fluctuations. In addition, Handley and Limao (2013) model trade policy uncertainty as a rare event to explain world trade patterns. A standard assumption in new trade theory is that firms are risk-neutral.

A recent literature emphasizes that uncertainty shocks may affect the choice to serve a foreign market through exports or affiliate sales. Lewis (2014) considers nominal uncertainty. He finds that when multinational sales are priced in the local currency while exports are priced in the producer currency, destination volatility benefits exporters: during a foreign nominal contraction, the foreign exchange rate appreciates, causing exports to be relatively cheaper. Exporters gain non-linearly through demand, making profit convex in prices. Ramondo, Rappoport, and Ruhl (2013) consider real uncertainty and changes in relative costs between exporters and multinationals. Exporters hire labor

at home compared to affiliates. Exporters' expected profits are thus increasing in the volatility of production costs in the destination country.

Our approach contributes to the trade literature in a number ways. First, we consider that when a firm chooses a certain quantity to serve a foreign market, the price that will obtain in the market is uncertain. The real value taken by foreign demand for each product is not known ahead of time. Second, we consider that firms are averse to risk and more particularly to downside risk. Third, we develop a model where firms are heterogeneous in productivity supplying a differentiated product (horizontal and vertical differentiation). Our approach differs from the current trade literature since we consider that managers know the productivity of their firm but do not have perfect information about the level of foreign demand.

3   Theory

In this section, we develop a multi-country model of trade with heterogeneous firms under imperfect competition. Firms differ in productivity, but unlike Melitz (2003), they know with certainty their production technology. Firms face instead an industry-wide uncertainty over foreign demand. Industry-specific demand is uncertain because industry level expenditures in destination country j, denoted by R_j, are subject to random shocks. Factors beyond the firm's control that influence the demand realization are climatic conditions, changes in consumer tastes, opinion leaders' attitudes, popularity of competing products, etc. We assume that R_j is independently distributed with a mean, a variance, and a skewness given by $\mathbb{E}(R_j)$, $\mathbb{V}(R_j)$, and $\mathbb{S}(R_j)$ respectively. Note that $\mathbb{E}(R_j)$ and $\mathbb{V}(R_j)$ are always positive while $\mathbb{S}(R_j)$ can be positive or negative. The economic interpretation of these three moments of R_j distribution is discussed below.

Hence, each firm located in country i and producing a variety v faces a downward sloping demand curve in destination country j given by $p_{ij}(v) = f[q_{ij}(v), R_j, .]$, where $p_{ij}(v)$ and $q_{ij}(v)$ are the price and the quantity of variety v respectively. We assume that the demand is not known for certain at the time the contracts with the importers are signed. As above-mentioned R_j is subject to random shocks that cannot be observed

at the time strategic variables (p_{ij} or q_{ij}) are chosen. The actual demand realization is therefore uncertain, and can be either higher or lower than the average expenditures, $\mathbb{E}(R_j)$. As a result, the dependence of price on quantity (and vice-versa) is given for every state of nature. In other words, the marginal revenue of each firm is volatile and not known with certainty at the time the contracts are signed.

Our objective is to analyze how risk-averse firms react to *industry-level* uncertainty in export decisions (both at the intensive and extensive margins), according to their characteristics and the features of destination country. On the one hand, the level of output may decrease for all firms due to demand fluctuations in accordance with the standard theory of production under uncertainty. On the other hand, some producers may not enter the export market or cease to export because of these fluctuations so that the demand for the remaining exporters may rise (due to a reallocation of demand). In addition, even if the demand shocks are common for all firms within an industry, it may modify the relative prices among varieties supplied by the surviving firms in this industry, leading to a reallocation of market shares. Hence, the effects of industry-specific uncertain demand on export performance at the firm level are not *a priori* clear.

Market structure, technology, and firm behavior

Varieties are provided by heterogeneous monopolistically competitive firms. Each variety is produced by a single firm and each firm supplies a single variety. This means that producers are negligible to the market, behave as monopolists on their market and their decisions do not account for the impact of their choice on aggregate statistics.

Labor is the only production factor and is assumed to be supplied inelastically. The production of $q_{ij}(v)$ units of variety v requires a quantity of labor equals to $\ell_{ij}(v) = \tau_{ij}q_{ij}(v)/\varphi$, where φ is the labor productivity and $\tau_{ij} > 1$ is an iceberg trade cost. We assume that the labor productivity is known *a priori* but differs among firms. Thus, the marginal requirement in labor is specific to each firm and to each destination, but does not vary with production.

Under imperfect competition, the choice of the action variables (quantity or price) merits a discussion. We know from Leland (1972) and Klemperer and Meyer (1986) that,

if the choice of behavioral mode by a monopolistic firm is unimportant under certainty, this is no longer the case under uncertainty. The firm has two options: (i) set quantity before demand is known and thereafter the actual demand curve yields the market clearing price or (ii) set price before demand is known and thereafter the actual demand curve yields the market clearing quantity. Ideally, we would determine endogenously if firms choose either a quantity to produce or a price to charge, as in Klemperer and Meyer (1986). In this section, we consider that firms set quantity first, before demand is known. In Appendix (A), we report the case where price is the strategic variable. We show that this configuration yields the same predictions than the case where firms set quantity even if the level of prices and quantities differ according to the behavioral mode.

Hence, without loss of generality, we assume that firms determine quantity, q_{ij}, for each destination j before knowing the value of R_j. Equilibrium prices p_{ij} are determined *ex post* in accord with realized demand. We assume that firms cannot adjust *ex post* quantity with respect to the demand shock. The decision to produce for exports has been taken *ex ante* and thus *ex post* adjustments of quantity are not feasible. The producer cannot refuse the deal *ex post* once the price is realized. This implies that products cannot be sent back. They are sold once exported.

As the shocks to market demand are unobservable, the impact of quantity on price is uncertain. The expected export profit in a given market is

$$\mathbb{E}\left[\pi_{ij}(v)\right] = \mathbb{E}\left[p_{ij}(v)\right] q_{ij}(v) - \frac{w_i \tau_{ij}}{\varphi} q_{ij}(v) - w_i f_{ij}, \tag{1}$$

where w_i is the wage rate prevailing in the exporting country i. Firms located in country i serving the destination country j have to pay a fixed cost f_{ij} to serve foreign markets, which are the costs to maintain a presence, (*i.e.*, maintaining a distribution and service network, minimum freight and insurance charges, costs of monitoring foreign customs procedures and product standards, etc.).

We assume that markets are segmented and that shocks are not correlated across countries, such that the covariance between π_{ij} and π_{ik}, with $k \neq j$, is zero as $\text{Cov}(R_k, R_j) = 0$. The uncertain terminal profit of a firm producing variety v and located in country i, π_i,

can be decomposed into two parts: the profit of domestic sales π_{ii} and the profit of total exporting sales $\Sigma_j \pi_{ij}$, such that $\pi_i = \pi_{ii} + \Sigma_j \pi_{ij}$. Throughout, we assume that the domestic profit π_{ii} is known with certainty.

Uncertainty and firm behavior

We consider an utility function of a manager $\Pi(\pi_i)$ representing his/her risk preferences with $\Pi'(\pi_i) > 0$. The manager is made better off by an increase in his/her terminal profit. Assume that the utility function $\Pi(\pi_i)$ is continuously differentiable up to order 3. We follow the methodology developed in Eeckhoudt, Gollier, and Schlesinger (2005). A third order Taylor series expansion of $\Pi(\pi_i)$ evaluated at $\mathbb{E}(\pi_i)$ gives

$$\Pi(\pi_i) \approx \Pi(\mathbb{E}(\pi_i)) + \Pi' [\pi_i - \mathbb{E}(\pi_i)] + \frac{1}{2}\Pi'' [\pi_i - \mathbb{E}(\pi_i)]^2 + \frac{1}{6}\Pi''' [\pi_i - \mathbb{E}(\pi_i)]^3.$$

Taking the expectation and assuming that the moments exist lead to

$$\mathbb{E}\Pi(\pi_i) \approx \Pi[\mathbb{E}(\pi_i)] + \frac{1}{2}\Pi'' \mathbb{E}[\pi_i - \mathbb{E}(\pi_i)]^2 + \frac{1}{6}\Pi''' \mathbb{E}[\pi_i - \mathbb{E}(\pi_i)]^3.$$

According to the expected utility theory, in the neighborhood of $\mathbb{E}(x)$ where x is a random variable, we have $\mathbb{E}\Pi(x) = \Pi(\mathbb{E}(x) - \Gamma)$ where Γ is the risk premium. In our case, the risk premium Γ is defined as the sure amount of money a manager would be willing to receive to become indifferent between receiving the risky return π_i versus receiving the sure amount $\mathbb{E}(\pi_i) - \Gamma$. Because $\mathbb{E}\Pi(\pi_i)$ can also be approximated as follows $\mathbb{E}\Pi(\pi_i) = \Pi[\mathbb{E}(\pi_i)] - \Gamma\Pi'$, we have

$$\Gamma \approx -\frac{1}{2}\frac{\Pi''}{\Pi'}\mathbb{V}(\pi_i) - \frac{1}{6}\frac{\Pi'''}{\Pi'}\mathbb{S}(\pi_i), \tag{2}$$

where $-\Pi''/2\Pi'$ and $-\Pi'''/6\Pi'$ are the marginal contributions of variance ($\mathbb{V}(\pi_i) = \mathbb{E}[\pi_i - \mathbb{E}(\pi_i)]^2$) and skewness ($\mathbb{S}(\pi_i) = \mathbb{E}[\pi_i - \mathbb{E}(\pi_i)]^3$) of π_i to the risk premium Γ, respectively. The term $-\Pi''/2\Pi'$ is known as the so-called Arrow–Pratt absolute risk aversion coefficient. The term $-\Pi'''/6\Pi'$ captures a preference for positive skewness when $\Pi''' > 0$, because it implies a low probability of obtaining a large negative return. Note that skew-

ness to the left ($\mathbb{S}(\pi) < 0$) is associated with "downside risk" exposure, while skewness to the right ($\mathbb{S}(\pi) > 0$) is associated with "upside risk" exposure.

Two remarks are in order. First, risk aversion can decrease with wealth of the individuals. Under this configuration, decision makers exhibit decreasing absolute risk aversion (DARA preferences) implying $\Pi''' > 0$. This entails that the risk aversion of the exporter decreases with its level of domestic sales. Second, $\Pi''' > 0$ corresponds to "downside risk aversion", implying that a rise in downside risk (a decrease in $\mathbb{S}(\pi)$) would tend to increase the willingness to pay to avoid risk (Menezes, Geiss, and Tressler, 1980).

Finally, we know from expected utility theory that maximizing $\mathbb{E}\Pi(x)$ is equivalent to maximizing the certainty equivalent $\mathbb{E}(x) - \Gamma$. Since expression (2) provides a local approximation to the risk premium Γ, it follows that the objective function of a decision-maker can always be approximated by

$$\Pi_v(\pi_i) \approx \mathbb{E}(\pi_i) - \rho_v \mathbb{V}(\pi_i) + \eta_v \mathbb{S}(\pi_i), \tag{3}$$

with $\rho_v \equiv -\Pi''/2\Pi'$ and $\eta_v \equiv \Pi'''/6\Pi'$. Remember that $\rho_v > 0$ expresses the absolute degree of the firm's risk aversion. If $\rho_v = 0$, firms are risk neutral. This general formulation does not require a full specification of the utility function $\Pi_v(\pi)$ and it allows us going beyond a simple mean-variance analysis in the investigation of export decision under demand uncertainty. This may be particularly useful in the analysis of "downside risk" exposure. However, the reader should keep in mind that expression $\Pi_v(\pi)$ is valid only in the neighborhood of the point $\mathbb{E}(\pi_i)$. In other words, we only consider small risk. Given that the share of export sales in one country to total sales is low, this assumption is not too restrictive.

Preferences and demand

To study the effect of uncertainty on export decision, we use a simple and tractable utility function yielding a specific demand curve.[4] The consumer preferences are identical

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[4]We could use the general setting in which the demand curve is $p_{ij} = f(q_{ij}, R_j)$. However, this increases the complexity of the formal developments while the gains in results are limited. What matters for most of our results is that export prices (1) decrease in export quantities ($\partial p_{ij}/\partial q_{ij} < 0$), (2) increase in destination demand ($\partial p_{ij}/\partial R_j > 0$), (3) with a diminishing marginal effect as export quantities increase

and the utility of the consumption of the differentiated good is given by

$$U_j = \int_{v \in \Omega_j} u_j(v) \mathrm{d}v, \tag{4}$$

where Ω_j is the set of available varieties v in country j. Hence, as in Dixit and Stiglitz (1977), Krugman (1979) and Zhelobodko *et al.* (2012), we assume that preferences over the differentiated product are additively separable across varieties. To keep things simple, we consider $u_j(.) = \theta_v q_j(v)^{1/2}$ where θ_v is the quality of variety v and $q(v)$ is the quantity consumed. Given that $\partial u(v)/\partial q(v) > 0$ and $\partial^2 u(v)/\partial q(v)^2 < 0$, consumers exhibit a preference for variety.

The budget constraint faced by a consumer is given by

$$\int_{\Omega_j} p_{kj}(v) q_{kj}(v) \mathrm{d}v = R_j, \tag{5}$$

where R_j represents the income of the consumer and its total expenses, while $p_{kj}(v)$ is the price of variety v produced in country k with $k = i, j, ..K$.[5] Notice that deviations from expected demand in individual foreign markets, due to random shocks, may lead to potential gains and losses. By neglecting their effect on total income, which may cancel out, we adopt a partial equilibrium approach.

Maximizing (4) under the budget constraint (5) leads to the inverse demand:

$$p_{ij}(v) = \frac{\theta_v}{2\lambda} q_{ij}(v)^{\frac{-1}{2}}, \tag{6}$$

where λ is the Lagrange multiplier. Plugging (6) into (5) implies $\lambda = \Psi_j/2R_j$ with

$$\Psi_j \equiv \int_{\Omega_j} \theta_v q_{kj}(v)^{\frac{1}{2}} \mathrm{d}v. \tag{7}$$

The expression Ψ_j can be interpreted as a measure of industry supply. As a consequence,

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$\partial^2 p_{ij}/(\partial R_{ij} \partial q_{ij}) < 0$.

[5]Note that we could extend easily this framework by considering the case where U is embodied in a Cobb-Douglas upper-tier utility.

the inverse demand for each variety is now

$$p_{ij}(v) = R_j \theta_v q_{ij}(v)^{\frac{-1}{2}} \Psi_j^{-1}. \tag{8}$$

As expected, the price of a variety increases with its quality (θ_v) and the market size (R_j) but decreases with its quantity (q_{ij}) and rivals' quantity and quality of products (Ψ_j).

Intensive margin of exports with no uncertainty

We start by analyzing briefly the export decision with no uncertainty before introduction uncertainty. Each firm maximizes its profit (1) by setting its output $q_{ij}(v)$ to serve market j and by taking into account its impact on prices $p_{ij}(v)$ given in (8). Profit-maximizing quantity is given by

$$q_{ij}(v)^{\frac{1}{2}} = \frac{R_j}{2} \frac{\varphi \theta_v}{w_i \tau_{ij}} \Psi_j^{-1}, \tag{9}$$

so that

$$p_{ij}(v) = 2 \frac{w_i \tau_{ij}}{\varphi}.$$

Thus, under certainty, the equilibrium price is equal to the marginal cost $w_i \tau_{ij}/\varphi$ times a constant (equals to 2), while exports (in value and quantity) increase with productivity, quality and demand.

In what follows, we analyze how uncertain demand curve affect equilibrium prices and quantities at the firm level.

Intensive margin of exports with uncertainty

Under uncertainty, remember that exporting firms face a downward sloping demand curve characterized by a random shift parameter R_j (common to all firms in a given industry). R_j is not known for certain at the time the contracts with the importers are signed. The expected price prevailing for each firm in the foreign market is therefore given by

$$\mathbb{E}\left[p_{ij}(v)\right] = \mathbb{E}(R_j)\theta_v q_{ij}(v)^{\frac{-1}{2}} \Psi_j^{-1}. \tag{10}$$

For the sake of clarity, we first consider a mean-variance utility function such that $\eta_v = 0$ (i.e., *downside* and *upside* risks are not accounted for). Then, we will consider the role of skewness with $\eta_v \neq 0$. The payoff of each firm when $\eta_v = 0$ is as follows:

$$\Pi_v(\pi_i) = \mathbb{E}(\pi_i) - \rho_v \mathbb{V}(\pi_i) = \sum_j \mathbb{E}(\pi_{ij}) - \rho_v \sum_j \mathbb{V}(\pi_{ij}),$$

where $\mathbb{E}(\pi_{ij})$ is given by (1) and $\Sigma_j \mathbb{V}(\pi_{ij}) = \mathbb{V}(\pi_i)$ because $\text{Cov}(R_k, R_j) = 0$ for all $k \neq j$. Hence, the marginal revenue is uncertain while the marginal cost is known with certainty. The expected export sales $\mathbb{E}[p_{ij}(v)]q_{ij}(v)$ increases with q_{ij} but decreases with the industry's output size (captured through Ψ_j). The profit variance is

$$\mathbb{V}(\pi_{ij}) = \mathbb{V}(R_j)\theta_v^2 q_{ij}(v)\Psi_j^{-2}, \tag{11}$$

which increases with the firm's output size q_{ij} and decreases with the industry's output size. Hence, the mass of rivals serving the same market has an ambiguous effect on the export performance at the firm level. Indeed, a rise in Ψ_j decreases the marginal revenue of the firm but reduces the variance of profits.

First order condition $\partial \Pi_v / \partial q_{ij} = 0$ implies

$$\frac{1}{2}\mathbb{E}(R_j)\theta_v q_{ij}(v)^{\frac{-1}{2}}\Psi_j^{-1} - \frac{w_i \tau_{ij}}{\varphi} - \rho_v \mathbb{V}(R_j)\theta_v^2 \Psi_j^{-2} = 0, \tag{12}$$

and it is readily to check that $\partial^2 \Pi_v / \partial q_{ij}^2 < 0$. As a result, *Payoff*-maximizing quantity is given by

$$q_{ij}(v)^{\frac{1}{2}} = \frac{\mathbb{E}(R_j)\theta_v \varphi}{2 w_i \tau_{ij}}\Psi_j^{-1}\left[1 + \rho_v \mathbb{V}(R_j)\Psi_j^{-2}\frac{\theta_v^2 \varphi}{w_i \tau_{ij}}\right]^{-1}. \tag{13}$$

In accordance with the standard literature related to producer theory under uncertainty, the risk averse firms produce less than they would under certainty (because $\rho_v > 0$ so that $\partial q_{ij} / \partial \mathbb{V}(R_j) < 0$), for a given mass of exporters. Further, we can readily check that quantities are concave in productivity ($\partial q_{ij} / \partial \varphi > 0$ and $\partial^2 q_{ij} / \partial \varphi^2 < 0$). Thus, the most productive firms are the largest in terms of labor and quantity produced. Another result standard in the trade theory literature is that quantities are convex in trade costs, such

that $\partial q_{ij}/\partial \tau_{ij} < 0$ and $\partial^2 q_{ij}/\partial \tau_{ij}^2 > 0$). Hence, export sales decrease with trade costs, while they increase with productivity. New and more original is the following proposition:

Proposition 3.1 *For a given positive degree of the firm's risk aversion ($\rho_v > 0$) and industry supply (Ψ), the negative effect of demand volatility on export quantities is strengthened when firm productivity increases and trade costs decrease.*

As a simple proof, we can establish from equation (13)

$$\frac{\partial^2 q_{ij}}{\partial \varphi \partial \mathbb{V}(R_j)} < 0 < \frac{\partial^2 q_{ij}}{\partial \tau \partial \mathbb{V}(R_j)},$$

when $\rho_v > 0$. Remember that the variance of profits in a given foreign market is equal to the variance of foreign demand times the output size dedicated to that foreign country (see equation 11). Stated differently, the variance of profits of a firm increases with its productivity and decreases with trade costs for a given mass of firms.

Using (8) and (13), we can now determine the *ex post* equilibrium price of variety v prevailing in country j:

$$p_{ij}(v) = \frac{w_i \tau_{ij}}{\varphi} 2 \frac{R_j}{\mathbb{E}(R_j)} \left[1 + \rho_v \mathbb{V}(R_j) \frac{\theta_v^2 \varphi}{w_i \tau_{ij}} \Psi_j^{-2} \right] \tag{14}$$

The equilibrium price is equal to the marginal cost ($w_i \tau_{ij}/\varphi$) times a markup. Remember that, under demand certainty, the markup is equal to 2 (because of $\mathbb{E}[R_j/\mathbb{E}(R_j)] = 1$ and $\mathbb{V}(R_j) = 0$). With uncertain demand and risk-averse firms, the markup is higher on average than the markup prevailing under certain demand due to the fluctuations of income. Hence, uncertain demand curve tends to increase prices through a higher markup.

It is worth stressing that, unlike models of monopolistic competition with perfect information, the markup is not a constant. Firms charge variable markups even under CES preferences. In other words, demand uncertainty and risk-averse firms allow for variable markups even though demand curve is iso-elastic. Markup depends on the demand volatility, firm's productivity and features of origin and destination countries. Note also that the markup increases with the firm's productivity (φ) and decreases with trade costs

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(τ_{ij}) and the mass of rivals (captured by Ψ_j). Those findings are in accordance with industrial organization theory. However, the mechanisms at work are different. Our results are related to the existence of demand fluctuations and risk aversion. The variance of profits being high for the most productive firms, they charge greater markups. Similarly, low market size induces low variance of profits so that the markup is lower for destinations with a low potential market. Hence, even though preferences exhibit an iso-elastic demand, markups vary according to destinations and firms.

In addition, under demand uncertainty, the markup captures two opposite effects associated with the destination income (R_j). On the one side, higher income raises the markup and, in turn, prices (demand effect). On the other side, higher expected foreign demand increases the competition across firms (which have an incentive to reduce their level of production) and, in turn, decreases the markup. However, on average, both effects cancel each other out ($\mathbb{E}[R_j/\mathbb{E}(R_j)] = 1$). The next proposition sums up our results on destination prices:

Proposition 3.2 *For a given positive degree of the firm's risk aversion ($\rho_v > 0$) and industry supply (Ψ), the markup increases more with foreign demand uncertainty, the higher the firm productivity and the lower the trade costs.*

Propositions (3.1) and (3.2) are related to the intensive margin of trade, i.e., variation in trade of existing trade relationships. They are established without accounting for the adjustment in the industry supply (Ψ). However, uncertainty leads to an adjustment in the quantities produced by the competitors. This adjustment reinforces proposition (3.2) on export prices but renders proposition (3.1) on exported quantities more ambiguous. Before presenting the effect of the industry adjustment, we study the role of uncertainty on the extensive margin of trade, i.e., on the emergence of new trade relationships and/or the death of existing ones.

Extensive margin of exports with uncertainty

The mass of domestic firms in each country is exogenously given,[6] while the mass of

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[6]An endogenous mass of domestic firms can be incorporated in the analysis without qualitatively changing any of the main results.

exporting firms is treated as endogenous. There is a large supply of potential entrants in the international market. However, firms located in country i serving destination country j have to pay a fixed cost f_{ij} to serve foreign markets (see equation 1). The decision to exit or enter a foreign market is taken on the basis of the expected payoff. A firm exports to destination j if and only if *ex ante* payoff Π_v is positive, i.e., $\mathbb{E}(\pi_{ij}) - \rho_v \mathbb{V}(\pi_{ij}) > w_i f_{ij}$. It is straightforward to check that $\Pi_v = s_{ij}/2$ where $s_{ij} \equiv \mathbb{E}(p_{ij}) q_{ij}$ with

$$s_{ij} = \frac{\mathbb{E}(R_j)^2}{2} \left[\frac{w_i \tau_{ij}}{\theta_v^2 \varphi} \Psi_j^2 + \rho_v \mathbb{V}(R_j) \right]^{-1}. \tag{15}$$

As a result, $\Pi_v = 0$ when $\varphi = 0$ and $\partial \Pi_v / \partial \varphi > 0$. Hence, there exists a quality-adjusted productivity cutoff $\theta_v^2 \varphi$ above which a firm serves country j. As expected, the probability of exporting decreases with $\mathbb{V}(R_j)$. In addition, we have $\partial^2 \Pi_v / \partial \varphi \partial \mathbb{V}(R_j) < 0$ so the payoffs of large firms are more impacted by a rise in demand volatility than the small firms. Notice also that $\partial \Pi_v / \partial \Psi_j < 0$ and $\text{sign}\{\partial^2 \Pi_v / \partial \varphi \partial \Psi_j\} = \text{sign}\left\{ \rho_v \mathbb{V}(R_j) \frac{\theta_v^2 \varphi}{w_i \tau_{ij}} - \Psi_j^2 \right\}$ so that a higher total supply decreases the *ex ante* payoff of each incumbent firm. However, the high productivity firms are less affected by a rise in Ψ_j.

Until now, we have studied the impact of $\mathbb{V}(R_j)$ on exports and prices for a given Ψ_j. However, Ψ_j adjusts when $\mathbb{V}(R_j)$ changes. Therefore, we have to take into account the indirect effect of demand volatility on prices and quantities through Ψ_j. In what follows, we determine the relationship between Ψ_j and $\mathbb{V}(R_j)$ and the total effect of $\mathbb{V}(R_j)$. Let $\xi \equiv 1/(\theta_v^2 \varphi) \geq 0$ be an inverse measure of quality-adjusted productivity and $\mu(\xi)$ is the distribution of ξ. The cutoff for exporting $\widehat{\xi}_{ij}$ is such that $\Pi_v(\widehat{\xi}_{ij}) = w_i f_{ij}$ or, equivalently,

$$\widehat{\xi}_{ij} \equiv \left[\frac{\mathbb{E}(R_j)^2}{4 w_i f_{ij}} - \rho_v \mathbb{V}(R_j) \right] \frac{\Psi_j^{-2}}{w_i \tau_{ij}}. \tag{16}$$

It follows that a firm exports as long as $\xi < \widehat{\xi}_{ij}$. As expected, high productivity firms are more likely to be exporters while high fixed and variable trade costs reduce the probability of exporting. However, unlike trade models with heterogeneous firms, the exporting zero-payoff cutoff conditions $\widehat{\xi}_{ij}$ can be non positive. No firm finds *a priori* profitable to serve country j if the expected income $\mathbb{E}(R_j)$ is not sufficiently high relatively to its variance

$\mathbb{V}(R_j)$. Hence, we provide a rationale for the prevalence of zeros in bilateral trade without making an *ad hoc* assumption on the distribution of productivity across firms. Helpman, Melitz, and Rubinstein (2008) allow also for zero bilateral trade volumes as the authors assume that the most productive firms exhibit a level of productivity which is below than the exporting threshold.

Uncertainty and industry adjustment

Although our modeling strategy gives our framework a partial equilibrium flavor, it does not remove the interdependence among firms within industries. We can show that

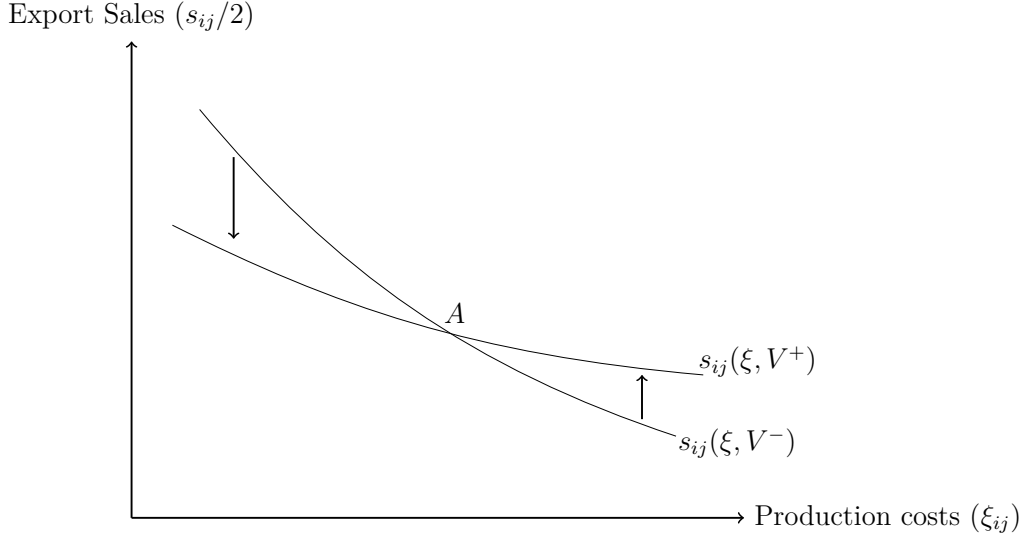$$\epsilon_{\Psi_j} \equiv -\frac{\mathbb{V}(R_j)}{\Psi_j}\frac{\partial \Psi_j}{\partial \mathbb{V}(R_j)} > 0,$$

or, equivalently, $\partial \Psi_j/\partial \mathbb{V}(R_j) < 0$ (see Appendix B). As expected, an increase in the variance of income reduces the aggregate supply for destination market j and, in turn, the equilibrium prices. Hence, equilibrium prices (14) increase with demand fluctuations through two effects: (i) a direct effect due to risk aversion (as explained above) and (ii) an indirect effect *via* the exit of firms relaxing competition among surviving firms. In contrast, the effect of demand volatility on the export sales (or profits) is ambiguous when Ψ_j adjusts to a change in $\mathbb{V}(R_j)$. Indeed, we have

$$\frac{\mathrm{d}s_{ij}(v)}{\mathrm{d}\mathbb{V}(R_j)} = \frac{\partial s_{ij}(v)}{\partial \mathbb{V}(R_j)} + \frac{\partial s_{ij}(v)}{\partial \Psi_j}\frac{\partial \Psi_j}{\partial \mathbb{V}(R_j)} = \frac{s_{ij}}{\mathbb{V}(R_j)}\frac{2w_i\tau_{ij}\xi\epsilon_{\Psi_j} - \rho_v\mathbb{V}(R_j)\Psi_j^{-2}}{w_i\tau_{ij}\xi + \rho_v\mathbb{V}(R_j)\Psi_j^{-2}},$$

where $\partial s_{ij}(v)/\partial \mathbb{V}(R_j) < 0$ while $\partial s_{ij}/\partial \Psi_j < 0$ and $\partial \Psi_j/\partial \mathbb{V}(R_j) < 0$ (see above). It follows that a rise in demand volatility induces a reallocation of market shares from larger firms to smaller ones as $\mathrm{d}s_{ij}(v)/\mathrm{d}\mathbb{V}(R_j)$ increases with ξ. Hence, the aggregate productivity of exporters can decrease *ceteris paribus* with a higher uncertainty, in accordance with empirical facts (see Bloom, 2014). In addition, as the larger firms reduce their export sales in high proportion when demand fluctuations increase, the export sales of smaller exporters may expand at their expense (see Figure 3).

As a result, the effect of demand volatility on the probability of exporting is also

Figure 3: Productivity and reallocation of export sales when demand volatility increases

ambiguous. Some standard calculations reveal that

$$\frac{\mathrm{d}\widehat{\xi}_{ij}}{\mathrm{d}\mathbb{V}(R_j)} = \frac{\partial\widehat{\xi}_{ij}}{\partial\mathbb{V}(R_j)} + \frac{\partial\widehat{\xi}_{ij}}{\partial\Psi_j}\frac{\partial\Psi_j}{\partial\mathbb{V}(R_j)} = \left[\frac{\mathbb{E}(R_j)^2}{4w_i f_{ij}} - \rho_v\mathbb{V}(R_j)\left(1 + \frac{1}{2\epsilon_{\Psi_j}}\right)\right]\frac{2\epsilon_{\Psi_j}\Psi_j^{-2}}{\mathbb{V}(R_j)w_i\tau_{ij}}$$

where $\partial\widehat{\xi}_{ij}/\partial\mathbb{V}(R_j) < 0$ while $\partial\widehat{\xi}_{ij}/\partial\Psi_j < 0$ and $\partial\Psi_j/\partial\mathbb{V}(R_j) < 0$ (see above). Hence, the probability of serving a country decreases with the volatility of its demand provided that fixed trade costs or demand volatility are not too high. If fixed trade costs are low enough, more medium sized firms can export when demand fluctuations rise as the export sales of large firms decrease (see Figure 4).

When we focus the total effect of demand fluctuation on quantity, it appears

$$\frac{\mathrm{d}q_{ij}(v)}{\mathrm{d}\mathbb{V}(R_j)} = \frac{q_{ij}(v)}{\mathbb{V}(R_j)}\frac{w_i\tau_{ij}\xi - \rho_v\mathbb{V}(R_j)\Psi_j^{-2}(1 + \epsilon_{\Psi_j})}{w_i\tau_{ij}\xi + \rho_v\mathbb{V}(R_j)\Psi_j^{-2}} \quad \text{and} \quad \frac{\mathrm{d}^2 q_{ij}}{\mathrm{d}\varphi\partial\mathbb{V}(R_j)} < 0 < \frac{\mathrm{d}^2 q_{ij}}{\mathrm{d}\tau\mathrm{d}\mathbb{V}(R_j)}$$

so that the effects of $\mathbb{V}(R_j)$ on $q_{ij}(v)$ when Ψ_j reacts to a change in demand volatility are qualitatively similar to the effects on export sales. It also be noted that higher uncertainty can make trade policy (lowering trade costs) or innovation policy (rising productivity) less effective, in accordance with Bloom (2014).

To summarize:

Figure 4: The impact of higher demand volatility on exporting cutoff

(a) Low export fixed costs $w_i f_{ij}$

(b) High export fixed costs $w_i f_{ij}$
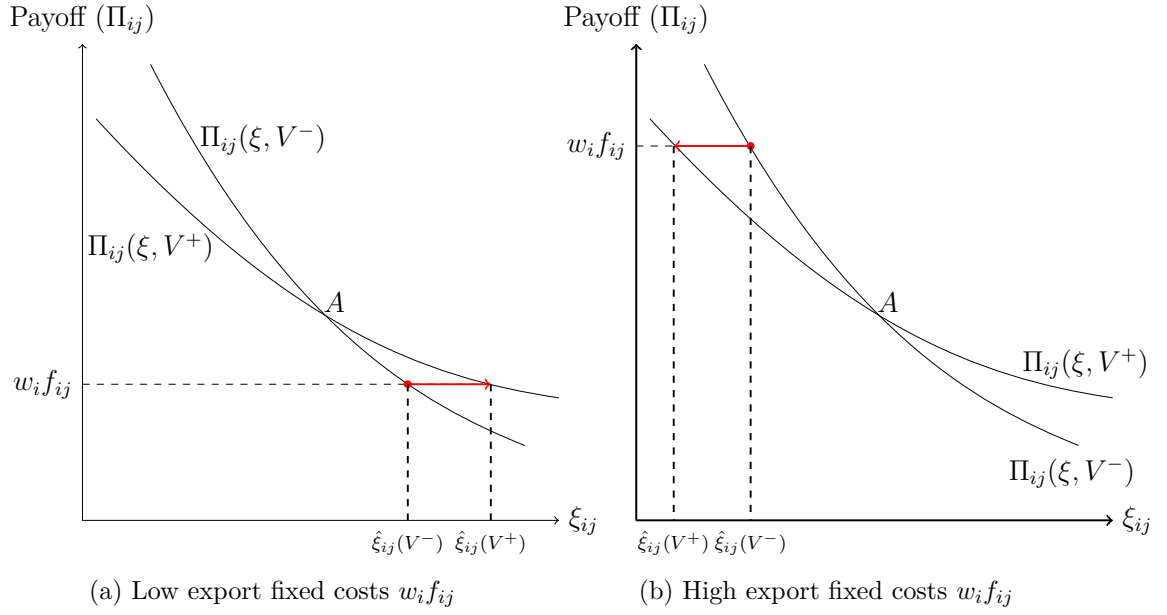
Notes: V^- and V^+ mean low and high volatility, respectively. ξ_{ij}: production costs.

Proposition 3.3 *A rise in* industry-level *foreign demand uncertainty decreases industry export sales but*

(i) decreases the export sales of large firms and increases the market share of medium sized firms;

(ii) increases the probability of exporting and the export sales of medium-sized firms when trade costs are not too high.

The bad and the good variance: the role of skewness

We have considered a mean-variance analysis. The basic intuition is that the exporters prefer higher expected returns and lower risk. However, we should consider that, *ceteris paribus*, entrepreneurs prefer a high probability of an extreme event in the positive direction over a high probability of an extreme event in the negative direction. In order to take into account the fact that the marginal willingness of exporter to accept a risk increases when the distribution of the risk becomes more skewed to the right, we now consider the mean-variance-skewness utility function where $\eta_v > 0$. The payoff of each firm is given

by (3). Given the inverse demand of consumers, we have

$$\mathbb{S}(\pi_{ij}) = \mathbb{S}(R_j)\theta_v^3 q_{ij}^{\frac{3}{2}}(v)\Psi_j^{-3}. \tag{17}$$

and the *Payoff*-maximizing quantity is implicitly given by $\partial\Pi_o/\partial q_{ij} = 0$, or, equivalently,

$$\frac{\mathbb{E}(R_j)}{2}\theta_v\Psi_j^{-1} - \left(w_i\frac{\tau_{ij}}{\varphi} + \rho_v\mathbb{V}(R_j)\theta_v^2\Psi_j^{-2}\right)q_{ij}(v)^{\frac{1}{2}} + \eta_v\frac{3\mathbb{S}(R_j)\theta_v^3\Psi_j^{-3}}{2}q_{ij}(v) = 0. \tag{18}$$

Clearly, if the income distribution is positively (resp., negatively) skewed, each exporter has an incentive to increase (resp., decrease) its level of output for a given $\mathbb{V}(R_j)$. The degree of skewness modifies the desirability of risk. It is readily to check that our predictions related to the impact of $\mathbb{V}(R_j)$ on quantity and prices according to the level of productivity and trade costs hold when $\mathbb{S}(R_j) \neq 0$. Using envelop theorem, it is straightforward to verify that $\partial q_{ij}/\partial\mathbb{S}(R_j) > 0$ whereas $\partial p_{ij}/\partial\mathbb{S}(R_j) < 0$ when the second order condition holds $(\mathbb{E}(R_j)\Psi_j^2 - \eta_v 3\mathbb{S}(R_j)\theta_v^2 q_{ij}(v) > 0)$. Regardless of the sign of $\mathbb{S}(R_j)$, an income distribution that is more skewed to the right induces higher level of output. More interesting, standard calculations show that

$$\frac{\partial^2 q_{ij}}{\partial\varphi\partial\mathbb{S}(R_j)} > 0 > \frac{\partial^2 q_{ij}}{\partial\tau\partial\mathbb{S}(R_j)} \quad \text{and} \quad \frac{\partial p_{ij}}{\partial\tau\partial\mathbb{S}(R_j)} > 0 > \frac{\partial p_{ij}(v)}{\partial\varphi\partial\mathbb{S}(R_j)}$$

as $\partial q_{ij}/\partial\varphi > 0$ and $\partial q_{ij}/\partial\tau > 0$. The magnitude of the positive impact of a higher $\mathbb{S}(R_j)$ on production is stronger for firms exhibiting a higher productivity and for destination implying lower trade costs. The prices move in the opposite direction.

4 Empirical Analysis

4.1 Identification strategy

According to our theoretical predictions exporters react in response to volatility by decreasing volumes $\left(\frac{\partial q_{ij}}{\partial\mathbb{V}(R_j)} < 0\right)$ and increasing prices $\left(\frac{\partial p_{ij}}{\partial\mathbb{V}(R_j)} > 0\right)$, while in response to

upside gains exporters increase volumes $\left(\frac{\partial q_{ij}}{\partial \mathbb{S}(R_j)} > 0\right)$ and reduce prices $\left(\frac{\partial p_{ij}}{\partial \mathbb{S}(R_j)} < 0\right)$.

The estimations of these predictions may be plagued by potential endogeneity at the aggregate level between trade openness and demand volatility. To mitigate this potential bias we exploit the following strategy of identification. We use French firm exports at the *4-digit* level k in a given year as our dependent variable. Then, we regress disaggregated French exports on three different moments of the distribution of demand R in destination j: the lagged expected value $\left(\mathbb{E}(R_{j,t-1}^K)\right)$, the volatility $\left(\mathrm{V}(R_{jt}^K)\right)$ and the skewness $\left(\mathrm{S}(R_{jt}^K)\right)$ of demand at the *3-digit* sector level. We expect variation in French 4-digit exports to be explained by 3-digit demand shifters in destination countries. However, in turn, it is unlikely that a particular 4-digit export in a destination affects substantially a 3-digit sector demand in that destination. The 3-digit demand in a country is made of imports from all sources (including itself) and all 4-digit sub-sectors. To reinforce this strategy of identification, we remove French flows to compute countries' demand and its moments. Moreover, we exploit the different sources of variation of our panel and use various combinations of fixed effects to control for unobservables: firm f, destination j, 4-digit sector k and time (year) t fixed effects.

4.2 Data

Demand R in destination country j is proxied with apparent consumption such as: $a_{jt}^K = \mathrm{Production}_{jt}^K + \mathrm{Imports}_{jt}^K - \mathrm{Exports}_{jt}^K$, where K is 3-digit sector and t year. Our sectoral data on production, exports and imports come from COMTRADE and UNIDO and covers the period 1995 to 2009. Using the absorption formula and the sector data, we construct three important regressors at the industry 3-digit level K in the destination country j. They correspond to three different moments of apparent consumption:

1. The mean demand or absorption $\left(\mathbb{E}(R_{j,t-1}^K)\right)$ computed in year t as the log of the lagged value of mean absorption over the 5 previous years;

2. The volatility of demand $\left(\mathrm{V}(R_{jt}^K)\right)$ computed as the standard deviation of the yearly growth rates of a_{jt}^K over 6 years and the sub-sectors k. As an example, consider

the manufacture of beverages (K=155) in the United Kingdom in 2000. We first
compute the yearly growth rates of the UK's apparent consumption over 1995 to
2000, and over the 4 sub-sectors of 155.[7] Then, we compute the standard deviation of
the 20 growth rates. Figure (5) reports the volatility of demand in the manufacture
of beverages in 2005. For a same level of mean demand for beverages in 2005, we
observe different levels of demand volatility.

3. The unbiased skewness of demand $\left(S(R_{jt}^K)\right)$ computed as the skewness of the yearly
   growth rates of a_{jt}^K over 6 years and the sub-sectors k.

Figure 5: Demand level and demand volatility of a given 3-digit sector
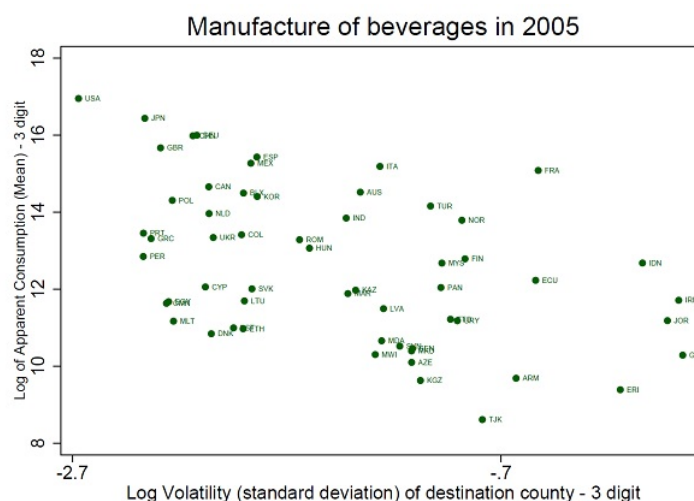
To construct our dependent variable and test our theoretical predictions we use very
rich firm-destination specific export data from the French customs over the period 2000
to 2009. We observe volume (in tons) and value (in euros) of exports for each product
and destination, for each firm located on the French metropolitan territory. Unit values
are computed as the ratio of export value to export volume.

4.2.1 Descriptive Statistics

We present in this section some descriptive statistics on French exports and firms, and
on the volatility and skewness of demand in sectors and destination countries included

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[7]The 4 sub-sectors are: 1551 - Distilling, rectifying and blending of spirits; ethyl alcohol production
from fermented materials; 1552 - Manufacture of wines; 1553 - Manufacture of malt liquors and malt;
1554 - Manufacture of soft drinks; production of mineral waters.

in our sample. In our empirical analysis, we focus on manufactured exports. French manufactured export flows reach on average 258,062 millions USD and 94,072 millions of tons per year. On average, our sample includes 70,239 firms per year, serving 81 countries and 119 4-digit sectors. The number of exporting firms is decreasing over time (except in 2006), with 79,151 firms in 2000 and only 65,803 firms in 2008 and 47,011 in 2009. All sectors are served every year. By contrast, we observe some changes in the number of destinations, with an increase over the 2000-2006 period from 80 to 88 destinations and a significant decrease during the 2008-2009 crisis (20 destinations disappear from the portfolio of destinations served by French firms between 2007 and 2009).

The turnover of firms in sectors and destinations is rather high in our sample over the period 2000-2009. On average, a firm is present 2.77 years in one destination-sector (4-digit). Firms serve on average 1.96 sectors per destination-year and 3.14 destinations per sector-year.

Each year, exporting firms may export to one sector (4-digit) and one destination (mono-destination and mono-sector firms), to various sectors but to one destination (mono-destination and multi-sectors firms), to various destinations and to one sector (multi-destinations and mono-sector firms) or to multi destinations and sectors (multi-destinations and multi-sectors firms). The share of each of the four categories in the total of exporting firms is fairly stable over time. The two main categories of firms in our sample are multi-destinations and multi-sectors firms (38.1% on average for the 2000-2009 period), and mono-destination and mono-sector firms (35.0%). The two other categories respectively represent 38.1% (multi-destination and mono-sectors firms) and 7.7% (mono-destination and multi-sectors firms). The share of French multi-destinations firms has slightly decreased in 2009. Some firms, which were present in several destinations, seem to have reduced their international exposure in 2009 because of the world crisis.

Figure (6) reports the distribution of demand volatility (in logs) and demand skewness across 2-digit sectors. The ranking of sectors is not similar for both moments and only two sectors (Tobacco and Office, accounting) have a negative median skewness.

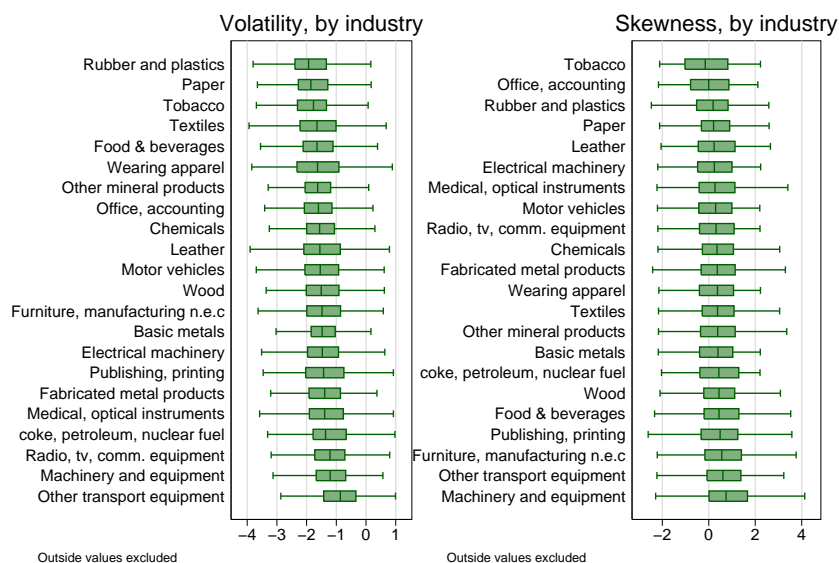Figure 6: Distribution of volatility and skewness demand

Figure (7) presents the distribution volatility across the destinations of French exports. For clarity, we select the 20 top main destinations and the 20 minor destinations over the 2000-2009 period. The figure reports the median (log) volatility for each of these partners. For each country, the median is computed using all 3-digit sectors and years for which we are able to compute the absorption (at most we have 10 years * 57 three-digit sectors = 570 observations). We can observe that the main destinations of French exports have lower median volatilities that minor destinations. Note that there is also a composition effect: main partners are often developed countries, which are less volatile than developing ones. This pattern is confirmed in Figure (8), where we try to answer to the question: which are the most/least volatile countries? The United States has very low volatility, as well as the United Kingdom and Canada. By contrast, the most volatile countries (in the left panel) tend to be developing countries. On average, developed countries are less volatile than developing ones.

Figure 7: Volatility of demand across destinations
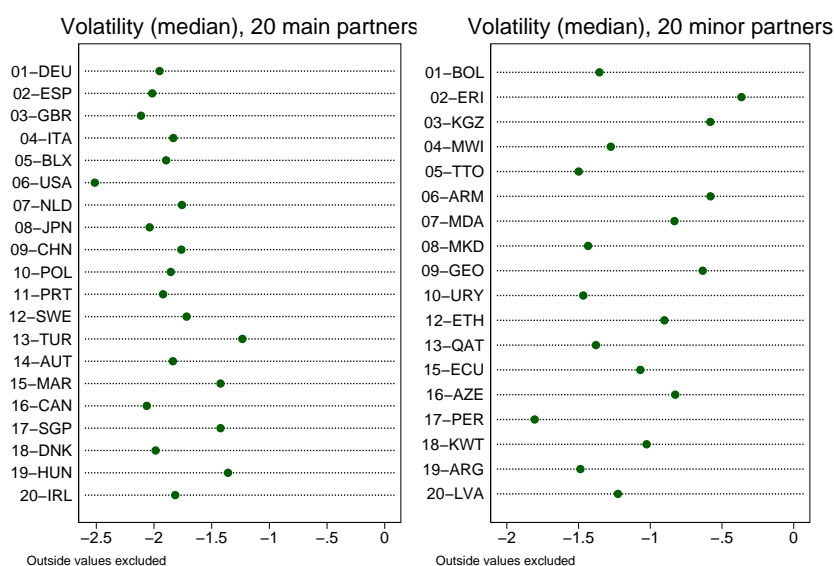
Which are the more/least skewed countries? Results are reported in Figure (9). As previously done, each sub-figure presents 20 countries and reports the median (log) skewness for each of these countries over 2000-2009. We keep only countries for which we have at least 10% of the 570 potential observations (we do the same for Figure 8). We can notice that developed countries are often less skewed. The difference for skewness between developing and developed countries seems to be less pronounced than for volatility. However, one limit of our approach is the number of observations per country: for some (developing) countries, the number of sector-year for which we are able to compute the volatility (and even more the skewness) is rather small and this restriction may of course bias the median value that we obtain. Two countries in our sample have a negative skewness: Russia and the US.

Figure 8: Most and least demand volatile countries
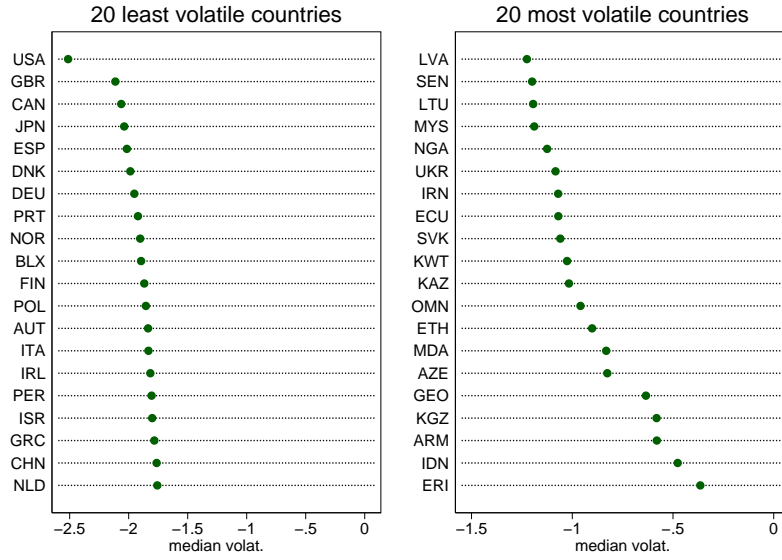
Figure 9: Most and least demand skewed countries
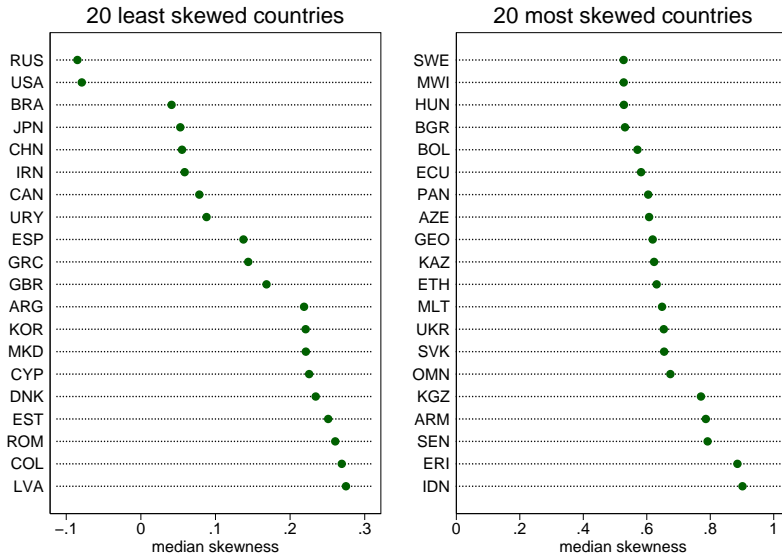
Before turning to the empirical results, we test the correlation between the share in total exports and demand, volatility and skewness for most and least productive firms (Table (1)). We first select the most productive firms (top 10%) and least productive ones (bottom 10%) for each 4 digit sector-year. We then compute the share of these most/least productive firms in total exports (by sector-year) and regress these shares on lagged demand, volatility and skewness defined at the 3 digit sector-destination-year level.

Our estimations also include year and destination-sector (4-digit) fixed effects. Results suggest that the relative share in total exports of most productive firms is mainly driven by demand, while for least productive firms, this share is not affected by demand but influenced positively by volatility and negatively by skewness.

Table 1: Correlation between share in total exports, demand, volatility and skewness for most and least productive firms

Dep. Var.:	Share in total exports$_{jkt}$	
	Most productive firms (Top 10%)	Least productive firms (Bottom 10%)
	(1)	(2)
Ln Demand$_{j,t-1}^{3K}$	0.006^b	0.002
	(0.003)	(0.002)
Ln Volatility$_{jt}^{3K}$	-0.011^c	0.016^a
	(0.006)	(0.004)
Skewness$_{jt}^{3K}$	0.001	-0.003^a
	(0.001)	(0.001)
AdjustedR^2	0.496	0.283
Fixed Effects:		
Destination.Sector$_{jk}$	Yes	Yes
Time$_t$	Yes	Yes

parentheses. $^a : p < 0.01$, $^b : p < 0.05$, $^c : p < 0.1$. N=49,059.

4.3 Empirical results

We now present our empirical results on the intensive and the extensive margin of trade.

4.3.1 Intensive trade margin

Export volumes

The estimated equation for the *export volumes* comes directly from the theoretical model:

$$\ln q_{fjt}^k = \ln \mathbb{E}(R_{jt}^K) + \rho \mathrm{V}(R_{jt}^K) + \eta \mathrm{S}(R_{jt}^K) + \mathbf{FE} + \varepsilon_{fjt}^k, \tag{19}$$

where q_{fjt}^k is French firm f export volumes to j in 4-digit k in year t. This variable is regressed on different moments of demand defined in the data section (4.2). **FE** represents a vector of different combinations of fixed effects. The estimations of equation (19) is reported in Table (2). The sample covers the period 2000 to 2009.

Table 2: Firm level estimations: export volumes

Dep. Var.:	Firm export volumes: $\ln q_{fjt}^k$		
	(1)	(2)	(3)
Ln Mean Demand$_{j,t-1}^{3K}$	0.250^a	0.075^a	0.060^a
	(0.028)	(0.025)	(0.21)
Ln Volatility$_{jt}^{3K}$	-0.017^b	-0.029^b	-0.022^b
	(0.008)	(0.014)	(0.011)
Skewness$_{jt}^{3K}$	0.007^b	0.012^b	0.009^b
	(0.003)	(0.006)	(0.004)
Adjusted R^2	0.814	0.377	0.635
Fixed Effects:			
Firm.Destination.Sector$_{fjk}$	Yes	-	-
Time$_t$	Yes	-	-
Firm.Destination.Time$_{fjt}$	-	Yes	-
Sector (4-digit)$_k$	-	Yes	-
Firm.Sector.Time$_{fkt}$	-	-	Yes
Destination$_j$	-	-	Yes

Note: Robust and industry-destination clustered standard errors in parentheses. $^a : p < 0.01$, $^b : p < 0.05$, $^c : p < 0.1$. N=5,668,638.

The results are in line with our theoretical predictions. An increase in demand level and demand skewness in destination markets increases export volumes. In contrast, an increase in volatility reduces exports. How economically meaningful are the estimates of volatility and skewness? Based on the first column within estimates, we find that in 2005 a one standard deviation increase in the average of volatility of Belgium, reduces aggregate French exports to Belgium by 1.2%, while a one standard deviation increase in the average of volatility of China, reduces aggregate French exports to China by 1.3%. Moreover, if the United Kingdom market would be as volatile as Vietnam, French exports to the UK would decrease by 2.5%. On the other hand, if the UK would be as skewed as Vietnam, French exports to the UK would increase by 0.5%. This implies that both absolute and downside risk matter for exporters.

Export prices

The estimated equation for the *export prices* comes from the theoretical model as well:

$$\ln p_{fjt}^k = \ln \left(\frac{R_{j,t-1}^K}{\mathbb{E}(R_{j,t-1}^K)} \right) + \rho \mathrm{V}(R_{jt}^K) + \eta \mathrm{S}(R_{jt}^K) + \mathbf{FE} + \varepsilon_{fjt}^k, \tag{20}$$

where p_{fjt}^k is French firm f export unit values to destination j in 4-digit sector k in

year t. Table (3) reports the estimates of equation (20) with the same sets of fixed effects as for the export volumes.

Table 3: Firm level estimations: export prices

Dep. Var.:	Firm export unit values: $\ln p_{fjt}^k$		
	(1)	(2)	(3)
Ln Demand$_{j,t-1}^{3K}$	0.016^c	0.012	0.007
	(0.009)	(0.014)	(0.006)
Ln Mean Demand$_{j,t-1}^{3K}$	-0.029^c	-0.017	-0.013
	(0.017)	(0.016)	(0.007)
Ln Volatility$_{jt}^{3K}$	0.015^b	0.004	0.003
	(0.007)	(0.007)	(0.003)
Skewness$_{jt}^{3K}$	-0.005^b	-0.003	-0.001
	(0.002)	(0.003)	(0.001)
Adj. R^2	0.843	0.656	0.810
Fixed Effects:			
Firm.Destination.Sector$_{fjk}$	Yes	-	-
Time$_t$	Yes	-	-
Firm.Destination.Time$_{fjt}$	-	Yes	-
Sector (4-digit)$_k$	-	Yes	-
Firm.Sector.Time$_{fkt}$	-	-	Yes
Destination$_j$	-	-	Yes

Note: Robust and industry-destination clustered standard errors in parentheses. $^a : p < 0.01$, $^b : p < 0.05$, $^c : p < 0.1$. N=5,376,961.

Results on export prices are in line with our predictions but are not robust across all specifications. The within estimates, reported in column (1), highlight the two opposite effects associated with demand in the destination market. On the one side, higher lagged demand raises export prices (demand effect). On the other side, higher expected foreign demand, captured by the mean demand variable, increases the competition across firms (which have an incentive to reduce their level of production) and, in turn, decreases prices. As expected, the volatility and skewness estimates have an opposite effect compared with their influence on export volumes.

Interaction effects of uncertainty

Proposition (3.1) establishes that the negative effect of demand volatility on export quantities is strengthened when firm productivity increases and trade costs decrease. Remember that the variance of profits in a given foreign market is equal to the volatility (variance) of foreign demand times the output size dedicated to that foreign country. Given that the most productive firms export more, they are at the margin more affected

by the increase in demand volatility. With the same logic, the lower the trade costs, the higher the quantities sold and the larger the effect of demand volatility at the margin.

To capture the non-linearity of demand volatility related to trade costs, we use the distance variable to destination markets, which is a usual proxy for trade costs. More precisely, we split the distance variable into quartiles. The four distance intervals (in km) are: $[0, 440)$; $[440, 1110)$; $[1110, 1875)$; and $[1875, \text{maximum}]$. Then, we interact the four categories with the volatility of demand and compute the predicted mean trade volumes (in logs) for the deciles of volatility. Results are presented in Figure (10).

<div align="center">Figure 10: Volatility, distance and export volumes</div>
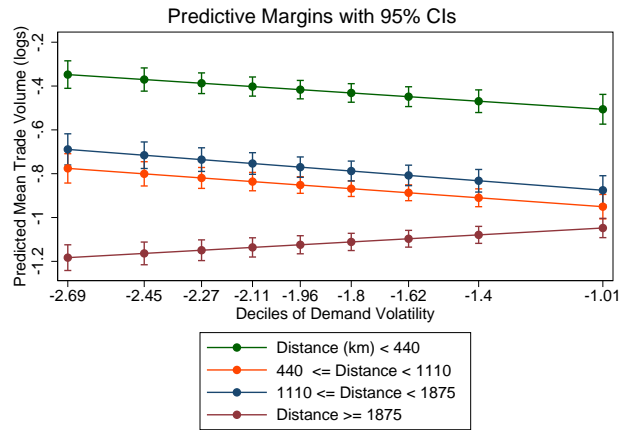
As expected and depicted in Figure (10), the lower the distance to a destination, the higher the exports, *ceteris paribus*. However, the increase in demand volatility affects differently the quartiles of distance. In particular, export volumes to the more distant markets are line with our theoretical prediction: $\partial^2 q_{ij}/\partial\tau_{ij}\partial\mathrm{V}(R_j) > 0$.

To capture the non-linear effect of firm productivity and volatility on export volumes $(\partial^2 q_{ij}/\partial\varphi\partial\mathrm{V}(R_j) < 0)$, we use a similar strategy: we split the log of productivity into quartiles and interact the four categories with demand volatility. Then, we compute the predicted mean trade volumes (in logs) for the deciles of volatility and the quartiles of productivity. The different predictions of trade are plotted in Figure (11). This plot shows three interesting results: (1) the most productive firms export more than the others; (2) the larger the demand volatility, the lower the export volumes for all levels of productivity; and (3) the marginal decrease in exports is larger for the most productive firms as the

volatility increases.

Figure 11: Volatility, productivity and export volumes
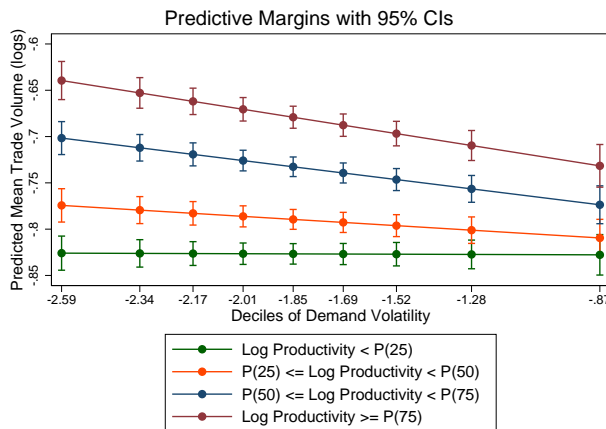
4.3.2 Extensive trade margin

Entry and exit

We now explore the impact of uncertainty on the extensive margin of trade. We distinguish between the entry of new firms on the international market and the exit of the incumbents from that market. For the entry, our dependent variable is the probability for a firm f to start exporting to destination j in 4-digit sector k in year t. Our counterfactual is firms that do not enter in destination j and sector k in year t. This choice model can be written in the latent variable representation, with y^*fjkt the latent variable that determines whether or not a strictly positive export flow is observed from firm f to destination j on sector k in year t. Our estimated equation is therefore as follows:

$$Pr(y_{fjk,t}|y_{fjk,t-1} = 0) = \begin{cases} 1 & \text{if} \quad y^*_{fjkt} > 0 \\ 0 & \text{if} \quad y^*_{fjkt} \leq 0 \end{cases} \tag{21}$$

with

$$y^*_{fjkt} = \ln \mathbb{E}(R^K_{jt}) + \rho \mathrm{V}(R^K_{jt}) + \eta \mathrm{S}(R^K_{jt}) + \mathbf{FE} + \varepsilon^k_{fjt}.$$

As previously, $\mathbb{E}(R^K_{jt})$, $\mathrm{V}(R^K_{jt})$ and $\mathrm{S}(R^K_{jt})$ represent different moments of demand (see section 4.2). This equation is estimated using a linear probability model. The inclusion of fixed effects (**FE**) in a probit would give rise to the incidental parameter problem. The

linear probability model avoids this issue. In all regressions, we account for correlation of errors by clustering at country-4-digit sector level. Results are reported in Table (4). Estimations cover the entry on the international market over the 2000-2009 period.

In addition to the probability of entry, one can also study the exit transition. Higher volatility or lower upside gains may indeed increase exit of firms from the export market. In that case, our dependent variable is the probability that firm f in destination j and sector k in year $t-1$ stop exporting to this destination that product k in year t. Our counterfactual is now firms that continue to serve destination j and sector k in year t. Explanatory variables are the same as for the entry estimations. Results are reported in Table (5).

In Tables (4) and (5), the two first columns deal with the within time dimension, columns (3) and (4) with the within sector dimension, and finally the two last columns with the within destination dimension. Results are in line with the theoretical model. The probability for a firm to enter the export market is positively and significantly influenced by an increase in demand and in potential upside gains (skewness) in the destination markets, while an increase in volatility reduces the firm's entry. Opposite effects are observed for the probability of exit: a higher demand and skewness lower the probability of exit, while a higher volatility increases it.

Tables (4) and (5) also show that in the within time dimension controlling for the skewness increases the significance of the coefficient estimates on volatility.

Table (7) in Appendix (C) tests the robustness of our results using a more strict definition for both entry and exit. For entry, we restrict our sample to firms which remain present on the international market the year after their entry. The probability of survival on the international market is indeed rather low and many (small and low productive) firms enter but exit just after. By focusing on firms that survive during at least one year on the international market, we exclude all these small firms from our sample. Our dependent variable is set to 1 if firm f enters in destination j and sector k in $t-1$ and stays present in t. Our counterfactual includes all firms that are never present in destination j and sector k in years $t-2$, $t-1$ and t. For exit, we consider firms that were exporters

Table 4: Probability of entry on the international market

Dep. Var.:	Firm's entry: $Prob(y_{fjk,t}=1\|y_{fjk,t-1}=0)$					
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Mean Demand$_{j,t-1}^{3K}$	0.006^a	0.006^a	0.006^a	0.006^a	0.002^a	0.002^a
	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
Ln Volatility$_{jt}^{3K}$	-0.0003^c	-0.001^a	-0.001^a	-0.001^a	-0.001^a	-0.001^a
	(0.0002)	(0.0002)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
Skewness$_{jt}^{3K}$		0.0003^a		0.0002^a		0.0001
		(0.0001)		(0.0001)		(0.0001)
R^2	0.355	0.355	0.352	0.352	0.090	0.090
Fixed Effects:						
Firm.Destination.Sector$_{fjk}$	Yes	Yes	-	-	-	-
Time$_t$	Yes	Yes	-	-	-	-
Firm.Destination.Time$_{fjt}$	-	-	Yes	Yes	-	-
Sector (4-digit)$_k$	-	-	Yes	Yes	-	-
Firm.Sector.Time$_{fkt}$	-	-	-	-	Yes	Yes
Destination$_j$	-	-	-	-	Yes	Yes

Note: Robust and clustered standard errors in parentheses.
$^a: p < 0.01$, $^b: p < 0.05$, $^c: p < 0.1$. N= 55,411,541.

Table 5: Probability of exit from the international market

Dep. Var.:	Firm's exit: $Prob(y_{fjk,t}=0\|y_{fjk,t-1}=1)$					
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Mean Demand$_{j,t-1}^{3K}$	-0.018^a	-0.018^a	-0.003^c	-0.003^c	-0.012^a	-0.012^a
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Ln Volatility$_{jt}^{3K}$	0.002^c	0.003^b	0.007^a	0.008^a	0.005^a	0.006^a
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Skewness$_{jt}^{3K}$		-0.001		-0.002^a		-0.001
		(0.001)		(0.001)		(0.001)
R^2	0.534	0.534	0.522	0.522	0.455	0.455
Fixed Effects:						
Firm.Destination.Sector$_{fjk}$	Yes	Yes	-	-	-	-
Time$_t$	Yes	Yes	-	-	-	-
Firm.Destination.Time$_{fjt}$	-	-	Yes	Yes	-	-
Sector (4-digit)$_k$	-	-	Yes	Yes	-	-
Firm.Sector.Time$_{fkt}$	-	-	-	-	Yes	Yes
Destination$_j$	-	-	-	-	Yes	Yes

Note: Robust and clustered standard errors in parentheses.
$^a: p < 0.01$, $^b: p < 0.05$, $^c: p < 0.1$. N= 4,683,164.

during the last two years $t-2$ and $t-1$ before exiting in year t. Our dependent variable is now equal to one if firm f serves sector k in market j in years $t-2$ and $t-1$ and not in year t. Our counterfactual retains firm that are present in sector k and destination j during the three years $t-2$, $t-1$, and t.

Results are similar to those reported in Tables (4) and (5), suggesting that they are not driven by firms' turnover on the international market.

Interaction effects of uncertainty

We now investigate whether the impact of volatility on the probability of entry and exit from the export market is affected by trade costs. To do so, we interact the volatility variable with the distance between France and the destination market j. Results are presented in Table (6). According to our theoretical predictions, we expect a positive estimated coefficient on the interaction term for the probability of entry and a negative one for the probability of exit: trade costs tend to lower the impact of volatility.

Empirical estimations are in line with these theoretical predictions. The interaction term is positive and highly significant for the probability of entry in the three within-dimensions (year, sector and destination) and for the probability of exit in the time and sector dimension. Furthermore, the inclusion of the interaction term affects the magnitude of the coefficient estimates on the volatility variable, which is much higher compared to those obtained in Tables (4) and (5). On the other hand, the estimates on the skewness variable are unaffected.

Table 6: Interaction of volatility with distance: probability of entry and exit

Dep. Var.:	Firm's entry: $Prob(y_{fjk,t}=1\|y_{fjk,t-1}=0)$			Firm's exit: $Prob(y_{fjk,t}=0\|y_{fjk,t-1}=1)$		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Mean Demand$^{3K}_{j,t-1}$	0.005^a	0.006^a	0.002^a	-0.018^a	-0.003^c	-0.012^a
	(0.0003)	(0.0002)	(0.0003)	(0.002)	(0.002)	(0.002)
Ln Volatility$^{3K}_{jt}$	-0.031^a	-0.021^a	-0.009^a	0.034^a	0.046^a	0.013
	(0.002)	(0.001)	(0.002)	(0.009)	(0.009)	(0.010)
Ln Volatility$^{3K}_{jt}$ × Ln Distance$_j$	$\mathbf{0.004}^a$	$\mathbf{0.003}^a$	$\mathbf{0.001}^a$	$\mathbf{-0.004}^a$	$\mathbf{-0.005}^a$	**-0.001**
	(0.0003)	(0.0002)	(0.0002)	(0.001)	(0.001)	(0.001)
Skewness$^{3K}_{jt}$	0.0003^a	0.0002^a	0.0002^c	-0.001	-0.002^a	-0.001
	(0.0001)	(0.0001)	(0.0001)	(0.001)	(0.001)	(0.001)
R^2	0.184	0.144	0.067	0.361	0.278	0.249
Fixed Effects:						
Firm.Destination.Sector$_{fjk}$	Yes	-	-	Yes	-	-
Time$_t$	Yes	-	-	Yes	-	-
Firm.Destination.Time$_{fjt}$	-	Yes	-	-	Yes	-
Sector (4-digit)$_k$	-	Yes	-	-	Yes	-
Firm.Sector.Time$_{fkt}$	-	-	Yes	-	-	Yes
Destination$_j$	-	-	Yes	-	-	Yes

Note: Robust and clustered standard errors in parentheses.
$^a: p < 0.01$, $^b: p < 0.05$, $^c: p < 0.1$. N= 55,411,541 for entry and N = 4,683,164 for exit.

5 Preliminary conclusion

Does demand volatility matter for exports? Yes and skewness as well!

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Appendices

A   Price setting

The demand for a variety v is

$$q_{ij}(v) = R_j^2 \theta_v^2 \Psi_j^{-2} p_{ij}(v)^{-2}$$

so that

$$\frac{p_{ij} q_{ij}(v)}{R_j} = R_j \theta_v^2 \Psi_j^{-2} p_{ij}(v)^{-1}$$

Summing this expression over each variety consumed in country j yields

$$\Psi_j^{-2} = R_j^{-1} \left[\int_{\Omega_j} \theta_v^2 p_{ij}(v)^{-1} \mathrm{d}v \right]^{-1}$$

implying the demand for a variety can be rewritten as follows

$$q_{ij}(v) = R_j \theta_v^2 \left[\int_{\Omega_j} \theta_v^2 p_{ij}(v)^{-1} \mathrm{d}v \right]^{-1} p_{ij}(v)^{-2} = R_j \theta_v^2 P_j p_{ij}^{-2}$$

with

$$P_j \equiv \left[\int_{\Omega_j} \theta_v^2 p_{ij}(v)^{-1} \mathrm{d}v \right]^{-1}.$$

Hence, the export profit is

$$\pi_{ij} = R_j \theta_v^2 P_j / p_{ij} - c_{ij} R_j \theta_v^2 P_j p_{ij}^{-2} - w_i f_{ij}$$

with $c_{ij} \equiv w_i \tau_{ij} / \varphi$. The payoff of each firm is as follows:

$$\Pi_o(v) = \mathbb{E}(\pi_i) - \rho_v \mathbb{V}(\pi_i),$$

Given the demand of consumers, we have

$$\mathbb{E}(\pi_{ij}) = \mathbb{E}(R_j)\theta_v^2 \frac{P_j}{p_{ij}} - c_{ij}\mathbb{E}(R_j)\theta_v^2 \frac{P_j}{p_{ij}^2} - w_i f_i,$$

and

$$\mathbb{V}(\pi_{ij}) = \left(p_{ij}^2 - c_{ij}^2 \right) p_{ij}^{-4} P_j^2 \theta_v^4 \mathbb{V}(R_j)$$

It appears that the expected profit is maximized when the price is equal 2 times the marginal cost c_{ij} while the variance is minimized whens the price is equal to the marginal cost.

The first order condition implies that the equilibrium price is implicitly given by $\Phi(p_{ij}) = 0$ with

$$\Phi(p_{ij}) \equiv -\left(p_{ij} - 2c_{ij} \right) \mathbb{E}(R_j) + \rho_v \left(p_{ij}^2 - 2c_{ij}^2 \right) 2p_{ij}^{-2} P_j \theta_v^2 \mathbb{V}(R_j) \tag{22}$$

while the second order condition implies

$$\mathbb{E}(R_j) - \rho_v 8 c_{ij}^2 p_{ij}^{-3} P_j \theta_v^2 \mathbb{V}(R_j) > 0$$

or, evaluated at $\Phi(p_{ij}) = 0$,

$$\left(p_{ij}^2 - 2c_{ij}^2\right) p_{ij} - 4c_{ij}^2 \left(p_{ij} - 2c_{ij}\right) > 0$$

Without uncertainty, the equilibrium price would be $p_{ij} = 2c_{ij}$, which is identical to the price prevailing when firms determine strategically the level of quantity. However, under uncertainty, $p_{ij} = 2c_{ij}$ is not an equilibrium as long as $\rho_v > 0$. Introducing $p_{ij} = 2c_{ij}$ into (22) implies $\Phi(p_{ij}) > 0$ so that the equilibrium price under uncertainty is higher than $2c_{ij}$. Using the envelop theorem:

$$\frac{\partial p_{ij}}{\partial \mathbb{V}(R_j)} = \frac{\mathbb{E}(R_j)}{\mathbb{V}(R_j)} \frac{p_{ij} - 2c_{ij}}{\mathbb{E}(R_j) - 8\rho_v c_{ij}^2 P_j \theta_v^2 \mathbb{V}(R_j) p_{ij}^{-3}} > 0$$

B Industry supply and income volatility

In this Appendix, we show that $\partial \Psi_j / \partial \mathbb{V}(R_j) < 0$. According to (7) and (13), we have $\Lambda[\Psi_j, \mathbb{V}(R_j)] = 0$ with

$$\Lambda \equiv \Psi_j - \sum_k M_k \int_0^{\widehat{\xi}_{kj}} \frac{\mathbb{E}(R_j)}{2} \Psi_j^{-1} \left[w_k \tau_{kj} \xi + \rho_v \mathbb{V}(R_j) \Psi_j^{-2}\right]^{-1} \mu(\xi) d\xi,$$

where $\partial \Lambda_j / \partial \mathbb{V}(R_j) > 0$ because both $\theta_v q_{ij}^{1/2}$ and $\widehat{\xi}_{ij}$ decrease with $\mathbb{V}(R_j)$. The envelop theorem implies

$$\text{sign} \frac{\partial \Psi_j}{\partial \mathbb{V}(R_j)} = -\text{sign} \frac{\partial^2 \Lambda}{\partial \Psi_j},$$

as $\partial \Lambda / \partial \mathbb{V}(R_j) > 0$. Standard calculations show that

$$\frac{\partial \Lambda}{\partial \Psi_j} = \begin{array}{l} 1 - \Psi_j^{-1} \sum_k M_k \int_0^{\widehat{\xi}_{kj}} \theta_v \left[q_{kj}(\xi)\right]^{\frac{1}{2}} \frac{\rho_v \mathbb{V}(R_j) \Psi_j^{-2} - w_k \tau_{kj} \xi}{\rho_v \mathbb{V}(R_j) \Psi_j^{-2} + w_k \tau_{kj} \xi} \mu(\xi) d\xi \\ \quad - \frac{\partial \widehat{\xi}_{kj}}{\partial \Psi_j} \theta_v \left[q_{kj}(\widehat{\xi}_{kj})\right]^{\frac{1}{2}}, \end{array} \tag{23}$$

where $\partial \Lambda / \partial \Psi_j > 0$ as the second term on the RHS of (23) is inferior to 1 and $\partial \widehat{\xi}_{kj} / \partial \Psi_j < 0$. As a result,

$$\epsilon_{\Psi_j} \equiv -\frac{\mathbb{V}(R_j)}{\Psi_j} \frac{\partial \Psi_j}{\partial \mathbb{V}(R_j)} > 0.$$

C Robustness: Extensive margin

Table 7: Extensive margin: stricter definition

Dep. Var.:	Firm's entry: $Prob(y_{fjk,t}=1\|y_{fjk,t-2}=0\ \&\ y_{fjk,t-1}=1)$			Firm's exit: $Prob(y_{fjk,t}=0\|y_{fjk,t-2}=1\ \&\ y_{fjk,t-1}=1)$		
	(1)	(2)	(3)	(4)	(5)	(6)
Ln Mean Demand$^{3K}_{j,t-1}$	0.004^a	0.003^a	0.002^a	-0.010^a	-0.013^a	-0.008^a
	(0.0003)	(0.0001)	(0.0002)	(0.001)	(0.002)	(0.002)
Ln Volatility$^{3K}_{jt}$	-0.0004^b	-0.001^a	-0.001^a	0.001	0.007^a	0.002^b
	(0.0002)	(0.0001)	(0.0002)	(0.001)	(0.001)	(0.001)
Skewness$^{3K}_{jt}$	0.0002^b	0.0001	0.0001	-0.001	-0.001^b	-0.001
	(0.0001)	(0.0001)	(0.0001)	(0.001)	(0.001)	(0.0004)
R^2	0.506	0.250	0.070	0.513	0.540	0.260
Fixed Effects:						
Firm.Destination.Sector$_{fjk}$	Yes	-	-	Yes	-	-
Time$_t$	Yes	-	-	Yes	-	-
Firm.Destination.Time$_{fjt}$	-	Yes	-	-	Yes	-
Sector (4-digit)$_k$	-	Yes	-	-	Yes	-
Firm.Sector.Time$_{fkt}$	-	-	Yes	-	-	Yes
Destination$_j$	-	-	Yes	-	-	Yes

Note: Robust and clustered standard errors in parentheses.
^{a} : $p < 0.01$, ^{b} : $p < 0.05$, ^{c} : $p < 0.1$. N= 38,992,092 for entry and N = 2,855,811 for exit.