Export Prices under Economic Uncertainty

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Abstract

I develop a monopolistic competition model of trade with firm heterogeneity and endogenous mark-ups. The model shows that exporters raise prices thus mark-ups in response to rising economic volatility in export markets. I then examine the hypotheses and investigate the impact of uncertainty on export prices using a panel dataset of Chinese firm export transactions in 2000-2008 and novel time-variant measures of market specific uncertainty. The empirical findings are broadly consistent with the theoretical predictions.

1 Introduction

Economic theory tells us that price will drop as the demand goes down. However, price index of U.S. imports from China surged during the 2007-2009 financial crisis while the U.S. demand was getting weaker(see Figure 1a and 1b). My paper explores this phenomenon by connecting export prices and uncertainty,[1] and shows that firms decisions under uncertainty is of great importance to understand the change in this aggregate statistic.

Removing the assumption that demand at the export markets is known with certainty at the time when the output and export decisions are made, a monopolistic competition model of trade with firm heterogeneity and risk-aversion suggests uncertainty could be the driver of export prices. To test the model predictions, a country-sector-year uncertainty proxy constructed from Bloomberg stock data is used with Chinese firm-level production data and firm-product-level export data. The empirical results are consistent with

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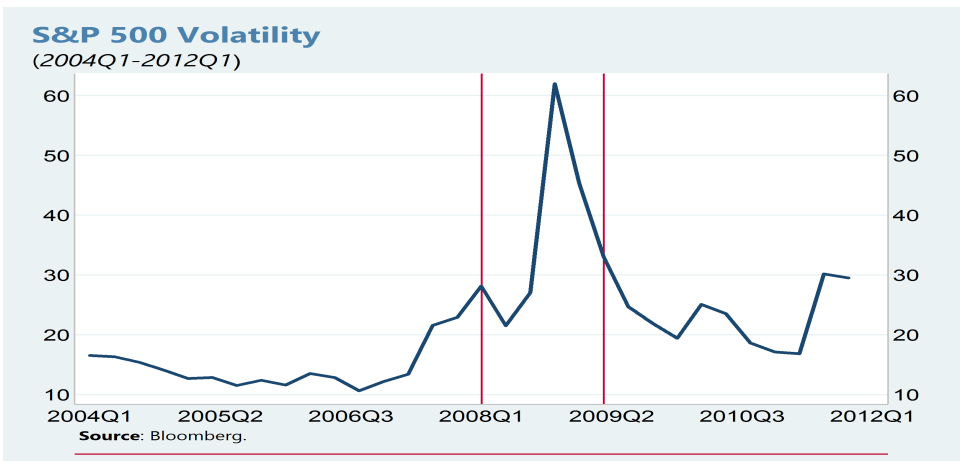
[1] Bloom (2014) refers to a single concept of uncertainty as a mixture of risk and uncertainty defined in Knight (1921), therefore risk and uncertainty terms are interchangeable. I will follow this routine.

my model predictions and provide evidences on firm-level heterogeneity in terms of marginal effects of uncertainty, i.e.,When uncertainty goes up, low-productivity firms who survive in the sample tend to raise their export prices more than those high-productivity ones, and their revenue increases more as well.

Figure 1a: Price Index of U.S. Imports from China

Figure 1b: S&P 500 Volatility



The key idea behind this argument is that low productivity firms have to charge a higher mark-up to cover the potential loss due to the lack of hedging or diversification options; high productivity firms, on the other hand, are more likely to absorb the uncertainty through other channels, e.g., Esposito (2016) shows that firms can reduce demand risk through geographical

diversification. Recent studies have provided evidence on the influence of demand uncertainty on firms market-entry and sourcing decisions (see Berman et al., 2015; Carballo, 2015; Nguyen, 2012), but little work has been done for export prices. Sousa et al. (2016) conclude that expenditure uncertainty has a negative effect on firm-level revenue, and firm-level heterogeneity will narrow the market share gap between high and low productivity firms. My work contributes to the export-under-uncertainty literature by establishing direct link between demand uncertainty and export prices both theoretically and empirically.

Bloom (2014) notes "our measures of uncertainty are far from perfect and in fact are best described as proxies rather than real measures. Developing a wider set of uncertainty measures is important". In the literature, macroeconomic uncertainty is common to be measured by some country-time specific proxies which are invariant across sectors (see Bachmann et al., 2012); sector (firm)-level demand uncertainty can be measured by calculating the standard deviation of sector (firm)-level revenue over the past time periods, but this moving average method is less likely to capture sharp change in uncertainty at a given year (see Dyer et al., 2014; Banker et al., 2013). My paper therefore contributes to the uncertainty-measure literature by constructing a country-sector-year level proxy using Bloomberg data.

Following Melitz (2003), firms are heterogeneous in terms of productivity. In my empirical analysis, firm-level productivity is measured by revenue-based total factor productivity (TFP) estimated by a wide range of methods in the literature (see Beveren, 2012; Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Ackerberg et al., 2006).

In Melitz-type trade models, uncertainty in productivity is resolved before firms production decisions, and firms selling at the equilibrium have non-negative profits (see Melitz, 2003; Melitz and Ottaviano, 2008); in my model, firms make the decisions under economic uncertainty and those who choose to produce can still receive negative profits due to a negative demand shock.

2 Model

I develop a monopolistically competitive model of trade with firm heterogeneity and uncertain demand. In this model, a risk-averse exporter's mark-up depends on both toughness of competition and uncertainty. An exporter charges a higher price thus mark-up when faces softer competition, or higher uncertainty.

Let S defines the set of countries. $\forall$ country $i \in S$, there are L_i workers (1 worker=1 unit of labor). Each country has a homogeneous goods sector with perfect competition. The marginal cost in producing 1 unit of this good is 1 unit of labor. Taking this homogeneous good as numeraire, i.e: its price equals 1, thus the wage for the workers in this sector equals 1. Each country also has a heterogeneous sector with the continuum of possible differential varieties defined by Ω. And a firm produces one variety ω.

Productivity of a firm in the heterogeneous sector, defined as φ, is drawn from a distribution function $G(\varphi)$. Iceberg transport costs for exporter i to destination j and the utility loss associated with sunk entry costs are denoted by τ_{ij} and f_e respectively.

Entry is endogenous following Melitz and Ottaviano (2008).

The timing of firms' decisions is as follows,

Choose location to enter $\longrightarrow$ Pay sunk entry costs $\longrightarrow$ Observe productivity $\varphi \longrightarrow$ Production/Exit/Export decisions $\longrightarrow$ Observe demand shock $v_j(\omega)$.

2.1 Consumer's Problem

The utility maximization problem for a representative consumer in country j is as follows

$$\begin{aligned}
\underset{q_j^c(\omega)}{\text{Max}} \quad & u_j^c = q_{j0}^c + \int_{\omega\in\Omega_j} (\alpha + v_j(\omega)) q_j^c(\omega) d\omega - \frac{1}{2}\gamma \int_{\omega\in\Omega_j} q_j^c(\omega)^2 d\omega \\
& - \frac{1}{2}\eta \left(\int_{\omega\in\Omega_j} q_j^c(\omega) d\omega \right)^2 \\
\text{s.t} \quad & \int_{\omega\in\Omega_j} p_j(\omega) q_j^c(\omega) d\omega + p_{j0}^c q_{j0}^c = w_j
\end{aligned}$$

Where q_{j0}^c is the consumption in homogeneous good sector, $q_j^c(\omega)$ is the consumption of variety ω, and $v_j(\omega)$ is the country-variety-specific demand shifter which captures the idea of economic uncertainty. The parameters α and η capture the substitution pattern between the numeraire and the differentiated variety respectively, i.e: the higher the α or the lower the η, the higher weight to differentiated goods sector; γ represents the degree of product differentiation between the varieties, i.e: low γ indicates goods are easy to substitute in the heterogeneous sector.

Maximizing (1) subject to (2) gives us the representative consumer's demand for variety ω in market j,

$$p_j(\omega) = \alpha + v_j(\omega) - \gamma q_j^c(\omega) - \eta Q_j^c \tag{1}$$

$$Q_j^c = \int_{\omega \in \Omega_j} q_j^c(\omega) d\omega \tag{2}$$

Let Ω_j^* be the set of firms at the equilibrium and $|\Omega_j^*| = N_j$. Therefore N_j is the number of firms at the equilibrium in country j. Rewrite (3) as

$$q_j^c(\omega) = \frac{\alpha}{\gamma} + \frac{v_j(\omega)}{\gamma} - \frac{\eta}{\gamma} Q_j^c - \frac{1}{\gamma} p_j(\omega) \tag{3}$$

Substituting (5) into (4) leads to

$$Q_j^c = \frac{(\alpha + \bar{v_j})N_j - \bar{p_j} N_j}{\gamma + \eta N_j} \tag{4}$$

$$\bar{p_j} = \frac{\int_{\omega \in \Omega_j^*} p_j(\omega) d\omega}{N_j} \tag{5}$$

$$\bar{v_j} = \frac{\int_{\omega \in \Omega_j^*} v_j(\omega) d\omega}{N_j} \tag{6}$$

$$\begin{aligned} p_{max_j(\omega)} &= \alpha + v_j(\omega) - \eta Q_j^c \\ &= \bar{p}_{max_j} + v_j(\omega) \\ &= \frac{\alpha\gamma + \eta N_j(\bar{p_j} - \bar{v_j})}{\gamma + \eta N_j} + v_j(\omega) \end{aligned} \tag{7}$$

Thus, a firm competes in market j will face a demand equation

$$\begin{aligned} q_j(\omega) &= L_j q_j^c(\omega) \\ &= \frac{L_j}{\gamma}(p_{max_j} - p_j(\omega)) \\ &= \frac{L_j}{\gamma}(\bar{p}_{max_j} + v_j(\omega) - p_j(\omega)) \end{aligned} \tag{8}$$

Let ϵ define the elasticity of demand,

$$\epsilon = [\frac{p_{max_j}}{p_j(\omega)} - 1]^{-1}$$

Prediction 1 Assuming $p_{max_j} \leq \alpha + v_j(\omega)$, lower average prices $\bar{p}_j$ or larger number of firms selling at the equilibrium N_j therefore a lower choke price p_{max_j} will lead to higher elasticity of demand ϵ. Intuitively, for a given price $p_j(\omega)$, lower p_{max_j} and higher ϵ indicate a "tougher" competitive environment.

The source of uncertainty in the firm's optimization problem is that firms fail to observe the actual $v_j(\omega)$, even they know all the aggregate indexes, i.e: $\bar{p_j}, \bar{N}_j$, and $\bar{v_j}$, while determining their output level. I assume v_j distributed with a mean of μ_{v_j} and a variance of $\sigma^2_{v_j}$ ($E[v_j(\omega)] = \mu_{v_j}$ and $Var[v_j(\omega)] = \sigma^2_{v_j}$ $\forall$ ω).

2.2 Firm's Problem

Firms located in country i face uncertain demand at the time the export contracts are signed. I assume firms decide their output level $q_{ij}(\omega)$ for each destination j before they know the realized value of $v_j(\omega)$; and equilibrium price $p_{ij}(\omega)$ is determined ex post following the realized demand shifter $v_j(\omega)$; firms cannot adjust quantity based on the observation of demand shock. Firms are assumed to be risk-averse with mean-variance utility function.

A firm located in country i exporting to destination j with iceberg trade costs, τ_{ij}, obtains profit π_{ij} from market j,

$$\pi_{ij}(\varphi) = p_{ij}(\varphi)q_{ij}(\varphi) - \frac{w_i\tau_{ij}}{\varphi}q_{ij}(\varphi)$$

and $\tau_{ij} = 1$ if $i = j$, otherwise $\tau_{ij} > 1$.

The firm maximizes its expected utility given all the aggregate level indexes

$$\begin{aligned} \underset{q_{ij}}{\text{Max}} \quad & \Pi_{ij} = E(\pi_{ij}) - \rho Var(\pi_{ij}) \\ & = E(p_{ij})q_{ij} - \frac{w_i\tau_{ij}}{\varphi}q_{ij}(\omega) - \rho\sigma^2_{v_j}q^2_{ij} \\ \text{s.t} \quad & p_j(\omega) = -\frac{\gamma}{L_(j)}q_j(\omega) + \bar{p}_{max_j} + v_j(\omega) \end{aligned}$$

The optimal output level is,

$$q^*_{ij} = q_{ij}(\omega)^* = \frac{\bar{p}_{max_j} + \mu_{v_j} - \frac{w_i\tau_{ij}}{\varphi}}{2(\gamma/L_j + \rho\sigma^2_{v_j})}. \tag{9}$$

Substitute the optimal output into the demand, the realized price is

$$p_{ij}(\omega)^* = \bar{p}_{max_j} - \frac{\gamma(\bar{p}_{max_j} + \mu_{v_j} - \frac{w_i\tau_{ij}}{\varphi})}{2(\gamma + L_j\rho\sigma^2_{v_j})} + v_j(\omega) \tag{10}$$

Prediction 2 Given $\bar{p}_{max_j}$, both $p^*_{ij}(\omega)$ and the mark-up, price over marginal cost, increase in the uncertainty proxy $\sigma^2_{v_j}$; and $p^*_{ij}(\omega)$ decreases in productivity φ, but the mark-up increases in φ if varieties are close substitutes (γ is small) or the unexpected demand shock is small ($v_j(\omega) - u_{v_j}$ is small); q^*_{ij} decreases in $\sigma^2_{v_j}$ (see Appendix).

Assuming the demand shock is uncorrelated to uncertainty,[2] partial equilibrium effect above shows exporter's price thus mark-up go up when uncertainty rises. Intuitively, one can consider that it will be more costly for risk-averse firms to lock up their profits through insurance when uncertainty is high, thus they tend to charge a higher mark-up.

2.3 Market Entry and Exit

Exit is driven by demand. Firms will exit from market j if $\Pi_{ij} \leq 0$. For the marginal firms in market j with productivity φ^*_{ij}, $\Pi_{ij} = 0$ indicates

$$\bar{p}_{max_j} + \mu_{v_j} = \frac{w_i\tau_{ij}}{\varphi^*_{ij}} = MC^*_{ij} \tag{11}$$

$$\varphi^*_{ij} = \frac{w_i\tau_{ij}}{\bar{p}_{max_j} + \mu_{v_j}}$$

Firms exit when their marginal cost, $MC_{ij} \geq MC^*_{ij}$.

Define $\pi_i \equiv \sum_{j\in S}\pi_{ij}$, and $U_i \equiv E(\pi_i) - \rho Var(\pi_i)$. Assuming non-correlated markets, i.e: $Cov(v_k, v_m) = 0 \; \forall \; k \neq m$, then $U_i = \sum_{j\in S}[E(\pi_{ij}) - \rho Var(\pi_{ij})]$. Prior to entry, firm's expected utility is given by $\int_{\varphi^*_i}^{+\infty} U_i dG(\varphi) - f_e$, where $G(\varphi)$ defines the cumulative distribution function of productivity φ in country i, and f_e defines the loss of utility associated with the sunk entry costs.

$$U_i(\varphi) = \sum_{j\in S} \frac{(\bar{p}_{max_j} + \mu_{v_j} - \frac{w_i\tau_{ij}}{\varphi})^2}{4(\frac{\gamma}{L_j} + \rho\sigma^2_{v_j})} \tag{12}$$

[2] If uncertainty is highly (negatively) correlated to the demand shock, we are less likely observe that prices increase with uncertainty, since a bad shock can drag the realized price down

Assuming φ is Pareto distributed with the probability density function $g_i(\varphi) = \frac{\theta_i}{\varphi^{\theta_i+1}}$, the free entry condition can be written as

$$\int_{\varphi_i^*}^{+\infty} U_i(\varphi)\frac{\theta_i}{\varphi^{\theta_i+1}}d\varphi = f_e, (\theta_i > 0) \tag{13}$$

The free entry condition can be used to pin down φ_i^* which in turn decides the number of firms in the equilibrium, N_j, and number of firms entering the market N_E^k, $\forall k \in S$.

2.4 Two-country Solution

In the previous section, I use a multiple-country model to present the partial equilibrium effects of uncertainty on firm and sector level performance variables. To assess the general equilibrium effects of uncertainty and keep the solution tractable, I refer to a simplified two-country model, i.e: $S = i, j$.

A firm located in country i receives profits from both domestic and foreign markets,

$$U_i(\varphi) = \frac{(\bar{p}_{max_i} + \mu_{v_i} - \frac{w_i\tau_{ii}}{\varphi})^2}{M_i} + \frac{(\bar{p}_{max_j} + \mu_{v_j} - \frac{w_i\tau_{ij}}{\varphi})^2}{M_j} \tag{14}$$

thus the free entry condition can be written as

$$\frac{\theta_i}{M_i}\int_{\varphi_i^*}^{+\infty}(1/\varphi_i^* - 1/\varphi)^2\varphi^{-\theta_i-1}d\varphi + \frac{\theta_i\tau_{ij}^2}{M_j}\int_{\varphi_{ij}^*}^{+\infty}(1/\varphi_{ij}^* - 1/\varphi)^2\varphi^{-\theta_i-1}d\varphi = f_e \tag{15}$$

For the marginal firms selling in market j,

$$\bar{p}_{max_j} + \mu_{v_j} = \frac{w_i\tau_{ij}}{\varphi_{ij}^*} = \frac{w_j\tau_{jj}}{\varphi_j^*} \tag{16}$$

which indicates $\varphi_{ij}^* = \varphi_j^*\tau_{ij}$.

$$\frac{\theta_i K_i}{M_i}(1/\varphi_i^*)^{\theta_i+2} + \frac{\theta_i K_i}{M_j}\tau_{ij}^{-\theta_i}(1/\varphi_j^*)^{\theta_i+2} = f_e \tag{17}$$

$$K_j = \frac{1}{\theta_j} - \frac{2}{\theta_j+1} + \frac{1}{\theta_j+2}$$

The condition can be used to solve for the cutoff productivities, i.e: $\varphi_i^*, \varphi_j^*, \varphi_{ij}^*$ and φ_{ji}^*. Without loss of generality, assuming $\theta_i = \theta_j = \theta$,

$$\varphi_j^* = [\frac{f_e(1-\tau_{ji}^{\theta})}{\frac{\theta K}{M_j}(\tau_{ij}^{-\theta}-\tau_{ji}^{\theta})}]^{-\frac{1}{\theta+2}} \tag{18}$$

$$M_j = 4(\frac{\gamma}{L_j} + \rho\sigma_{v_j}^2)$$

We can show $\varphi_{ii}^* = \varphi_i^* > \varphi_{ij}^*$ (see Appendix).

The cut-off φ_j^* thus depends on bilateral trade costs, sunk entry utility f_e , distribution parameter θ, demand parameter γ, market size L, Arrow−Pratt risk aversion measure ρ, and uncertainty proxy $\sigma_{v_j^2}$. It is worth emphasizing that the productivity cut-off is independent of the realized value of demand shock $v_j(\omega)$ due to the timing of firms' decisions.

Prediction 3 φ_j^* decreases in domestic uncertainty proxy $\sigma_{v_j}^2$, and the degree of product differentiation γ; φ_j^* increases in market size L_j; the sector average productivity of firms at the equilibrium will fall due to the rise in uncertainty.

Combining φ_j^* with (9) and (10), the general equilibrium effects of uncertainty on firm-level prices and outputs are as follows.

Prediction 4 p_{ij}^*, thus the firm level mark-up, increases in domestic uncertainty proxy $\sigma_{v_j}^2$; q_{ij}^* decreases in domestic uncertainty proxy $\sigma_{v_j}^2$.

2.4.1 Prices and product variety

Price level in country j consists of both the prices of domestic producers, $p_j^*(\omega)$, and the prices of exporters from country i, p_{ij}^*. These prices can be written as:

$$p_{ij}^*(\omega) = \bar{p}_{max_j} - \frac{\gamma(\bar{p}_{max_j} + \mu_{v_j} - \frac{w_i\tau_{ij}}{\varphi})}{2(\gamma + L_j\rho\sigma_{v_j}^2)} + v_j(\omega), \varphi \in [\tau_{ij}\varphi_j^*, +\infty]$$

$$p_j^*(\omega) = \bar{p}_{max_j} - \frac{\gamma(\bar{p}_{max_j} + \mu_{v_j} - \frac{w_j\tau_{jj}}{\varphi})}{2(\gamma + L_j\rho\sigma_{v_j}^2)} + v_j(\omega), \varphi \in [\varphi_j^*, +\infty]$$

where the productivity of domestic firms $\varphi \in [\varphi_j^*, +\infty]$, and the productivity of exporters discounted by the trade costs $\varphi/\tau_{ij} \in [\varphi_j^*, +\infty]$ have identical distribution over the support (see Appendix). Assuming the distribution of variety-specific shifter $v_j(\omega)$ independent of φ, the above prices can be interpreted as the shifter plus a non-variety-specific component.

Therefore, the non-variety-specific component of domestic firms in market j, $p_j^*(\omega) - v_j(\omega)$, and that of exporters producing in i, $p_{ij}^*(\omega) - v_j(\omega)$, are also distributed identically and the cumulative distribution function is defined as $G_D(\varphi)$. The average price in country j thus is given by

$$\begin{aligned}
\bar{p_j} &= \frac{\int_{\omega\in\Omega_j^*} p_j(\omega)d\omega}{N_j} \\
&= \int_{\varphi_j^*}^{+\infty} (p_j(\varphi) - v_j(\omega))dG_D(\varphi) + \frac{\int_{\omega\in\Omega_j^*} v_j(\omega)d\omega}{N_j} \qquad (19) \\
&= \underbrace{(1/\varphi_j^*)}_{\text{Selection Effect}} \times \underbrace{\Phi(\sigma_{v_j}^2;\gamma, L_j, \theta, \rho)}_{\text{Risk-aversion Effect}} + \underbrace{\bar{v_j} - \mu_{v_j}}_{\text{Error of Sampling}}
\end{aligned}$$

$$\Phi(\sigma_{v_j}^2;\gamma, L_j, \theta, \rho) = 1 - \frac{\gamma}{2(\gamma + L_j\rho\sigma_{v_j}^2)(\theta+1)}$$

Combining (19) with (7) and (11) to solve the number of firms selling in country j at the equilibrium:

$$N_j = 2\varphi_j^*(\theta+1)(\gamma + L_j\rho\sigma_{v_j}^2)(\alpha + u_{v_j} - 1/\varphi_j^*)/\eta \qquad (20)$$

Prediction 5 The average price $\bar{p}_j$ increase in $\sigma_{v_j}^2$; however, the effects of $\sigma_{v_j}^2$ on number of sellers is ambiguous.

The change in average price is a combination of selection effect and risk-aversion effect, i.e., as the rise in uncertainty, the less productive firms selected into the equilibrium charge higher prices than those incumbents, and the surviving firms charge a higher price as well. These two effects together push the average price up.[3] These two effects can be interpreted as the extensive and intensive margin as well,

$$\frac{d\bar{p}_j}{d\sigma_{v_j}^2} = \underbrace{\frac{\partial\bar{p}_j}{\partial p_j(\varphi)}\frac{dp_j(\varphi)}{d\sigma_{v_j}^2}}_{\text{Intensive Margin}} + \underbrace{\frac{\partial\bar{p}_j}{\partial\varphi_j^*}\frac{d\varphi_j^*}{d\sigma_{v_j}^2}}_{\text{Extensive Margin}} > 0$$

Both of these two effects are positive, and the empirics show intensive margin, the pricing behavior of firms, is the main force which drove the average price up with increasing uncertainty.

Unlike average price, the impact of uncertainty $\sigma_{v_j}^2$ on number of firms at the equilibrium N_j is ambiguous. The rise in uncertainty proxy will lower

[3] If the economy is really bad, i.e., $\bar{v_j}$ is negative and small, sector-level price will fall even we have selection effect and risk-aversion effect.

the productivity cut-off which indicates a less competitive market; however, the increase in uncertainty may also deter potential entrants. The total effect is determined by the relative magnitude of these two forces.

The comparative statics shows the higher the trade cost τ_{ij}, the larger the competition effect is (see Appendix). This says the competition effect in terms of change in $\bar{p}_{max_j}$ is more likely to dominate the deterrence effect in a less open market which means the increase in uncertainty will push N_j up.

2.4.2 Number of entrants, domestic producers, and exporters

The number of sellers in market j, N_j, is comprised of domestic producers and exporters from country i. Given entrants in country i and j are N_E^i and N_E^j respectively, there are $(1 - G(\varphi_j^*))N_E^j$ domestic producers and $(1 - G(\varphi_{ij}^*))N_E^i$ exporters selling in market j satisfying $(1 - G(\varphi_j^*))N_E^j + (1 - G(\varphi_{ij}^*))N_E^i = N_j$. This condition is also true for country i, the number of entrants in both countries hence can be solved.

$$N_E^j = \frac{(\varphi_j^*)^\theta (N_j - (\varphi_i^*/\varphi_{ij}^*)^\theta N_i)}{1 - \tau_{ij}^{-\theta}\tau_{ji}^{-\theta}} \tag{21}$$

Observation 6 The impact of uncertainty $\sigma_{v_j}^2$ on the number of entrants from country i and country j is ambiguous.

To better understand the implications of this model, one can consider the following two situations (see Appendix).

If τ_{ij} is high, the number of firms selling in country j N_j will increase as the rise in uncertainty $\sigma_{v_j}^2$. However, we are not sure the impact on N_E^j and N_E^i without further assumptions on the model parameters.

If τ_{ij} is low, the number of firms selling in country j, N_j, will decrease with the rise in uncertainty $\sigma_{v_j}^2$. And the number of entrants from country i will increase, while the number of entrants from country j will decrease. Intuitively, increase of uncertainty in a more open market will bring higher importing competition through a lower productivity cut-off, thus the number of domestic entrants will drop.

3 Data

The implications of the model are put into test with Chinese firm-level export data, Chinese firm level production data and Bloomberg data. Relevant Macroeconomic controls are obtained from World Economic Outlook

Database published by International Monetary Fund and Penn World tables. Tariff data can be accessed through the WTO and the trade analysis and information system (TRAINS).

3.1 Firm-Product-Level Export Data

The firm-product-level export data from China's General Administration of Customs reports eight-digit harmonized system(HS) transactions by firm and destination. It covers relevant information such as free-on-board(FOB) export value and volume. This monthly data is collapsed to annual level. The data period is from 2000 to 2008. Considering the possible different export strategies between processing trade and ordinary trade, I keep only ordinary trade in my samples.

3.2 Firm-level Production Data

The firm-level production data from China's National Bureau of Statistics (NBS) contains complete information on the three major accounting statements (i.e. balance sheet, profit and loss account, and cash flow statement) of manufacturing firms. The data period for the analysis is 1999 to 2007. Based on Feenstra et al.(2013a) and Yu(2014), I drop observations if any of the following are true:

(i) total assets or net fixed assets or sales revenue are missing;
(ii) number of employees is less than 8;
(iii) pure trading firms (identified by key Chinese characters).

3.3 Bloomberg Stock-Market Volatility

Firms in the matched sample of China customs data and NBS data can be classified into seven Global Industry Classification Standard (GICS) sectors based on their China Industry Classification (CIC) code. The uncertainty proxy used in the empirical analysis is country-sector(GICS)-year specific and given by the corresponding Bloomberg stock market volatility index.

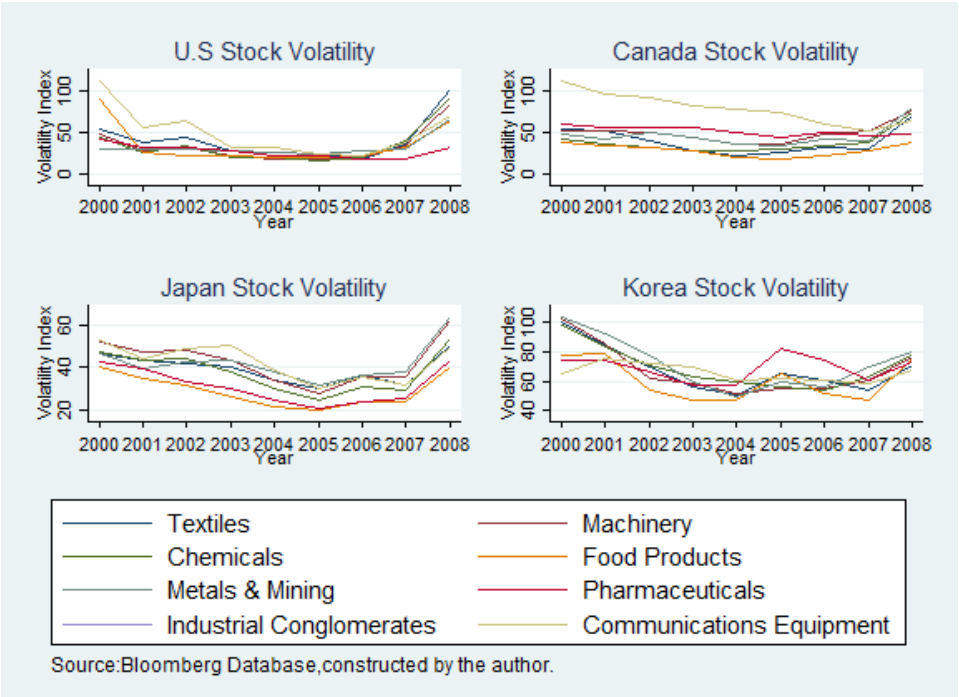
Figure 2a-2c display data pattern of the uncertainty proxy. Lines in different colors represent the volatility in different GICS sectors. This proxy covers China's 12 main export destinations each of which consists of 7 GICS sectors from 2000 to 2008. Several features of this proxy can be found from the figures: first, volatilities for all country-sector are countercyclical, e.g., volatilities are high during the 2007-2010 Subprime mortgage crisis; second,

most of the variation in the uncertainty proxy comes from its fluctuation over time, and the variation across country or sector[4] are relatively small.

3.4 TFP Measures

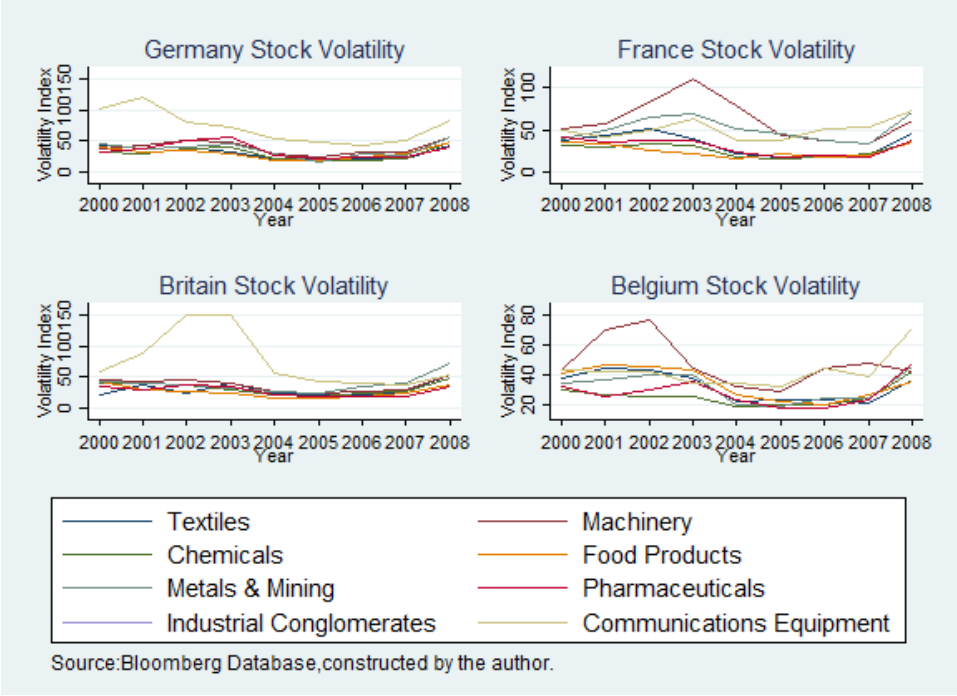
Firm-level productivity is estimated from NBS data by CIC industries with OLS, GMM, Olley-Pakes, and ACF method respectively.

Figure 2a



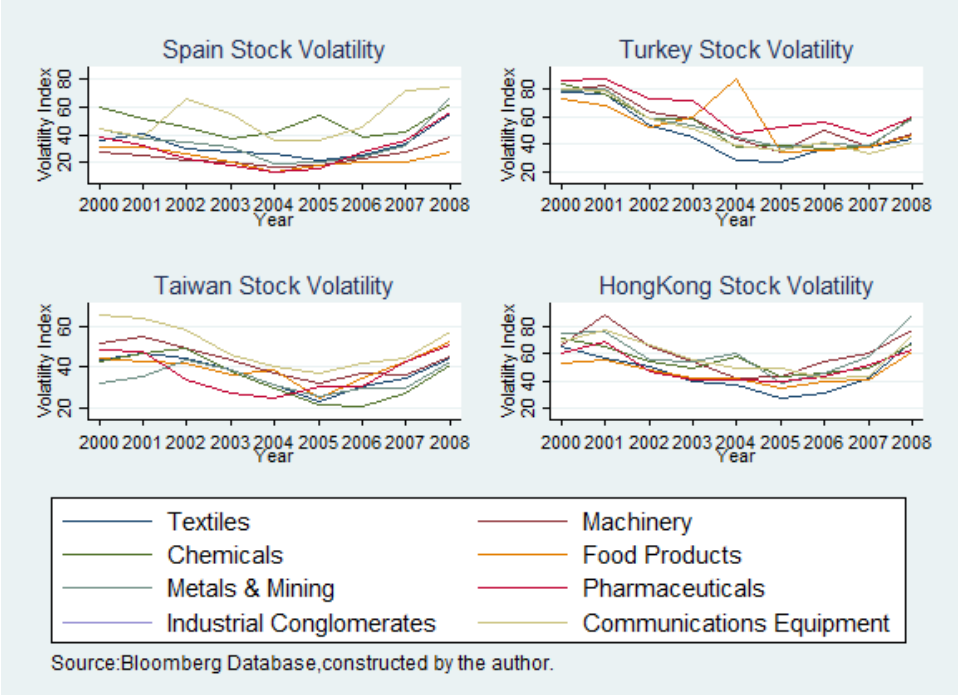
[4]Within a country, the gaps between those sector volatility lines show us how volatilities vary across sectors.

Figure 2b



Source:Bloomberg Database,constructed by the author.

Figure 2c



Source:Bloomberg Database,constructed by the author.

4 Empirics

The empirics start with firm-product level evidence for a positive correlation between export prices and uncertainty (Prediction 4). Price of exports can be defined as the ratio of FOB value divided by export volume for each firm-product-destination-year observation, thus unit value and price can be used interchangeably throughout this paper. Then firm-level analysis explores the correlation while taking firm heterogeneity into account. In the end, the sector-level analysis is performed.

4.1 Firm-Product-Level Results

The most disaggregate data used in the analysis allows me to explore the variation in prices of all products[5] sold by Chinese exporters.

[5]Firm-level analysis only uses the representative product, which is referred to as "core product", for each firm.

VARIABLES	(1) Log Unit Value	(2) Log Unit Value	(3) Log Unit Value	(4) Log Unit Value
Log Volatility	0.0673***	0.0717***	0.114***	0.121***
	(0.00204)	(0.00205)	(0.00231)	(0.00232)
Observations	2,690,198	2,690,198	2,690,198	2,690,198
R-squared	0.923	0.923	0.923	0.923
Firm-Product FE	Yes	Yes	Yes	Yes
Sector FE	No	Yes	No	Yes
Destination FE	No	No	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 1: Product-Level Regressions

Table 1 shows that export prices are positively correlated to the uncertainty proxy. One concern about the firm-product-level analysis is that it fails to capture firm-level heterogeneity in the absence of product-level TFP measure. To further explore firms' pricing strategy under uncertainty, firm-level analysis is introduced.

4.2 Firm-Level Results

4.2.1 Sample Selection for Firm-Level Analysis

Export prices at firm level can be calculated from average price of products, however, these defined firm-level prices are problematic when it comes to measure the price of a multi-product exporter. Since the change in the firm-level prices will not only reflect the change in pricing strategy but also the change in product composition. Following Berman et al (2012), firm-level price can also be defined as the price of exporter's core product, which is given by restricting products of a multi-product exporter to its core product according to sample selection standards I discuss below. While eliminating the product composition issue, representativeness issue will arise in the selected samples. This paper thus takes the "core" product approach with different variants of samples.

Four samples are created for my firm-level analysis. The benchmark sample picks the product with highest export value by the firm worldwide over the sample period (2000-2008) as the core product. Export-destination sample (Sample_2) keeps the top product in terms of number of export des-

tinations over the sample period. One-product sample (Sample_3) contains the firm-destinations which have only one export goods over the sample period, e.g., if firm A export both product 1 and 2 to Japan in 2000 to 2008, firm A - Japan pair will be excluded from this sample. Export-value (Sample_4) is a variation of the benchmark sample which keeps the top product in terms of export value for each firm-year pair, therefore, the core product in this sample changes over time. Berman et al (2012) discusses the trade-off between product composition and representativeness of the sample selection procedure. Table I shows the coverage of each sample.

	(1)	(2)	(3)	(4)
Sample	Benchmark	Export-Destination	One-Product	Export-Value
# Observations	3,888,882	4,337,348	2,892,983	4,394,481
# Firms	288,415	288,415	255,819	288,415
China's export value (Ordinary Trade)	52%	35%	15%	46%
China's exporters	100%	100%	89%	100%

Table 2: Sample Representativeness

The main firm-level prediction tested in this section is that unit value of exports increases in the market uncertainty. In the following set-ups, i, k, j, t indicate firm, sector, destination and year respectively.

$$\begin{aligned} ln(y^k_{ijt}) = \beta_1 ln(\bar{\varphi}^k_{it-1}) + \beta_2 ln(UNC^k_{jt}) + \beta_3 ln(\bar{\varphi}^k_{it-1}) \times ln(UNC^k_{jt}) \\ + \beta_z Z_{jt} + \beta_x X^k_{jt} + \psi^k + \mu_{ij} + \epsilon_{ijt} \end{aligned} \tag{22}$$

where y^k_{ijt} is the performance variable, i.e., unit value or revenue of exporter i selling to market j on year t; UNC^k_{jt} is a country-industry-year-specific uncertainty proxy, and the measure used in the analysis is standardized stock volatility[6]; $\bar{\varphi}^k_{it-1}$ is the total factor productivity of firm i at the period of t-1; the interaction term captures the firm-level heterogeneity in terms of productivity; Z_{jt} is a vector of country-level control variables, such as log real GDP per capita and log real exchange rate; X^k_{jt} is a vector of country-sector-level control variables, such as tariff; ψ^k is sector fixed effects which capture all the sector-variant only shocks common to all Chinese exporters; μ_{ij} is the firm-destination fixed effects, used for controlling the time-invariant factors that vary by firm (e.g., management skill), by export destination (e.g., market size), or by the combination of them (e.g: consumer's preference for goods exported by the firm).

[6]The stock volatility is divided by the average within its country-sector for each year.

Manova and Zhang (2012) suggest that product quality is of great importance to characterize the performance of Chinese exporters. They find that more successful Chinese exporters use higher quality inputs to produce outputs of better quality, and firms charge higher prices in richer markets. My empirical analysis deals with the quality difference across destinations with firm-destination fixed effects, but does not capture the quality difference explained by input costs due to lack of product-level cost data.

The coefficient of uncertainty proxy is expected to be positive according to the model prediction; The sign for the interaction term is uncertain in my model. Intuitively, larger firms with higher productivity should have more bargaining power thus more likely to raise their prices; on the other hand, smaller firms with lower productivity may need charge higher risk premium to survive a bad day since they are likely to have less options to hedge the risk. Therefore, the marginal impact of uncertainty on the unit value could increase or decrease in firm productivity.

Table 3 - Table 6 apply specification (22) to selected samples with variants of TFP measures. The main prediction that unit values are positively correlated to volatility are robust against sample selection and choice of TFP measure. And the coefficients are economically significant and consistent in magnitude. Besides, there are some evidences supporting the standpoint that firms respond to uncertainty with heterogeneity, i.e., marginal effect of uncertainty on export prices decrease in productivity.

The positive correlation between uncertainty and firm revenue can be displayed using (22) as well [7] (see Table 7 through Table 10). The results of firm revenue can partly justify why exporters choose to raise their prices as uncertainty goes up. That is firms' revenue increase in uncertainty.

[7] Real exchange rate (RER) is defined as the ratio of Chinese Yuan to one unit of foreign currency, multiplied by the ratio of foreign CPI over Chinese CPI. By definition, an increase in RER indicates a real depreciation of the Chinese Yuan.

Benchmark/Dependent Var. Log Unit Price

VARIABLES	(1) OP	(2) OLS	(3) GMM	(4) ACF
$LogTFP_OP_{t-1}$	0.111*			
	(0.0576)			
Log Volatility	0.122***	0.115***	0.0872***	0.0946***
	(0.0266)	(0.0194)	(0.0117)	(0.0120)
$LogTFP_OP_{t-1}$ × Log Volatility	-0.0204*			
	(0.0123)			
Log Real Exchange Rate	-0.519***	-0.521***	-0.546***	-0.546***
	(0.0203)	(0.0203)	(0.0240)	(0.0240)
Log RGDP per Cap	1.617***	1.625***	1.528***	1.526***
	(0.0495)	(0.0493)	(0.0667)	(0.0665)
Log Tariff	-0.0510***	-0.0516***	-0.0162	-0.0165
	(0.0183)	(0.0182)	(0.0253)	(0.0253)
Log GDP deflator	0.294***	0.297***	0.424***	0.430***
	(0.0378)	(0.0378)	(0.0535)	(0.0535)
$LogTFP_OLS_{t-1}$		0.161**		
		(0.0781)		
$LogTFP_OLS_{t-1}$ × Log Volatility		-0.0325*		
		(0.0168)		
$LogTFP_GMM_{t-1}$			0.228***	
			(0.0667)	
$LogTFP_GMM_{t-1}$ × Log Volatility			-0.0474***	
			(0.0143)	
$LogTFP_ACF_{t-1}$				0.374***
				(0.0893)
$LogTFP_ACF_{t-1}$ × Log Volatility				-0.0771***
				(0.0191)
Observations	106,611	106,611	79,066	79,066
R-squared	0.056	0.055	0.053	0.054
Number of Firm-Destination	53,995	53,995	44,091	44,091
Firm-Destination FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 3: Firm-level Results - Unit Value A

Sample_2/Dependent Var. Log Unit Price

VARIABLES	(1) OP	(2) OLS	(3) GMM	(4) ACF
$LogTFP_OP_{t-1}$	0.0910			
	(0.0596)			
Log Volatility	0.124***	0.116***	0.0987***	0.104***
	(0.0277)	(0.0204)	(0.0122)	(0.0125)
$LogTFP_OP_{t-1}$ × Log Volatility	-0.0171			
	(0.0128)			
Log Real Exchange Rate	-0.530***	-0.532***	-0.552***	-0.552***
	(0.0214)	(0.0214)	(0.0250)	(0.0250)
Log RGDP per Cap	1.581***	1.589***	1.457***	1.454***
	(0.0514)	(0.0513)	(0.0689)	(0.0686)
Log Tariff	-0.0520***	-0.0524***	-0.0368	-0.0378
	(0.0197)	(0.0197)	(0.0272)	(0.0271)
Log GDP deflator	0.321***	0.324***	0.493***	0.499***
	(0.0384)	(0.0384)	(0.0540)	(0.0540)
$LogTFP_OLS_{t-1}$		0.122		
		(0.0811)		
$LogTFP_OLS_{t-1}$ × Log Volatility		-0.0254		
		(0.0175)		
$LogTFP_GMM_{t-1}$			0.234***	
			(0.0684)	
$LogTFP_GMM_{t-1}$ × Log Volatility			-0.0508***	
			(0.0147)	
$LogTFP_ACF_{t-1}$				0.366***
				(0.0908)
$LogTFP_ACF_{t-1}$ × Log Volatility				-0.0780***
				(0.0196)
Observations	109,105	109,105	80,876	80,876
R-squared	0.052	0.052	0.051	0.052
Number of Firm-Destination	57,146	57,146	46,267	46,267
Firm-Destination FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 4: Firm-level Results - Unit Value B

Sample_3/Dependent Var. Log Unit Price

VARIABLES	(1) OP	(2) OLS	(3) GMM	(4) ACF
$LogTFP_OP_{t-1}$	0.0755			
	(0.0831)			
Log Volatility	0.103***	0.0770***	0.0657***	0.0529**
	(0.0385)	(0.0277)	(0.0137)	(0.0255)
$LogTFP_OP_{t-1}$ × Log Volatility	-0.0133			
	(0.0178)			
Log Real Exchange Rate	-0.615***	-0.617***	-0.606***	-0.584***
	(0.0298)	(0.0298)	(0.0342)	(0.0463)
Log RGDP per Cap	1.792***	1.794***	1.770***	1.516***
	(0.0702)	(0.0700)	(0.0927)	(0.122)
Log Tariff	-0.0702***	-0.0702***	-0.0357***	-0.0848**
	(0.0106)	(0.0106)	(0.0132)	(0.0411)
Log GDP deflator	0.305***	0.307***	0.424***	0.436***
	(0.0540)	(0.0539)	(0.0754)	(0.0924)
$LogTFP_OLS_{t-1}$		0.0185		
		(0.110)		
$LogTFP_OLS_{t-1}$ × Log Volatility		-0.00110		
		(0.0238)		
$LogTFP_GMM_{t-1}$			0.0584	
			(0.0826)	
$LogTFP_GMM_{t-1}$ × Log Volatility			-0.0109	
			(0.0176)	
$LogTFP_ACF_{t-1}$				0.108
				(0.202)
$LogTFP_ACF_{t-1}$ × Log Volatility				-0.0259
				(0.0433)
Observations	121,981	121,981	88,096	42,443
R-squared	0.030	0.030	0.030	0.044
Number of Firm-Destination	60,854	60,854	48,651	30,398
Firm-Destination FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 5: Firm-level Results - Unit Value C

Sample_4/Dependent Var. Log Unit Price

VARIABLES	(1) OP	(2) OLS	(3) GMM	(4) ACF
$LogTFP_OP_{t-1}$	0.0755			
	(0.0831)			
Log Volatility	0.103***	0.0770***	0.0657***	0.0962***
	(0.0385)	(0.0277)	(0.0137)	(0.0172)
$LogTFP_OP_{t-1}$ × Log Volatility	-0.0133			
	(0.0178)			
Log Real Exchange Rate	-0.615***	-0.617***	-0.606***	-0.600***
	(0.0298)	(0.0298)	(0.0342)	(0.0341)
Log RGDP per Cap	1.792***	1.794***	1.770***	1.750***
	(0.0702)	(0.0700)	(0.0927)	(0.0907)
Log Tariff	-0.0702***	-0.0702***	-0.0357***	-0.0523***
	(0.0106)	(0.0106)	(0.0132)	(0.0131)
Log GDP deflator	0.305***	0.307***	0.424***	0.417***
	(0.0540)	(0.0539)	(0.0754)	(0.0747)
$LogTFP_OLS_{t-1}$		0.0185		
		(0.110)		
$LogTFP_OLS_{t-1}$ × Log Volatility		-0.00110		
		(0.0238)		
$LogTFP_GMM_{t-1}$			0.0584	
			(0.0826)	
$LogTFP_GMM_{t-1}$ × Log Volatility			-0.0109	
			(0.0176)	
$LogTFP_ACF_{t-1}$				0.369***
				(0.128)
$LogTFP_ACF_{t-1}$ × Log Volatility				-0.0763***
				(0.0274)
Observations	121,981	121,981	88,096	89,903
R-squared	0.030	0.030	0.030	0.030
Number of Firm-Destination	60,854	60,854	48,651	49,484
Firm-Destination FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 6: Firm-level Results - Unit Value D

Benchmark/Dependent Var. Log Revenue

VARIABLES	(1) OP	(2) OLS	(3) GMM	(4) ACF
$LogTFP_OP_{t-1}$	0.531***			
	(0.166)			
Log Volatility	0.310***	0.237***	0.157***	0.180***
	(0.0766)	(0.0560)	(0.0328)	(0.0339)
$LogTFP_OP_{t-1}$ × Log Volatility	-0.0832**			
	(0.0356)			
Log Real Exchange Rate	-0.208***	-0.225***	-0.0818	-0.0820
	(0.0585)	(0.0585)	(0.0675)	(0.0675)
Log RGDP per Cap	2.417***	2.484***	2.019***	2.068***
	(0.143)	(0.142)	(0.187)	(0.187)
Log Tariff	-0.362***	-0.367***	-0.360***	-0.363***
	(0.0526)	(0.0527)	(0.0711)	(0.0711)
Log GDP deflator	1.732***	1.759***	2.095***	2.116***
	(0.109)	(0.109)	(0.150)	(0.150)
$LogTFP_OLS_{t-1}$		0.513**		
		(0.225)		
$LogTFP_OLS_{t-1}$ × Log Volatility		-0.0893*		
		(0.0485)		
$LogTFP_GMM_{t-1}$			0.692***	
			(0.188)	
$LogTFP_GMM_{t-1}$ × Log Volatility			-0.128***	
			(0.0402)	
$LogTFP_ACF_{t-1}$				1.023***
				(0.251)
$LogTFP_ACF_{t-1}$ × Log Volatility				-0.207***
				(0.0539)
Observations	106,673	106,673	79,114	79,114
R-squared	0.027	0.026	0.021	0.021
Number of Firm-Destination	54,029	54,029	44,119	44,119
Firm-Destination FE	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 7: Firm-level Results - Revenue A

Sample_2/Dependent Var. Log Revenue

VARIABLES	(1) OP	(2) OLS	(3) GMM	(4) ACF
$LogTFP_OP_{t-1}$	0.265			
	(0.167)			
Log Volatility	0.236***	0.185***	0.189***	0.173***
	(0.0777)	(0.0570)	(0.0336)	(0.0345)
$LogTFP_OP_{t-1}$ × Log Volatility	-0.0352			
	(0.0360)			
Log Real Exchange Rate	-0.178***	-0.189***	-0.0890	-0.0894
	(0.0601)	(0.0600)	(0.0691)	(0.0691)
Log RGDP per Cap	2.469***	2.510***	2.193***	2.232***
	(0.144)	(0.144)	(0.190)	(0.189)
Log Tariff	-0.331***	-0.334***	-0.294***	-0.298***
	(0.0553)	(0.0553)	(0.0750)	(0.0750)
Log GDP deflator	1.618***	1.635***	1.990***	2.004***
	(0.108)	(0.108)	(0.149)	(0.149)
$LogTFP_OLS_{t-1}$		0.162		
		(0.227)		
$LogTFP_OLS_{t-1}$ × Log Volatility		-0.0185		
		(0.0492)		
$LogTFP_GMM_{t-1}$			0.698***	
			(0.189)	
$LogTFP_GMM_{t-1}$ × Log Volatility			-0.135***	
			(0.0407)	
$LogTFP_ACF_{t-1}$				0.615**
				(0.251)
$LogTFP_ACF_{t-1}$ × Log Volatility				-0.126**
				(0.0542)
Observations	109,192	109,192	80,944	80,944
R-squared	0.025	0.025	0.021	0.021
Number of Firm-Destination	57,200	57,200	46,312	46,312
Firm-Destination FE	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 8: Firm-level Results - Revenue B

Sample_3/Dependent Var. Log Unit Price

VARIABLES	(1) OP	(2) OLS	(3) GMM	(4) ACF
$LogTFP_OP_{t-1}$	0.0755			
	(0.0831)			
Log Volatility	0.103***	0.0770***	0.0657***	0.0529**
	(0.0385)	(0.0277)	(0.0137)	(0.0255)
$LogTFP_OP_{t-1}$ × Log Volatility	-0.0133			
	(0.0178)			
Log Real Exchange Rate	-0.615***	-0.617***	-0.606***	-0.584***
	(0.0298)	(0.0298)	(0.0342)	(0.0463)
Log RGDP per Cap	1.792***	1.794***	1.770***	1.516***
	(0.0702)	(0.0700)	(0.0927)	(0.122)
Log Tariff	-0.0702***	-0.0702***	-0.0357***	-0.0848**
	(0.0106)	(0.0106)	(0.0132)	(0.0411)
Log GDP deflator	0.305***	0.307***	0.424***	0.436***
	(0.0540)	(0.0539)	(0.0754)	(0.0924)
$LogTFP_OLS_{t-1}$		0.0185		
		(0.110)		
$LogTFP_OLS_{t-1}$ × Log Volatility		-0.00110		
		(0.0238)		
$LogTFP_GMM_{t-1}$			0.0584	
			(0.0826)	
$LogTFP_GMM_{t-1}$ × Log Volatility			-0.0109	
			(0.0176)	
$LogTFP_ACF_{t-1}$				0.108
				(0.202)
$LogTFP_ACF_{t-1}$ × Log Volatility				-0.0259
				(0.0433)
Observations	121,981	121,981	88,096	42,443
R-squared	0.030	0.030	0.030	0.044
Number of Firm-Destination	60,854	60,854	48,651	30,398
Firm-Destination FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 9: Firm-level Results - Revenue C

Sample_4/Dependent Var. Log Revenue

VARIABLES	(1) OP	(2) OLS	(3) GMM	(4) ACF
$LogTFP_OP_{t-1}$	0.260			
	(0.159)			
Log Volatility	0.249***	0.240***	0.137***	0.210***
	(0.0737)	(0.0529)	(0.0268)	(0.0335)
$LogTFP_OP_{t-1}$ × Log Volatility	-0.0338			
	(0.0342)			
Log Real Exchange Rate	-0.398***	-0.409***	-0.290***	-0.285***
	(0.0570)	(0.0570)	(0.0667)	(0.0663)
Log RGDP per Cap	2.907***	2.957***	2.656***	2.663***
	(0.134)	(0.134)	(0.180)	(0.176)
Log Tariff	-0.0134	-0.0136	0.0287	0.00719
	(0.0203)	(0.0203)	(0.0258)	(0.0254)
Log GDP deflator	1.531***	1.550***	1.668***	1.719***
	(0.103)	(0.103)	(0.147)	(0.145)
$LogTFP_OLS_{t-1}$		0.324		
		(0.211)		
$LogTFP_OLS_{t-1}$ × Log Volatility		-0.0546		
		(0.0455)		
$LogTFP_GMM_{t-1}$			-0.0637	
			(0.161)	
$LogTFP_GMM_{t-1}$ × Log Volatility			0.0259	
			(0.0343)	
$LogTFP_ACF_{t-1}$				0.787***
				(0.249)
$LogTFP_ACF_{t-1}$ × Log Volatility				-0.163***
				(0.0534)
Observations	122,068	122,068	88,161	89,970
R-squared	0.026	0.026	0.020	0.020
Number of Firm-Destination	60,900	60,900	48,690	49,523
Firm-Destination FE	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 10: Firm-level Results - Revenue D

To further explore the firm level uncertainty, I take a variation of the (22) by replacing the TFP (and the interaction) terms with a dummy indicating the rank of TFP, and the results are summarized in Table 11 and Table 12.

I create the percentile dummies for firm representative TFP[8], e.g., Bottom 50% is a time-variant dummy to indicate whether a firm's representative TFP belongs to the bottom 50% of the selected sample. The regressions with percentile dummies using the benchmark sample and ACF TFP measure are shown below (see Table 11 and Table 12). The results support the findings based on specification(22) that export prices and revenue increase when uncertainty goes up. Besides, firm-level heterogeneity is proved to be strong by the coefficients of interaction terms, i.e., the marginal effects of uncertainty are almost twice as strong in the bottom 50% TFP group as those in the top 50% TFP group. And the firm-level heterogeneity are robust across those selected samples and TFP measures (see Appendix).

The intuition behind these findings about firm heterogeneity is that low productivity firms with small scale tend to have less options to hedge the risk, and probably face higher costs to finance compared to large-scale firms with high productivity.

[8] I first calculate "representative TFP" for each firm by averaging its lagged TFP over the sample period (2000-2008), then use this representative TFP to calculate those percentiles

	Benchmark/ACF		
	(1)	(2)	(3)
VARIABLES	Log Unit Value	Log Unit Value	Log Unit Value
Log Volatility	0.0656***	0.0760***	0.0847***
	(0.00913)	(0.00763)	(0.00713)
Log Real Exchange Rate	-0.507***	-0.506***	-0.506***
	(0.0187)	(0.0187)	(0.0187)
Log RGDP per Cap	1.653***	1.652***	1.652***
	(0.0410)	(0.0410)	(0.0410)
Log Tariff	-0.0307**	-0.0311**	-0.0314**
	(0.0157)	(0.0157)	(0.0157)
Log GDP deflator	0.279***	0.279***	0.278***
	(0.0332)	(0.0332)	(0.0332)
Bottom 50% TFP_{t-1} × Log Volatility	0.0484***		
	(0.0131)		
Bottom 25% TFP_{t-1} × Log Volatility		0.0596***	
		(0.0166)	
Bottom 10% TFP_{t-1} × Log Volatility			0.0435
			(0.0266)
Observations	128,085	128,085	128,085
R-squared	0.058	0.058	0.058
Number of Firm-Destination	63,454	63,454	63,454
Firm-Destination FE	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 11: Firm-level Results - Heterogeneity - Unit Value

	Benchmark/ACF		
	(1)	(2)	(3)
VARIABLES	Log Revenue	Log Revenue	Log Revenue
Log Volatility	0.138***	0.163***	0.190***
	(0.0268)	(0.0224)	(0.0210)
Log Real Exchange Rate	-0.352***	-0.352***	-0.349***
	(0.0549)	(0.0549)	(0.0549)
Log RGDP per Cap	2.894***	2.891***	2.893***
	(0.121)	(0.121)	(0.121)
Log Tariff	-0.327***	-0.328***	-0.329***
	(0.0460)	(0.0460)	(0.0460)
Log GDP deflator	1.778***	1.778***	1.775***
	(0.0977)	(0.0976)	(0.0977)
Bottom 50% TFP_{t-1} × Log Volatility	0.133***		
	(0.0386)		
Bottom 25% TFP_{t-1} × Log Volatility		0.185***	
		(0.0488)	
Bottom 10% TFP_{t-1} × Log Volatility			0.138*
			(0.0783)
Observations	128,165	128,165	128,165
R-squared	0.034	0.034	0.033
Number of Firm-Destination	63,496	63,496	63,496
Firm-Destination FE	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 12: Firm-level Results - Heterogeneity - Revenue

4.3 Sector-Level Results

The testable sector-level predictions from my model are average prices rise (Prediction 5) and cutoff productivities fall (Prediction 3) with the rise of uncertainty. The findings in Table 13 are consistent with the prediction 5, however, Table 14 shows little evidence for Prediction 3 (see Appendix for the robustness check).

$$ln(y_{jt}^k) = \beta_1 ln(UNC_{jt}^k) + \beta_z Z_{jt} + \beta_x X_{jt}^k + \mu_j^k + \epsilon_{ijt} \tag{23}$$

Benchmark/Dependent Var. Log Average Price

VARIABLES	(1) OP	(2) OLS	(3) GMM	(4) ACF
Log Volatility	0.900**	0.972**	0.993**	0.860**
	(0.386)	(0.386)	(0.420)	(0.383)
Log Real Exchange Rate	-4.422***	-4.670***	-4.632***	-4.554***
	(0.787)	(0.768)	(0.833)	(0.762)
Log RGDP per Cap	13.70***	12.93***	13.33***	12.44***
	(1.124)	(1.126)	(1.221)	(1.120)
Log Average Tariff	-0.0905	-0.310*	-0.293	-0.410**
	(0.163)	(0.184)	(0.183)	(0.185)
Log GDP deflator	1.113*	1.527***	1.305**	1.507***
	(0.612)	(0.582)	(0.631)	(0.577)
Observations	359	375	371	375
R-squared	0.410	0.404	0.373	0.399
Number of Sector-Destination	42	42	42	42
Sector-Destination FE	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 13: Sector-Level Results - Average Price

Benchmark/Dependent Var. Log Average TFP

VARIABLES	(1) OP	(2) OLS	(3) GMM	(4) ACF
Log Volatility	0.0963*	0.00387	-0.00271	-0.0403
	(0.0557)	(0.0199)	(0.0418)	(0.0263)
Log Real Exchange Rate	-0.109	-0.0506	-0.0636	0.0224
	(0.112)	(0.0389)	(0.0814)	(0.0514)
Log RGDP per Cap	0.775***	0.653***	0.915***	0.433***
	(0.153)	(0.0551)	(0.116)	(0.0734)
Log Average Tariff	0.0147	-0.0323***	-0.0162	-0.0268**
	(0.0194)	(0.00802)	(0.0152)	(0.0107)
Log GDP deflator	-0.0410	-0.0103	0.0871	-0.101***
	(0.0784)	(0.0264)	(0.0555)	(0.0351)
Observations	317	333	329	331
R-squared	0.104	0.458	0.306	0.173
Number of Sector-Destination	42	42	42	42
Sector-Destination FE	Yes	Yes	Yes	Yes

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 14: Sector-Level Results - Average Productivity

The results on sector-level TFP show that there is little evidence to support the extensive margin proposed in 2.4.1. The rise in sector-level prices thus is more likely to be explained by the intensive margin.

5 Conclusion

Both of the model and empirics show firm-level risk-aversion contribute to the variation of export prices. Empirical results on firm-product, firm, and sector level prices support the hypothesis that export prices increase in uncertainty. Except for the model predictions, evidence for that low productivity firms tend to raise their export prices hence revenue more than those with high productivity is found in the data.

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