Prices of Chinese Exports: Beyond Productivity

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Abstract

Using a unique dataset that links trade transactions to 77,642 exporting firms in China over the period 2000-2006, we study the cross-firm variation of export prices within product-destination markets. We find that more productive, more capital intensive, and more skill intensive firms charge a higher price. Strikingly, we also find that export prices are on average 22% higher for foreign invested firms than for domestic firms even after controlling for productivity, firm size, capital intensity, and worker skills. The price premium enjoyed by foreign invested firms is higher in R&D intensive industries and for differentiated goods. We interpret this price premium as a payoff to the intangible assets of foreign invested firms, including advanced technology, brand names, and reputation for high quality. The result also implies that for domestic firms, catch-up with foreign invested firms requires factors beyond increasing productivity or capital intensity.

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1 Introduction

In the recent quality-and-trade literature Baldwin and Harrigan (2009), Verhoogen (2008), Johnson (2009) and Crozet et al. (forthcoming) augment the Melitz (2003) model by accounting for quality differentiation across firms. They predict a positive relationship between productivity and export prices because productive firms use more expensive inputs to produce goods of higher quality and higher prices. In these models productivity is the single source of firm heterogeneity, and productivity and quality are perfectly correlated in equilibrium. In contrast to these models, Sutton (2007) and Hallak and Sivadasan (2009) consider firms to be different in two dimensions: productivity and the ability to produce quality ("caliber" in Hallak and Sivadasan, 2009). The two-dimensional framework allows for the fact that productivity and quality may be uncorrelated across firms (Womack et al., 1990). It also implies that the quality gap between firms is not fully attributable to productivity differences between them, which has important implications especially for developing economies because low wages can compensate for low productivity, but not low quality. To be competitive on the international market, both productivity and quality are essential.

In this paper we follow Hallak and Sivadasan (2009) and derive export prices as a function of firm productivity and caliber, and destination attributes (e.g., market size, bilateral trade costs). To empirically examine the pattern of export prices across firms, we use a comprehensive dataset that links trade transactions to a panel data of manufacturing firms operating in China over the period 2000-2006. Our dataset covers detailed information on both firms and their trade transactions, which differs from Manova and Zhang (forthcoming) who use Chinese data on trade transactions only. Our merged dataset contains rich information on 76,642 exporting firms as well as detailed information on trade transactions of 7,517 8-digit HS products with 217 destination countries. Overall, our sample covers about 70% of Chinese exports in the manufacturing sector. See Section 4 for more detail about the data.

We focus on the variation of export prices across firms who compete on the same product-destination markets. Firms are characterized by ownership, total factor productivity (TFP), firm size (the number of employment), capital intensity (capital stock per worker), and worker skills (proxied by average wages). We classify firms into three ownership types: domestic firms, foreign invested firms, and firms owned by investors from Hong Kong, Taiwan and Macau. Compared to domestic firms, foreign invested firms have the know-how to produce sophisticated and high-quality products, own brand names that are well-known on the international market, and can spread R&D investments across more output in global production. Unlike foreign invested firms, firms invested by Hong Kong, Taiwan and Macau specialize in lower-end manufacturing. Thus, in this paper we consider foreign invested firms to have higher capabilities to produce high quality goods than domestic firms and the firms invested by Hong Kong, Taiwan and Macau.

We find that the prices of Chinese exports vary systematically across firms with different productivity and ownership types. The baseline estimate implies that when a firm doubles its TFP, its export price is increased by 4.8%. The magnitude of this coefficient is similar to what is obtained in Bastos and Silva (2010) for Portuguese firms.[1] In the recent quality-and-trade literature, the positive relationship between export prices and firm productivity is viewed as evidence for quality sorting based on productivity.

Strikingly, we find that exports of foreign invested firms are sold at a price 22% higher than exports of domestic firms even after controlling for TFP, firm size, capital intensity and worker skills, implying that the 22% price premium enjoyed by foreign invested firms is not attributable to cross-ownership differences in those observed firm characteristics. In addition, the price premium enjoyed by foreign invested firms is higher in R&D intensive industries and for differentiated goods. We interpret the price premium for foreign invested firms as a payoff to their capability to produce high quality goods. It is also possible that foreign invested firms may keep the production of more profitable goods and goods that require more strict quality control within the firm boundary, while outsource less profitable goods and those that require less quality control to Chinese firms. Overall, the 22% price

[1] Two points are worth noting. First, Bastos and Silva (2010) use labor productivity to measure firm productivity while we use the TFP. Second, Bastos and Silva (2010) characterize firms using labor productivity only, while we add additional measures of firm attributes, including ownership, firm size, capital intensity, and average wages. Our analysis shows that besides productivity, these additional firm characteristics are important factors in affecting export prices.

premium for foreign invested firms may reveal the quality gap between domestic firms and foreign invested firms, and this gap is not simply due to observed differences in firm productivity, size, capital intensity, or worker skills.

Next we examine whether the quality of inputs and innovation activities can help explain the price gap between domestic firms and foreign invested firms. To this end, we include the use of imported inputs, R&D expenditures (relative to sales), output of new products in the estimating equation of export prices. We find that export prices are about 10% higher for firms that use imported inputs than for firms that use domestic inputs only. This result is consistent with existing findings that imported inputs are an important source of technology for less developed countries (see Amiti and Konings, 2007; Goldberg et al., forthcoming). We also find that export prices are 16% higher for firms that do R&D than for those that do not, and export prices are higher for firms that have a higher R&D intensity (R&D expenditures relative to firm sales). Furthermore, export prices are 9% higher for firms that introduce new products than for those that do not, and export prices are positively related to the output share of new products. Therefore, the quality of inputs and innovation are strongly and positively related to output quality and export prices.

However, adding controls for the quality of inputs and innovation activities has little impacts on the estimated price gap between domestic firms and foreign invested firms. In our sample, a higher fraction of domestic firms than foreign invested firms reported R&D activities and introduced new products, which reflects that foreign invested firms can effectively spread R&D investments done elsewhere across more output in their operations in China. After controlling for R&D and output of new goods, there is in fact a small increase in the estimated price premium associated with exports by foreign invested firms. The result again indicates that there exits a substantial gap between domestic firms and foreign invested firms and this gap cannot be easily narrowed in the short term.

Our empirical study makes several contributions to the literature. First, we relate export prices directly to firm attributes. We provide direct evidence that *both* firm productivity and the capability to produce quality are important factors in determining export prices. Our approach is in contrast to the studies that use product-level trade data to examine the quality-and-trade relationship, e.g., Schott (2004), Hallak (2006), Johnson (2009), and Baldwin and Harrigan (2009). These studies relate export prices to trade costs (usually proxied by distance) and country characteristics (income levels, market size, etc.) to infer quality sorting. Our study also differs from Manova and Zhang (forthcoming) who use Custom trade data for 2005 to examine the prices of Chinese exports. Although their trade transaction data are at the firm level, their trade dataset is not linked to the panel data of firms and does not contain information about firm productivity, size, capital intensity, etc. Therefore, they cannot show empirically the relationship between export prices and firm attributes. Furthermore, in contrast to Bastos and Silva (2010) who use labor productivity to capture firm-level heterogeneity, we include a wider set of variables to capture firm characteristics, including TFP (or labor productivity), ownership, firm size, capital intensity, worker skills. Our study reveals important factors beyond productivity that may affect export prices.

Second, we provide direct evidence that the quality of inputs and innovation are strongly and positively associated with output quality and export prices. Although the quality-and-trade literature emphasizes the role of R&D investments in improving output quality, there is lack of empirical evidence for the link between firm-level R&D investments and output quality and export prices. Our study fills this gap. In addition, our study suggests that the use of imported inputs is positively correlated with quality differentiation and export prices. It complements the result obtained by Goldberg et al. (forthcoming) that the use of imported inputs increases production scope for Indian firms.

Third, our work reveals a substantial price premium associated with exports by multinational firms. It has been well recognized in the literature that multinational firms outperform domestic firms – multinational firms are larger, more productive, more capital intensive, more skill intensive, and offer higher wage than domestic firms. However, our study is the first to reveal that there exists a price/quality premium associated with multinationals. Even after controlling for firm productivity, size, capital intensity, worker skills, the quality of inputs, and innovation activities, exports of foreign invested firms are sold at a substantially higher price than those of domestic firms. The price/quality premium may stem from the firm-specific intangible assets of multinationals, including advanced technology, brand names, reputation for high quality, corporate governance, etc.

The price premium for foreign invested firms may also reflect the optimal decisions made by multinational firms with respect to the choice between outsourcing and foreign direct investment (FDI). It is possible that multinational firms keep sophisticated goods that require more strict quality control within the firm boundary in order to avoid the hold-up problem or higher costs of quality control and verification associated with international outsourcing. The role of quality differentiation in the choice between outsourcing and FDI has not be examined in the theoretical literature on trade and organizational forms (e.g., Antràs, 2003; Antràs and Helpman, 2004).

Finally, our results imply that for domestic firms, catch-up with foreign invested firms requires factors beyond improving productivity, increasing capital intensity or skill intensity. It may be more challenging for domestic firms to build up intangible assets including reputation for high quality, brand names or corporate governance.

This paper is organized as follows. Section 2 outlines the theoretical framework for product pricing on the export market. Section 3 describes the empirical specification. Section 4 gives details about the merged trade and firm dataset. Sections 5-8 present the empirical results. Section 9 concludes the paper.

2 Theoretical Framework

In this section we present a simple partial equilibrium model to study export prices across the firms that compete on the same product-destination markets. To simplify notation, the indices for products and destinations are subsumed. We assume that a representative consumer on a particular destination market has the constant-elasticity-of-substitution (CES) utility function $U = \left[\int_{\omega\in\Omega} \left(q\left(\omega\right)x\left(\omega\right)\right)^{\frac{\sigma-1}{\sigma}} d\omega\right]^{\frac{\sigma}{\sigma-1}}$, where ω indexes varieties in the product set Ω, $q\left(\omega\right)$ is the quality of variety ω, $x\left(\omega\right)$ is the quantity demanded, and σ captures the elasticity of substitution between varieties ($\sigma > 1$). Quality here can be the physical attributes of products (e.g., accuracy, efficiency), reputation, or brand images.

Let Y be total expenditure on the particular product. Consumer optimization yields the following demand for variety ω

$$x(\omega) = q(\omega)^{\sigma-1} p(\omega)^{-\sigma} P^{\sigma-1} Y, \tag{1}$$

where $p(\omega)$ is the price of variety ω, and $P = \left[\int_{\omega\in\Omega} (p(\omega)/q(\omega))^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$ is an aggregate quality-adjusted price index. Given the same price, products of higher quality generate a larger demand. So q can be interpreted as a demand shifter.

Each variety is produced by one firm. Regarding firm production, the set-up closely follows Hallak and Sivadasan (2009). We assume firm heterogeneity comes from two sources. One is productivity, indexed by φ. The other is the ability to produce high quality or "caliber", indexed by λ. This assumption allows for the fact that productivity and quality may be uncorrelated across firms (Womack et al., 1990). It is in contrast to Kugler and Verhoogen (forthcoming), Baldwin and Harrigan (2009), and Crozet et al. (forthcoming) in which productivity is the single source of firm heterogeneity, and productivity and quality are perfectly correlated in equilibrium.

The marginal cost of production is assumed to be mq^{α}/φ, where $0 \leq \alpha < 1$ and m is a constant.[2] The marginal cost increases in quality, and α measures the elasticity of marginal cost with respect to quality. The positive relationship between quality and marginal cost is common to the recent quality-and-trade literature, including Baldwin and Harrigan (2009), Verhoogen (2008), and Johnson (2009). The fixed cost of production is $F_o + fq^{\beta}/\lambda$, where F_o is a fixed operating cost, f is a constant,[3] fq^{β}/λ represents fixed investments in quality (e.g, R&D expenditures), and $1/\beta$ measures the effectiveness of fixed outlays in raising quality. A high-λ firm has a lower fixed cost of producing a given level of quality.

Firms incur a fixed cost F_x to enter the foreign market. Exporters also incur an iceberg trade cost τ, whereby $\tau > 1$ units of a good must be shipped in order for one unit to arrive at the foreign market. Let p_0 be the producer price. Foreign consumers

[2] The parameter m can also be specified as a function of wages and rental rates. See Verhoogen (2008) and Hallak and Sivadasan (2009) for the formulation.

[3] Similar to the parameter m, the parameter f can also be specified as a function of wages and rental rates. See Hallak and Sivadasan (2009) for more detail.

pay the price $p = p_0\tau$. The profit earned from exporting to the foreign market is $\pi = (p_0 - mq^\alpha/\varphi)\, x\tau - fq^\beta/\lambda - F_o - F_x$. Plugging the demand function (1) into it yields

$$\pi = \left(p_0 - \frac{mq^\alpha}{\varphi}\right)\left(q^{\sigma-1}p_0^{-\sigma}\tau^{1-\sigma}P^{\sigma-1}Y\right) - \frac{fq^\beta}{\lambda} - F_o - F_x. \tag{2}$$

Firms choose price and quality to maximize profits. The optimal price (conditional on quality q) is

$$p_0 = \frac{\sigma}{\sigma-1}\frac{m}{\varphi}q^\alpha. \tag{3}$$

It is the standard result of constant markup in a monopolistic model with CES preferences. Using this result, the first-order condition of profit maximization with respect to quality implies that the optimal quality is

$$q^* = \left[\frac{1-\alpha}{\beta}\left(\frac{\sigma-1}{\sigma}\right)^\sigma \frac{P^{\sigma-1}Y}{\tau^{\sigma-1}}\left(\frac{\varphi}{m}\right)^{\sigma-1}\frac{\lambda}{f}\right]^{\frac{1}{\beta-(1-\alpha)(\sigma-1)}}. \tag{4}$$

Under the assumption that $\beta - (1-\alpha)(\sigma-1) > 0$, equation (4) implies that quality increases in both productivity φ and caliber λ. Improving quality has two opposing effects on a firm's profit. On the one hand, given the same price, higher quality increases the market demand and raises a firm's profit. On the other hand, improving quality requires a firm to incur higher costs, which reduces the firm's profit. Because high-φ firms and high-λ firms have a smaller increase in the cost of improving quality, more productive firms (with a higher φ) and more capable firms (with a higher λ) optimally choose a higher quality level.

Combining equations (3) and (4) yields a simple equation that expresses the producer price as a function of productivity, caliber, and destination attributes including expenditure Y, bilateral trade cost τ, and an aggregate price index P:

$$p_0 = \left(\frac{\sigma}{\sigma-1}\right)^{\frac{\beta-\alpha-(\sigma-1)}{\gamma}}\left(\frac{1-\beta}{\alpha}\frac{P^{\sigma-1}Y}{\tau^{\sigma-1}}\right)^{\frac{\alpha}{\gamma}}\left(\frac{\varphi}{m}\right)^{\frac{(\sigma-1)-\beta}{\gamma}}\left(\frac{\lambda}{f}\right)^{\frac{\alpha}{\gamma}} \tag{5}$$

where $\gamma \equiv \beta - (1-\alpha)(\sigma-1) > 0$. Equation (5) serves the basis of our empirical specification. We are especially interested in the role of firm productivity and caliber in determining the producer price. Conditional on productivity, higher-λ firms have higher prices. Conditional on caliber, the relationship between the producer price and productivity depends on the sign of $(\sigma-1)-\beta$. This is because productivity has two opposing effects on prices. On the one hand, high-φ firms have a lower marginal cost. With fixed quality, the producer price is lower for high-φ firms. On the other hand, high-φ firms invest more to produce high quality, leading to a higher producer price. For products with a high elasticity of substitution between varieties (i.e., a high σ), and a high degree of effectiveness of fixed outlays in raising quality (a high $1/\beta$), the quality effect dominates, implying a positive correlation between price and productivity. This is in contrast to the Melitz (2003) model in which price and productivity are negatively correlated.[4]

In addition, we are interested in the cross-product variation in the relationship between export prices and caliber. Using equation (5), it is straightforward to derive that the price gap between high-λ firms and low-λ firms is larger for products with a higher degree of effectiveness of fixed outlays in raising quality (i.e., a higher $1/\beta$) and for products with a higher elasticity of substitution between varieties (i.e., a higher σ).[5]

3 Empirical Specification

Equation (5) implies that export prices are a function of firm productivity, caliber and destination attributes in terms of total expenditures, bilateral trade costs, and the aggregate price index. Based on equation (5), we use the following empirical specification

$$\log p_{fgct} = X_{f,t-1}b_1 + \Lambda_f b_2 + Z_{ct}\gamma_1 + D_{gc} + D_t + \varepsilon_{fgct}, \tag{6}$$

where p_{fgct} represents the price of product g exported by firm f to country c in year t; $X_{f,t-1}$ is a vector of time-varying firm attributes (including productivity) at a one-year lag; Λ_f indicates ownership types which proxy for a firm's ability to produce quality; Z_{ct} is

[4] Melitz and Ottaviano (2008) use a linear demand function and allow for variable markup. In their model more productive firms set a higher markup. However, since the efficiency effect dominates, their model still predicts a negative relationship between productivity and prices.

[5] Equation (5) implies that $\partial \ln p_0/\partial \ln \lambda = \alpha/\left[\beta-(1-\alpha)(\sigma-1)\right]$. Thus, it is easy to see that $\partial \ln p_0/\partial \ln \lambda$ increases in σ and reduces in β.

a vector of time-varying destination attributes; D_{gc} represents product-destination fixed effects; D_t is year fixed effects; and ε_{fgct} is the error term that includes all unobserved factors that may affect the export price.

The vector of time-varying firm attributes include productivity, size, capital intensity, and average wages. Our preferred measure of productivity is total factor productivity (TFP) estimated using the Levinsohn-Petrin method. Because the TFP measure may not fully capture the technology level of a firm, we include the following additional variables: (i) firm size measured by the number of workers and used as a control for economies of scales; (ii) capital intensity computed as the ratio of capital stock to the number of workers and used as a control for production technique; (iii) average wages used to control for variable costs and worker skills. In equation (6) we use lagged firm attributes to avoid the possible feedback effects of export prices on firm productivity, size, capital intensity or wages. Because firms that charge higher prices are likely to be more profitable, they may be able to pay a higher wage, invest more in physical capital and hire more workers, which implies that the use of contemporaneous firm attributes could overstate the impact of those firm attributes on export prices. Using the lagged value can ensure that the estimated coefficients on firm attributes are not contaminated by the possible feedback effect of export prices on firm attributes. This cannot be done in Bastos and Silva (2010) because they use a cross-sectional dataset.

Firms are classified into three ownership types: domestic firms, foreign invested firms, and firms owned by investors from Hong Kong, Macau and Taiwan. Investors in foreign invested firms mainly come from advanced countries including Japan, the United States, and western Europe. Compared to domestic firms, foreign invested firms are more capable to produce high-quality goods. In addition, many of these foreign invested firms own brand names that are well known on the international market. In contrast to foreign invested firms, investments from Hong Kong, Macau and Taiwan mainly specialize in unskilled labor intensive products and use China as an export platform. The production of those low-end goods has often been relocated from these regions to China to take advantage of low labor costs and favorable FDI policies (especially favorable treatment of foreign firms in trade policy and corporate tax policy) (Zhang et al., 2003; Branstetter and Lardy, 2006). Therefore, we treat foreign invested firms as those with the highest capability to produce high quality goods.

The destination markets are characterized by the following variables: (i) market size captured by GDP and used to proxy for expenditures on Chinese goods, (ii) income level measured by GDP per capita and used to capture the preferences for high-quality products, and (iii) remoteness computed as a weighted average of the country's bilateral distance to all other countries in the world where the weight is other countries' GDP.[6] A destination is remote in economic terms if it is faraway from big economies. The product-destination fixed effects control for all factors common to product g and destination c, e.g., the fixed costs that are the same to all of the firms that sell product g to destination c. The product-destination fixed effects also subsume all time-invariant gravity variables for destination c, e.g., the distance from China, language, landlocked or not.

Previous studies (e.g., Baldwin and Harrigan, 2009; Manova and Zhang, forthcoming) have largely relied on the relationship between export prices and destination attributes, e.g., distance, to infer the presence of quality sorting. In contrast to the existing literature, our main focus in this paper is on the relationship between export prices and firm attributes. We are mainly interested in the coefficients b_1 and b_2. Because equation (6) controls for product-destination fixed effects, the identification of b_1 and b_2 relies on the variation of export prices and the variation of firm attributes within product-destination pairs.

4 Linked Firm-Trade Data

We link data on trade transactions to a panel data of manufacturing firms in China. The trade transaction data come from Chinese Customs and cover monthly imports and exports for 2000-2006. The data are classified at the 8-digit HS level which includes 7,517 product categories. The variables include the value and quantity of trade, country, and contact information of the firm (e.g., company name, telephone, zip code, contact person).

[6] Data on bilateral distance come from CEPII. GDP and GDP per capita are drawn from the Penn World Table.

We calculate the export price as export value divided by quantity. Because the reported value of exports does not include costs of insurance and freight, the inferred export price is free-on-board (f.o.b) price and corresponds to the producer price in the theoretical model.

The panel data of manufacturing firms come from the National Bureau of Statistics Enterprise Dataset for 1998-2007. The National Bureau of Statistics of China (NBSC) obtains annual reports from all state enterprises and large- and medium-sized non-state enterprises (with sales above 5 million RMB) in the manufacturing sector. The annual reports contain information on financial statement and nonfinancial variables. The key variables include ownership, employment, capital stock, gross output, value added, wages, and contact information of the firm (e.g., company name, telephone, zip code, contact person). Based on this firm dataset, the basic statistics on the aggregate manufacturing sector are summarized in China Statistical Yearbooks (NBSC, 1999-2008), and the statistics on the 2-digit manufacturing industries are summarized in China Industry Economy Statistical Yearbooks (NBSC, 1999-2008). For 2004, the data include information about workforce composition by education levels. For 2005-2006, the data contain information about R&D expenditures.

We aggregate the monthly trade data to be at annual level and match trade transactions to manufacturing firms based on the firms' contact information. In total 86,835 firms are matched. The vast majority of firms (94%) are matched by company names exactly. An additional 4% are matched by zip code and contact person exactly, and the remaining 2% of firms are matched by telephone number exactly. The matched trade and firm sample includes 76,642 Chinese exporters[7] and covers more than 70% of firm exports in the manufacturing sector.[8] The sample coverage of trade is comparable to the 75% reported in Bernard et al. (2005) about their link of trade transactions to U.S. firms. Because a higher proportion of domestic firms trade through the intermediary of trading companies, the matched firm-trade sample has a lower coverage for domestic firms than

[7] About 10,000 firms in the merged dataset are pure importers.

[8] The panel data of manufacturing firms report export values without detailed information on destinations or products. The 70% trade coverage rate is calculated as a ratio of total export values by exporters in the merged dataset relative to total export values by all exporters in the panel data of manufacturing firms.

for other ownership types.

Using the matched firm and trade database has two major advantages. First, it provides us rich information on *both* firms and trade, which enables us to relate export prices directly to firm attributes. Second, the matched database excludes non-manufacturing firms that purely serve as trade intermediaries. Compared to using company names to identify these two types of firms as done by Manova and Zhang (forthcoming), merging the trade and firm data is a more reliable approach of separating manufacturing firms from trading companies.

The summary statistics of the firms in our sample are reported in Table 1. Domestic firms are similar to foreign invested firms in terms of productivity. Domestic firms are also more likely to report R&D activities, and introduce new products than foreign invested firms. However, domestic firms are less capital intensive, less skill intensive, and less likely to use imported inputs than foreign invested firms. Compared to other ownership types, firms owned by investors from Hong Kong, Macau, and Taiwan are the least productive, least capital intensive, least skill intensive, and least likely to do R&D and introduce new products. These statistics confirm our previous discussions that those firms specialize in lower-end manufacturing production.

5 Baseline Estimates

The estimates of equation (6) are presented in column 1 of Table 2. We find that more productive firms charge a higher price. The estimate of 0.048 implies that a 100% increase in firm productivity translates into a 4.8% increase in export prices. The magnitude of this estimate is twice as much as that is obtained by Bastos and Silva (2010) for Portuguese exporters (see column 2 of Table 12 in Bastos and Silva (2010)).[9] As stated in the theory, firm productivity affects product prices through two channels. On the one hand, more productive firms have a lower marginal cost, leading to a lower product price. On the other hand, more productive firms use more expensive inputs to produce goods of higher

[9] Note that Bastos and Silva (2010) use contemporaneous labor productivity in their regression. Using labor productivity at a one-year lag, we obtain a coefficient of 0.095, as shown in column 6 of Table 6.

quality, leading to a higher product price. For goods with a high elasticity of substitution between varieties (i.e., a high σ), and a high degree of effectiveness of fixed outlays in raising quality (a high $1/\beta$), the quality effect dominates, leading to a positive correlation between price and productivity. Therefore, in the recent quality-and-trade literature the positive relationship between firm productivity and product prices is viewed as evidence for quality sorting based on productivity.

Column 1 of Table 2 also shows that firms of different ownership types have drastically different prices. In the regression, domestic firms are the excluded group. Compared to domestic firms, foreign-invested firms enjoy a price premium of 21.6%. Because the regression controls for productivity, size, capital intensity, and wages, the price premium associated with the exports of foreign-invested firms is not attributable to the differences in those observed firm attributes between domestic firms and foreign-invested firms. There are several possible sources of this price premium. First, foreign-invested firms use more expensive inputs to produce goods of higher quality and charge a higher price. Second, foreign-invested firms own brand names and thus enjoy a price premium on the international market. Third, foreign-invested firms may keep more profitable products and products that require more strict quality control within the firm boundary. In Section 6 we will examine the relationship between the use of imported inputs and export prices. Due to higher quality, imported inputs tend to be more expensive than domestic supplies. We will show that the price premium remains large even after controlling for the use of imported inputs. Therefore, we interpret the price premium as a payoff to the capability to produce high-quality products and to owning brand names. The price premium may also reflect the optimal decisions by multinational firms with respect to the choice between foreign direct investment and outsoucing. The role of quality differentiation and quality control in influencing the decision about whether to integrate or not has not been studied in the theoretical literature on trade and organizational forms (e.g., Antràs, 2003; Antràs and Helpman, 2004).

By contrast, firms that are owned by investors from Hong Kong, Macau or Taiwan have an export price about 8% lower than domestic firms. This indicates that firms owned by Hong Kong, Macau or Taiwanese investors largely focus on lower-end manufacturing to take advantage of low wages in China.

Furthermore, column 1 of Table 2 reports that larger firms charge a higher price. The estimated coefficient on firm size (measured by the logarithm of total employment) is 0.020, implying that a 100% increase in firm size is associated with a 2% increase in export prices. A positive correlation between export prices and firm size is also documented by Kugler and Verhoogen (forthcoming) on Colombia firms. Interestingly, although we use different specifications and look at different samples, the estimated price elasticity of firm size is close to what is obtained in Kugler and Verhoogen (forthcoming).[10] For instance, columns 2 and 3 of Table 2 in Kugler and Verhoogen (forthcoming) report a price elasticity of total employment to be about 0.025. Kugler and Verhoogen (forthcoming) interpret the positive correlation between prices and firm size as supporting evidence for quality differentiation of outputs. Note that Kugler and Verhoogen (forthcoming) do not have direct measure of firm productivity. In their model larger firms are equivalent to more productive firms. What we find here is that even after controlling for productivity, large firms have higher product prices. In the following sections we will show that firm size is closely related to other aspects of firms, e.g., the use of imported inputs, innovation activities.

Finally, column 1 of Table 2 displays that more capital intensive firms and the firms that pay higher wages sell products at a higher price. Firms with a higher capital intensity may be using more advanced technology and thus find it easier to reach acceptable quality standards. Therefore, we observe a positive relationship between export prices and capital intensity. Average wages are used to control for variable costs. Because skilled workers have higher wages, firms with a higher average wage are more skill intensive on average.[11] Hence, average wages are also a proxy for skill intensity of a firm. The coefficient on average wage is 0.0765, which suggests that a 100% difference in wages is associated

[10] Differing from our study, Kugler and Verhoogen (forthcoming) include both exporters and non-exporters. They are interested in the correlation between prices (of outputs and inputs) and firm size. Furthermore, unlike our work, their analysis does not control for firm productivity or other firm attributes.

[11] The panel data of firms contain information on worker education only for the year of 2004. In Section 6.2 we will present the results for 2004 when the skill composition of a firm is measured by the share of workers with a college degree or above. We also correlate average wages with the skill composition of workforce and find a strong positive correlation between them.

with just 7.65% difference in product price. It can be explained by the fact that wages constitute a small portion of production costs. In our sample, the median value of the ratio of wage bills to intermediate inputs is just 0.11. This result also implies that there are limits to replying on low wages to compete on the global market.

To summarize, column 1 of Table 2 shows that there is a strong positive relationship between export prices and firm productivity. In addition, we find that various firm attributes beyond productivity are strongly related to export prices. In particular, the price gap between foreign invested firms and domestic firms is substantially large even after controlling for various observed firm attributes.

5.1 Cross-product Evidence

Now we examine the cross-product variation in the price premium of exports by foreign invested firms. The theoretical model suggests that the price premium should be larger for products with a higher degree of effectiveness of fixed outlays in raising quality (i.e., with a lower $1/\beta$) and for products with a higher elasticity of substitution between varieties. Following Sutton (1998), we measure the effectiveness of fixed outlays in raising quality using the industry-level R&D intensity. Our dataset has information on R&D expenditures at the firm level for 2005 and 2006. We construct the measure of industry-level R&D intensity by computing the median of firm R&D expenditures (relative to sales) at the 4-digit Chinese Industry Classification level.

Column 2 of Table 2 reports the results when the industry-level R&D intensity and its interaction with ownership are included. To facilitate interpretation, the industry-level R&D intensity is expressed as deviations from its global mean. Consistent with the theoretical prediction, we find that the price premium of exports by foreign invested firms is larger in industries that are more R&D intensive. The magnitude of the estimate is large: a 1 percentage point increase in the industry-level R&D intensity is associated with a 3% increase in price premium of exports by foreign invested firms. On the other hand, the estimated coefficient on the interaction between industry-level R&D intensity and firms owned by investors from Hong Kong, Macau, and Taiwan suggests that a 1 percentage point increase in the industry-level R&D intensity is related to a 3.9% increase in price discount of exports by those firms.

In column 3 we further add the interaction between ownership and the Rauch measure of product differentiation. We use the Rauch (1999) measure of product differentiation to classify products into differentiated or homogeneous goods. Homogeneous goods include goods traded on an organized exchange or reference priced. The theoretical model suggests that the price premium should be higher for differentiated goods than for homogeneous goods. The results shown in column 3 confirm our expectation. We find that the price premium enjoyed by foreign-invested firms is 4% higher for differentiated goods than for homogeneous goods.

Therefore, the results in columns 2-3 of Table 2 are consistent with the theoretical model which predicts that the price gap between domestic firms and foreign invested firms should be larger in more R&D intensive industries and for differentiated products.

6 Quality of Inputs

As suggested by the theoretical model, high-φ firms and high-λ firms use more expensive inputs to produce goods of higher quality. Input prices are often unobserved in the data.[12] To capture the quality of inputs, we focus on the use of imported inputs and worker skills. There is strong evidence that imported inputs are an important source of technology for less developed countries (e.g., see Amiti and Konings, 2007; Goldberg et al., forthcoming). Compared to domestic supplies, imported inputs are of higher quality and are more expensive. Skilled workers are also essential in raising quality. In previous sections we have used average wages as a proxy for worker skills. In this section we also use the share of college graduates to measure worker skills. The data on worker education are available only for 2004.

We are mainly interested in two questions. First, do firms that use imported inputs and more skilled workers sell at a higher price? Second, are the price premium enjoyed by foreign invested firms and the higher export price of more productive firms attributable

[12] An important exception is Kugler and Verhoogen (forthcoming) who observe the price of inputs in their dataset of Colombian firms.

to the use of imported inputs and more skilled workers?

6.1 Imported Inputs

In our sample of exporters, 38% of domestic firms, 78% of foreign invested firms and 73% of firms owned by investors from Hong Kong, Macau and Taiwan reported to use imported inputs in 2006. Because capital goods are likely to embody more technology than intermediate inputs, we further break imports into intermediate inputs and capital goods. We augment the specification in equation (6) by adding measures of the use of imported inputs. Unlike Manova and Zhang (forthcoming), we link export prices directly to the use of imported inputs at the firm level. There is one caveat in interpreting our results. Because we do not know whether or which imported inputs are used in producing the goods exported, we measure the use of imported inputs at the firm level. Although doing this may generate measurement errors, it is likely to reduce the chance for us to find any significant results.

Column 1 of Table 3 adds a dummy variable that indicates whether a firm imports foreign inputs or not. The estimates suggest that export prices are on average 11.4% higher for exporters that use foreign inputs than for exporters that use domestic inputs only. After controlling for the use of imported inputs, the price premium of exports by foreign-invested firms reduces from 21.6% to 19.3%. Therefore, a small fraction of the price premium associated with foreign-invested firms is due to the use of imported inputs. At the same time, the coefficient on productivity is little changed.

Because the binary measure of the use of imported inputs may fail to capture the quality variation in imported inputs, in column 2 of Table 3 we include the firm-level import price index to capture quality differentiation in imported inputs.[13] Two points are worth noting. First, because the import price index can only be constructed for importers,

[13] We construct the firm-level price index of imported inputs as follows. Let p^I_{fgt} denote the log price of input g (at the 8-digit HS level) imported by firm f in year t. Let $\overline{p}^I_{gt}$ denote the log price of input g averaged across all importers of g in year t. Let dp^I_{gt} denote the standard deviation of the log prices of input g in year t. Then the standardized log price of good g imported by firm f in year t can be calculated as $\widehat{p}^I_{fgt} = (p^I_{fgt} - \overline{p}^I_{gt})/dp^I_{gt}$. For firms that import a single input, the import price index is $p^I_{ft} = \widehat{p}^I_{fgt}$. For firms that import multiple inputs, the import price index is a simple average of the standardized log prices of all of their imports: $p^I_{ft} = \Sigma_g \widehat{p}^I_{fgt}$.

the results shown in column 2 are conditional on being an importer (and an exporter). Second, because we do not observe which foreign inputs are used to produce which output that is exported, the price index of imported inputs is constructed for the firm as a whole. Column 2 shows that controlling for firm attributes, export prices are 39.3% higher for firms with an import price index that is one standard deviation higher than the sample average. Therefore, the result in column 2 shows a strong correlation between the use of more expensive inputs and export prices. On the other hand, similar to column 1, the price premium of exports by foreign invested firms reduces just slightly. There is little change to the coefficient on productivity. Therefore, productivity may work through other channels that affect product prices.

Because capital goods contain higher technology contents than intermediate inputs, in columns 3-4 we report the results when intermediate inputs and capital goods enter the regressions separately.[14] The classification of an import into an intermediate or a capital good is based on the correspondence between HS and Broad Economic Classification (BEC) constructed by the United Nations. As shown in column 3, importers of either intermediate inputs or capital goods have significantly higher export prices than nonimporters. Compared to importers of intermediate inputs, importers of capital goods charge even higher export prices. Notably, the coefficient on foreign-invested firms drops to 16.8%. Therefore, the use of imported inputs, and capital goods in particular, partially contribute to the price premium enjoyed by foreign-invested firms. However, the coefficient on productivity remains little changed.

Column 4 adds the firm-level price indexes of imported intermediates and capital goods. Because price indices can only be constructed for firms that have imported both intermediate inputs and capital goods, the results reported in column 4 are conditional on being an importer of both types of inputs.[15] The results suggest that more expensive

[14] Unlike intermediate inputs, the import of capital goods occurs less frequently. Because capital goods are likely to be used in production over the years after the purchase, we assume that if a firm imports capital goods in year t, the firm is treated as an importer of capital goods in year t and all the years after t. Accordingly, if the import price index of capital goods is $\widehat{p}_{ft}^{I}$ in year t, the firm is assumed to have an import price of capital goods of $\widehat{p}_{ft}^{I}$ in the years after t.

[15] We also ran regressions including either the import price index of intermediate inputs or that of capital goods. The estimated coefficients on the price indexes are very similar to the results reported in

imports of intermediate inputs and capital goods are strongly related to higher export prices, which are consistent with column 2 when the price index of all imported inputs is used.

In column 5 we include the share of intermediate inputs in total inputs and the share of imported capital goods in total capital stock. The coefficient on the share of imported capital goods is large: a 10% increase in the share of imported capital goods translates into a 6.9% increase in export prices. At the same time, similar to the result in column 3, the coefficient for foreign-invested firms reduces to 15.2%. Therefore, the use of imported inputs, and capital goods in particular, partially contributes to the price premium of foreign-invested firms.

The estimated coefficients on firm productivity, wages, capital intensity are stable across the specifications. However, firm size is very unstable. The effect of firm size becomes much small when the binary measure of the use of imported inputs is controlled for (see column 2). It turns into insignificant or even significantly negative when we control for the price index of imported inputs, or break the inputs into intermediates or capital goods.

6.2 Worker Skills

Workers skills can also affect a firm's capability to produce high-quality products. In the above we have included average wages as a proxy for worker skills (in addition to serve as a control for variable costs of production). Because the Census of Manufacturing in 2004 contains information about worker composition in terms of schooling, we match this information to our dataset. We use the share of workers with a college degree or above to measure the composition of worker skills and add this direct measure of worker skills to the regressions as an additional control. The results are shown in Table 4. For comparison, in column 1 of Table 4 we report the estimates when the measure of worker composition by skills is excluded. As shown in column 1, the estimates for the year of 2004 are very close to the baseline estimates displayed in column 1 of Table 2.

column 4. To save space, we do not include those results in the table.

Column 2 shows that export prices are significantly higher for firms with a larger share of more educated workers. The economic size of the estimate is large. a 10 percentage point increase in the share of college graduates is associated with a 9.4% increase in export price. A comparison of columns 1 and 2 also reveals that the coefficient on average wages reduces by a half after the direct measure of worker skills is added. It reflects the fact that firms with a higher share of more educated workers are likely to have a higher average wages, thus average wages are a good proxy for worker skills. The coefficient on foreign invested firms is little changed. However, the coefficient on firms owned by investors from Hong Kong, Macau, and Taiwan increases from -0.08 to -0.06, revealing the fact that firms from Hong Kong, Macau, and Taiwan focus on lower-end manufacturing and use more unskilled workers in production than other ownership types.

In addition, the coefficients on capital intensity and TFP become smaller while the coefficient on the number of employment becomes significantly larger when the direct measure of worker skills is included. The direction of changes in the estimated coefficients reflect the fact that in our sample more skill intensive firms are smaller (in terms of employment), more capital intensive, and more productive.

In column 3 we add a binary variable indicating whether a firm imported inputs and the interaction between the import indicator and the share of skilled workers. The estimated coefficient on the interaction between the import indicator and the share of skilled workers is 0.20, implying that among firms that use imported inputs, a 10 percentage point increase in the share of skilled workers is related to a 2% increase in export prices. In column 4 we include the price index of imported inputs and its interaction with the share of skilled workers. Similarly, we find that firms that use more expensive imported inputs and have a higher share of skilled workers also have higher export prices. The results in columns 3-4 imply that imported inputs and worker skills are complementary and are consistent with our expectation that more expensive inputs of higher quality are used to produce goods of higher quality and higher prices. The results also suggest that simple assembly of imported inputs using low skilled workers may not fully capture the feature of Chinese exports.

To summarize, we find that the quality of inputs is strongly and positively related to export prices. However, the price premium of foreign invested firms remains substantially large even after controlling for the use of imported inputs and worker skills. In addition, after accounting for the quality of inputs, the coefficient on firm productivity is changed only slightly.

7 Innovation

Innovation activities often lead to reduction in production costs or improvement of product quality. In this section we examine the relationship between innovation and export prices. We are also interested in the extent to which the coefficients on ownership and firm attributes are affected by including controls for innovation activities. We measure firm-level innovation using R&D expenditures and production of new products.

7.1 R&D

Our dataset provides information on firm-level R&D expenditures for 2005 and 2006. About 22% of domestic firms, 14% of foreign invested firms, and 11% of firms from Hong Kong, Macau, and Taiwan reported R&D activities in 2006. Although R&D expenditures are fixed investments, they can affect export prices in two ways. First, R&D may lead to improvement in productivity. Second, R&D may lead to improvement in product quality in terms of functionality or appearance.

Table 5 reports the results when firm-level measures of R&D activities are included. For comparison, in column 1 we report the estimates of equation (6) for the 2005-2006 sample when the information on R&D expenditures is available. Compared to the full sample of 2000-2006, the 2005-2006 sample contains more younger domestic firms. There are a few small differences between the baseline estimates displayed in column 1 of Table 2 and the estimates based on the 2005-2006 sample. The coefficient on TFP becomes larger. The price premium associated with foreign invested firms becomes smaller, suggesting that new entries of domestic firms are better than older ones. The coefficient on firm size gets much smaller.

Column 2 of Table 5 reports the results when an R&D indictor is included. The

R&D indicator equals one if a firm reports any R&D expenditures in a given year, and zero otherwise. We find that export prices are 15.8% higher for firms that do R&D than for firms that do not. In column 3 we replace the R&D indicator with R&D intensity measured as R&D expenditures normalized by firm sales. It shows the firms that have higher R&D intensity enjoy higher export prices. The coefficient on R&D intensity is large. A 1% point increase in R&D intensity translates into a 5.6% increase in price.

Results shown in columns 1-3 indicate that the control for R&D activities increases the price premium for foreign invested firms, which reflect the fact that in our sample a higher share of domestic firms reported R&D activities than foreign invested firms. Unlike domestic firms, foreign invested firms may undertake R&D activities in their foreign headquarters and concentrate on manufacturing production in their operations in China. At the same time, the price discount for firms that are owned by investors from Hong Kong, Macau, and Taiwan becomes smaller. It is due to the fact that these firms are the least innovative ones in the sample.

The change in the coefficient on firm size is also interesting. When the R&D indicator is included in column 2, firm size becomes negatively correlated with export prices. It is because large firms are more likely to do R&D so that R&D expenditures can be spread across more output. That is, there are scope economies involved in R&D. On the other hand, when R&D intensity is included in column 3, firm size remains positively related with export prices, although the significance level is reduced. It is consistent with the finding in Cohen et al. (1987) that firm size is an important determinant of doing R&D or not, but it is not a determinant of R&D intensity.

7.2 New Products

The firms in our dataset also reported the output share of new products (except for the year of 2004). Unlike R&D expenditures, introduction of new products can be considered as an outcome of innovation. In our sample about 21% of domestic firms, 11% of foreign invested firms, and 9% of firms from Hong Kong, Macau, and Taiwan reported to have new products in 2006. Firms that do R&D are also more likely to report they have introduced new products. In column 5 of Table 5 we add a new product indicator in the baseline regression. The new product indicator is one if a firm reported positive output of new products, and zero otherwise. We find that the export price is 9.4% higher for firms that introduce new products than firms that do not. In column 6 we replace the new product indicator with the output share of new products. The estimated coefficient on the share of new products suggests that a 10% point increase in the output share of new products is associated with 2.5% increase in export prices.

Therefore, the results in Table 5 provide strong evidence that more innovative firms enjoy higher export prices. This result can be considered as additional evidence for quality differentiation by firms. On the other hand, the additional control for firm-level innovation increases the estimated price premium for foreign invested firms rather than reduces it. It is due to the fact that compared to domestic firms, foreign invested firms are less likely to report R&D activities or introduce new products in their operations in China.

8 Robustness

In this section we examine whether our baseline estimates are robust to various alternative specifications. The results are displayed in Tables 5-6.

8.1 Processing Trade

In the above we have shown that there is a substantial price premium associated with exports by foreign invested firms even after controlling for productivity, firm size, capital intensity, worker skills, and the use of imported inputs. This price premium may reflect the decisions by multinational firms about whether to integrate or outsource – it may be optimal for multinational firms to keep products that require more quality control within the firm boundary while outsourcing products that require less quality control to Chinese firms. That is, there may exist quality differentiation across different organization forms.

To investigate this further, we exploit the information about trade regimes in our trade data. The Chinese trade data classify each export transaction into processing export or non-processing export ("ordinary export"). Processing trade is a typical example of vertical specialization in which imported inputs are further processed in China with finished goods exported. Processing export by domestic firms represents a form of "contractual outsourcing" in which local suppliers serve a particular foreign buyer with specialized contracts (Feenstra and Spencer, 2005). Processing export by foreign invested firms represents a form of vertical integration. Thus, different ownership types in processing export reflect the choice between outsourcing and integration for the same task in global production sharing. Processing trade is an important component of Chinese export, and has been studied in Feenstra and Hanson (2005) and Feenstra and Spencer (2005).

Column 2 of Table 6 reports the results for processing export. The estimated coefficient on foreign invested firms is 0.25 and statistically significant, which confirms our baseline result that there exists quality differentiation across different organization forms. The result indicates that multinational firms may keep sophisticated products that require more strict quality control within the firm boundary in order to avoid the holdup problem or higher costs of quality control and verification associated with international outsourcing. The coefficients for other firm attributes are similar to the baseline estimates. Overall, our conclusions drawn from the full sample hold for the sample of processing trade.

8.2 Persistent Exporters

In column 1 of Table 2 we have used an unbalanced panel in which there are entry and exit of firms from the export market. To examine whether our baseline results are influenced by firm entry and exit from the export market, we construct a panel by including those firms that exported every year during our sample period. Thus, this panel is composed of more established firms.[16] As shown in column 3 of Table 6, the estimates for firm attributes and ownership types are qualitatively similar to the baseline results reported in column 1, which implies that our conclusions drawn from the unbalanced panel remain hold for the smaller sample of persistent exporters.

A comparison the estimates in columns 1 and 4 reveals several interesting patterns. First, in the smaller sample the price premium associated with foreign-invested firms be-

[16]There are 76,642 firms in the full sample and 11,475 firms in the smaller sample. However, because persistent exporters sell more products to more destinations, the number of observations in the regression (at the level of firm-product-destination-year) reduces from 4,267,715 for the full sample to 1,968,067 for the smaller sample.

comes even large, up to 30% higher than the price of exports by domestic firms. However, the price gap between foreign-invested firms and the firms that are owned by investors from Hong Kong, Macau, and Taiwan remains little changed. Since the full sample includes many new entries into the export market, these results may indicate that new domestic exporters are better than older ones.

Second, the estimated coefficient on productivity reduces from 0.048 in column 1 to 0.036 in column 3. The difference in the estimates for productivity reveals that productivity has a larger positive impact on export prices for new exporters. On the other hand, the estimated coefficients on firm size, capital intensity, and wages become larger for the smaller sample of persistent exporters.

8.3 Excluding Exports to Hong Kong

Hong Kong has played an important role in intermediating trade between China and the rest of the world (Feenstra and Hanson, 2004). Over the period 1988-98, 53% of Chinese exports were shipped through Hong Kong and re-exported to the rest of the world. During the more recent period, the share of Chinese goods that are re-exported through Hong Kong becomes smaller. In our matched sample, 18% of Chinese goods were exported to Hong Kong. The statistical problem with exports to Hong Kong is that the final destination of the exports is unknown in the data. In order to show that our baseline estimates are not affected by re-exports through Hong Kong, we drop all exports to Hong Kong from our regression. The results reported in column 4 of Table 6 are very similar to our baseline estimates.

8.4 Excluding Extreme Values

In order to show that our results are not influenced by extreme values of export prices or firm attributes, e.g., TFP, firm size, capital intensity, or wages, we drop observations that have values of those variables in the top or bottom 1 percent of their distributions. As shown in column 5, the results are very close to the baseline estimates.

8.5 Labor Productivity

Given the important role of productivity in the theoretical model, we now examine whether our results are robust when we use alternative measures of productivity. Column 6 of Table 6 reports the results when firm productivity is measured by labor productivity (the logarithm of value added per worker). The estimated coefficient on labor productivity is 0.095, which is twice as large as the coefficient on TFP.

8.6 Firm-specific Markup

Since the specification in equation (6) includes product-destination fixed effects, the destination-specific markup is effectively controlled for, e.g., markup expects to be higher for richer markets than for poorer markets. In the theoretical framework outlined in Section 2 we have assumed CES preferences which imply a constant markup by firms. Now we add additional controls to account for the possible cross-firm variation in markup. We make the following two assumptions: (i) larger exporters have a bigger market power; and (ii) markup is higher for larger exporters in more concentrated markets.

We capture the size of an exporter using the export share of a firm relative to total exports from China to a destination. We measure the concentration of Chinese exports on a destination market using an Herfindale index defined as $H_{gct} \equiv \Sigma_f \left(x_{fgct}/\Sigma_{f'} x_{f'gct} \right)^2$ where x_{fgct} is the value of exports of good g by firm f to destination c in year t. Here we implicitly assume that Chinese exports are close substitutes among themselves. We add the export share and its interaction with the Herfindale index to the baseline regression. The results are reported in Table 7. For comparison, the baseline estimate is presented in column 1.

Column 2 shows that firms with a larger export share sell at a higher price after controlling for various firm attributes and ownership types. This may reflect that bigger exporters have a bigger market power and set a higher markup. However, the result may also be interpreted as supporting evidence for quality differentiation. This is because the theoretical model presented in Section 2 implies that without quality differentiation, there is a negative correlation between export prices and export shares.[17] The positive relationship between export shares and export prices indicates that firms with a larger market share may be selling a product that is more appealing to consumers and thus consumers are willing to pay a higher price for the product. That is, to some extent the significantly positive coefficient on export shares may also reflect the impact of quality differentiation on export prices.

In column 3, we add the Herfindale index and its interaction with export shares. Note that the Herfindale index is at a one-year lag.[18] The estimated effect of export shares on export prices is $0.057 + 0.086 * H_{gc,t-1}$. The 25% and 75% of H_{gct} are, respectively, 0.15 and 0.58 for the year of 2005. Therefore, although we find that bigger exporters sell at a higher price on more concentrated markets, the estimated effect of export shares on export prices varies very little between more concentrated markets and less concentrated markets. On the other hand, we find the coefficients on ownership, firm productivity, and other firm attributes are very close to the baseline estimates. Therefore, our baseline estimates are robust to the inclusion of controls for market power of a firm.

Overall, Tables 5-6 show that our baseline estimates are robust to various alternative specifications.

9 Conclusion

In this paper we studied the cross-firm variation in export prices within product-destination markets. Our dataset links trade transactions to a panel data of manufacturing firms in China during 2000-2006. Because our data contain rich information on both firms and trade, we are able to relate export prices directly to firm attributes.

[17]Let us consider two firms, firm 1 and firm 2. Using equation (1), we can derive that

$$\ln \frac{p_1}{p_2} = \frac{1}{1-\sigma} \ln \frac{(p_1 x_1)}{(p_2 x_2)} + \ln \frac{q_1}{q_2}$$

where subscripts 1 and 2 index firm 1 and firm 2. Since $\sigma > 1$, without quality differentiation (i.e., $\ln(q_1/q_2) = 0$), there is a negative relationship between prices and export shares.

[18]Because many exporters do not export in consecutive years, when the lagged value of export share is included, the number of observations is reduced substantially.

We find that more productive, more capital intensive and more skill intensive firms charge a higher export price. We also find that the export price is 22% higher for foreign invested firms than for domestic firms even after controlling for productivity, capital intensity, firm size, and worker skills. The price premium enjoyed by foreign invested firms is higher in R&D intensive industries and for differentiated goods. We interpret the price premium as a payoff to the capability to produce high quality goods. It may also reflect the optimal decision by multinational firms with respect to the choice between FDI and outsourcing. That is, it may be optimal for multinational firms to keep sophisticated goods that require more strict quality control within the firm boundary while outsource the goods that require less quality control to Chinese firms. The role of quality differentiation and quality control in influencing the decision about integration or not has not bee examined in the recent theoretical literature on trade and organizational forms. Our results also suggest that for domestic firms, catch-up with foreign invested firms requires factors beyond increasing productivity or capital intensity. Building up the capacity to produce quality is a more challenging task facing domestic firms.

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Table 1 Summary Statistics

	2000			2006		
	Domestic Firms	Foreign invested Firms	HK-Macau-Taiwanese owned firms	Domestic Firms	Foreign invested Firms	HK-Macau-Taiwanese owned firms
	(1)	(2)	(3)	(4)	(5)	(6)
Firm characteristics						
Log(TFP)	6.95	6.73	6.44	7.20	7.28	7.08
	(1.40)	(1.31)	(1.18)	(1.31)	(1.37)	(1.26)
Log(capital/labor)	3.70	3.96	3.44	3.66	3.83	3.40
	(1.14)	(1.50)	(1.37)	(1.22)	(1.43)	(1.37)
Log(labor)	6.13	5.20	5.33	5.23	5.22	5.40
	(1.31)	(1.13)	(1.06)	(1.14)	(1.16)	(1.09)
Log(wage)	10.74	10.33	10.09	10.57	10.64	10.50
	(1.42)	(1.37)	(1.16)	(1.31)	(1.40)	(1.23)
Share of college graduates				0.13	0.16	0.11
				(0.16)	(0.19)	(0.14)
Use of imported inputs						
Import dummy	0.48	0.87	0.85	0.38	0.78	0.73
Capital goods import dummy	0.18	0.57	0.46	0.22	0.65	0.55
Intermediate import dummy	0.44	0.84	0.82	0.33	0.74	0.70
Innovation						
R&D dummy	0.22	0.12	0.09	0.22	0.14	0.11
R&D intensity	0.02	0.02	0.01	0.02	0.02	0.01
	(0.08)	(0.05)	(0.03)	(0.22)	(0.04)	(0.04)
New product dummy	0.26	0.09	0.05	0.21	0.11	0.09
Output share of new products	0.30	0.49	0.44	0.40	0.46	0.46
	(0.27)	(0.36)	(0.36)	(0.32)	(0.37)	(0.36)
Number of firms	6127	6480	7969	21576	16258	13487

Notes : This table reports the mean statistics of the firms in our sample for the years of 2000 and 2006. In parentheses are standard deviations. For the share of college graduates, the data are available only for 2004. For R&D dummy and R&D intensity, the data are available only for 2005 and 2006. The statistics on R&D intensity are computed for the firms that reported R&D activities. The statistics on the output share of new products are computed for the firms that reported to have introduced new products.

Table 2 Export Prices: Beyond Productivity

	Baseline (1)	(2)	(3)
Log(TFP)	0.0483***	0.0466***	0.0465***
	(0.00147)	(0.00146)	(0.00146)
Log(capital/labor)	0.0709***	0.0711***	0.0711***
	(0.00124)	(0.00124)	(0.00124)
Log(labor)	0.0204***	0.0208***	0.0207***
	(0.00182)	(0.00180)	(0.00180)
Log(wage)	0.0765***	0.0746***	0.0748***
	(0.00256)	(0.00250)	(0.00250)
Foreign invested firms (FIE)	0.216***	0.219***	0.187***
	(0.00358)	(0.00384)	(0.00711)
HK-Macau-Taiwanese owned firms (HMT)	-0.0816***	-0.0897***	-0.0950***
	(0.00322)	(0.00361)	(0.00834)
industry R&D intensity		6.454***	6.449***
		(0.614)	(0.613)
industry R&D intensity * FIE		3.024***	3.053***
		(0.479)	(0.480)
industry R&D intensity * HMT		-3.903***	-3.930***
		(0.527)	(0.527)
Differentiated goods * FIE			0.0400***
			(0.00808)
Differentiated goods * HMT			0.00684
			(0.00891)
Log(GDP)	-0.0701	-0.0400	-0.0400
	(0.0530)	(0.0533)	(0.0533)
Log(GDP per capita)	0.0435	0.0128	0.0127
	(0.0534)	(0.0537)	(0.0537)
Log(remoteness)	-0.0229	-0.0269	-0.0277
	(0.0684)	(0.0683)	(0.0683)
Year fixed effects	yes	yes	yes
Product-destination fixed effects	yes	yes	yes
Number of products * destinations	212,835	212,825	212,825
Observations	4,267,715	4,267,028	4,267,028
R^2	0.720	0.721	0.721

Note : The dependent variable is the logarithm of the unit price of exports. FIE stands for foreign invested firms. HMT stands for firms owned by investors from Hong Kong, Macau, and Taiwan. Log(TFP), log(capital/labor), log(labor), and log(wage) are at a one-year lag. The indicator for differentiated goods is based on the Rauch measure of product differentiation. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 3 Imported Inputs

	All imports		Intermediates vs. capital goods		
	(1)	(2)	(3)	(4)	(5)
Log(TFP)	0.0482***	0.0400***	0.0480***	0.0410***	0.0513***
	(0.00147)	(0.00161)	(0.00147)	(0.00197)	(0.00146)
Log(capital/labor)	0.0657***	0.0492***	0.0581***	0.0412***	0.0578***
	(0.00125)	(0.00137)	(0.00128)	(0.00178)	(0.00128)
Log(labor)	0.0113***	-0.00125	0.00180	-0.0167***	-0.00488***
	(0.00186)	(0.00202)	(0.00189)	(0.00248)	(0.00179)
Log(wage)	0.0749***	0.0731***	0.0745***	0.0861***	0.0643***
	(0.00259)	(0.00274)	(0.00260)	(0.00309)	(0.00241)
Foreign invested firms	0.193***	0.193***	0.168***	0.196***	0.152***
	(0.00357)	(0.00391)	(0.00351)	(0.00507)	(0.00323)
HK-Macau-Taiwanese owned firms	-0.106***	-0.0720***	-0.127***	-0.0677***	-0.140***
	(0.00318)	(0.00363)	(0.00319)	(0.00485)	(0.00318)
Import dummy	0.114***				
	(0.00252)				
Import price index		0.389***			
		(0.00370)			
Intermediate import dummy			0.0701***		0.0615***
			(0.00250)		(0.00252)
Capital goods import dummy			0.107***		0.0935***
			(0.00261)		(0.00268)
Intermediate import price index				0.491***	
				(0.00474)	
Capital goods import price index				0.0774***	
				(0.00189)	
Share of imported intermediates					0.0838***
					(0.00819)
Imported capital goods/capital stock					0.689***
					(0.0195)
Log(GDP)	-0.0519	-0.114*	-0.0513	-0.256***	-0.0550
	(0.0530)	(0.0627)	(0.0532)	(0.0766)	(0.0537)
Log(GDP per capita)	0.0275	0.0717	0.0282	0.204***	0.0302
	(0.0533)	(0.0635)	(0.0534)	(0.0786)	(0.0538)
Log(remoteness)	-0.0468	-0.0772	-0.0640	0.0607	-0.0565
	(0.0684)	(0.0737)	(0.0687)	(0.0858)	(0.0693)
Year fixed effects	yes	yes	yes	yes	yes
Product-destination fixed effects	yes	yes	yes	yes	yes
Number of products * destinations	212,835	190,174	212,835	162,748	212,835
Observations	4,267,715	3,379,985	4,267,715	2,404,253	4,267,715
R^2	0.720	0.747	0.720	0.834	0.721

Notes: The dependent variable is the logarithm of the unit price of exports. Log(TFP), log(capital/labor), log(labor), and log(wage) are at a one-year lag. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 4 Worker Skills

	(1)	(2)	(3)	(4)
Log(TFP)	0.0381***	0.0366***	0.0372***	0.0341***
	(0.00271)	(0.00265)	(0.00265)	(0.00302)
Log(capital/labor)	0.0681***	0.0538***	0.0506***	0.0410***
	(0.00195)	(0.00190)	(0.00193)	(0.00228)
Log(labor)	0.0240***	0.0285***	0.0218***	0.00591*
	(0.00282)	(0.00278)	(0.00283)	(0.00313)
Log(wage)	0.0830***	0.0409***	0.0391***	0.0382***
	(0.00373)	(0.00374)	(0.00375)	(0.00416)
Foreign invested firms	0.199***	0.199***	0.184***	0.196***
	(0.00517)	(0.00519)	(0.00519)	(0.00603)
HK-Macau-Taiwanese owned firms	-0.0809***	-0.0619***	-0.0773***	-0.0437***
	(0.00483)	(0.00471)	(0.00470)	(0.00566)
Share of college graduates		0.944***	0.751***	0.750***
		(0.0216)	(0.0346)	(0.0224)
Import dummy			0.0554***	
			(0.00556)	
Share of college graduates * Import dummy			0.206***	
			(0.0382)	
Import price index				0.370***
				(0.00666)
Share of college graduates * Import price index				0.149***
				(0.0310)
Product-destination fixed effects	yes	yes	yes	yes
Number of products * destinations	123,409	123,408	123,408	107,087
Observations	700,045	699,962	699,962	551,628
R^2	0.757	0.760	0.760	0.802

Notes : The dependent variable is the logarithm of the unit price of exports. The regressions are for the year of 2004 only. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 5 Innovation

	R&D			Output of New Products		
	(1)	(2)	(3)	(4)	(5)	(6)
Log(TFP)	0.0587***	0.0583***	0.0563***	0.0503***	0.0493***	0.0486***
	(0.00198)	(0.00198)	(0.00196)	(0.00147)	(0.00146)	(0.00145)
Log(capital/labor)	0.0730***	0.0693***	0.0692***	0.0715***	0.0691***	0.0686***
	(0.00137)	(0.00138)	(0.00137)	(0.00125)	(0.00125)	(0.00125)
Log(labor)	0.00771***	-0.00638***	0.00533**	0.0204***	0.0153***	0.0163***
	(0.00220)	(0.00229)	(0.00221)	(0.00183)	(0.00189)	(0.00186)
Log(wage)	0.0721***	0.0641***	0.0731***	0.0763***	0.0747***	0.0731***
	(0.00284)	(0.00284)	(0.00287)	(0.00259)	(0.00259)	(0.00257)
Foreign invested firms	0.182***	0.199***	0.192***	0.221***	0.234***	0.234***
	(0.00389)	(0.00387)	(0.00390)	(0.00365)	(0.00359)	(0.00360)
HK-Macau-Taiwanese owned firms	-0.0865***	-0.0690***	-0.0741***	-0.0810***	-0.0673***	-0.0680***
	(0.00352)	(0.00347)	(0.00348)	(0.00326)	(0.00314)	(0.00317)
R&D dummy		0.158***				
		(0.00370)				
R&D intensity			5.646***			
			(0.235)			
new product dummy					0.0940***	
					(0.00340)	
Output share of new products						0.250***
						(0.00696)
Log(GDP)	-0.423*	-0.437*	-0.457*	-0.0569	-0.0559	-0.0578
	(0.244)	(0.244)	(0.244)	(0.0554)	(0.0553)	(0.0553)
Log(GDP per capita)	0.447*	0.459*	0.477*	0.0252	0.0240	0.0261
	(0.252)	(0.251)	(0.252)	(0.0560)	(0.0559)	(0.0559)
Log(remoteness)	-0.693***	-0.678***	-0.676***	-0.0844	-0.0690	-0.0708
	(0.172)	(0.172)	(0.172)	(0.0756)	(0.0754)	(0.0754)
Year fixed effects	yes	yes	yes	yes	yes	yes
Product-destination fixed effects	yes	yes	yes	yes	yes	yes
Number of products * destinations	171,613	171,613	171,605	204,389	204,389	204,389
Observations	1,936,263	1,936,263	1,935,701	3,572,385	3,572,385	3,572,385
R^2	0.725	0.726	0.726	0.721	0.721	0.721

Notes : The dependent variable is the logarithm of the unit price of exports. Log(TFP), log(capital/labor), log(labor), and log(wage) are at a one-year lag. Regressions in columns 1-3 are for the years of 2005 and 2006. Regressions in columns 4-6 are for the years of 2000-2003 and 2005-2006. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 6 Robustness

	Baseline	Processing trade	persistent exporters	drop exports to HK	drop top & bottom 1%	labor productivity
	(1)	(2)	(3)	(4)	(5)	(6)
Log(TFP)	0.0483***	0.0428***	0.0360***	0.0484***	0.0483***	0.0952***
	(0.00147)	(0.00267)	(0.00199)	(0.00150)	(0.00141)	(0.00155)
Log(capital/labor)	0.0709***	0.0986***	0.0832***	0.0703***	0.0655***	0.0580***
	(0.00124)	(0.00231)	(0.00201)	(0.00125)	(0.00118)	(0.00119)
Log(labor)	0.0204***	0.0849***	0.0595***	0.0160***	0.0163***	0.0507***
	(0.00182)	(0.00329)	(0.00252)	(0.00179)	(0.00174)	(0.00146)
Log(wage)	0.0765***	0.181***	0.101***	0.0699***	0.0729***	0.0384***
	(0.00256)	(0.00436)	(0.00356)	(0.00243)	(0.00243)	(0.00239)
Foreign invested firms	0.216***	0.250***	0.300***	0.206***	0.196***	0.210***
	(0.00358)	(0.00667)	(0.00552)	(0.00354)	(0.00338)	(0.00356)
HK-Macau-Taiwanese owned firms	-0.0816***	-0.162***	-0.0230***	-0.0761***	-0.0796***	-0.0837***
	(0.00322)	(0.00649)	(0.00495)	(0.00318)	(0.00308)	(0.00322)
Log(GDP)	-0.0701	-0.0998	-0.287***	-0.0890*	-0.0548	-0.0616
	(0.0530)	(0.0994)	(0.0641)	(0.0528)	(0.0518)	(0.0528)
Log(GDP per capita)	0.0435	0.0311	0.250***	0.109**	0.0316	0.0356
	(0.0534)	(0.102)	(0.0651)	(0.0525)	(0.0521)	(0.0532)
Log(remoteness)	-0.0229	-0.148	0.179**	0.00706	-0.0646	-0.0288
	(0.0684)	(0.101)	(0.0775)	(0.0691)	(0.0672)	(0.0681)
Year fixed effects	yes	yes	yes	yes	yes	yes
Product-destination fixed effects	yes	yes	yes	yes	yes	yes
Number of products * destinations	212,835	96,596	147,638	208,742	212,202	212,835
Observations	4,267,715	1,385,330	1,968,067	3,891,315	4,202,645	4,267,715
R^2	0.720	0.733	0.730	0.726	0.742	0.720

Notes: The dependent variable is the logarithm of the unit price of exports. Log(TFP), log(capital/labor), log(labor), and log(wage) are at a one-year lag. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7 Firm-specific Markup

	baseline (1)	(2)	(3)
Log(TFP)	0.0483***	0.0529***	0.0529***
	(0.00147)	(0.00216)	(0.00216)
Log(capital/labor)	0.0709***	0.0712***	0.0712***
	(0.00124)	(0.00182)	(0.00182)
Log(labor)	0.0204***	0.0286***	0.0287***
	(0.00182)	(0.00268)	(0.00268)
Log(wage)	0.0765***	0.0942***	0.0943***
	(0.00256)	(0.00365)	(0.00365)
Foreign invested firms	0.216***	0.212***	0.212***
	(0.00358)	(0.00500)	(0.00500)
HK-Macau-Taiwanese owned firms	-0.0816***	-0.0709***	-0.0708***
	(0.00322)	(0.00461)	(0.00461)
Export share		0.0910***	0.0568***
		(0.0116)	(0.0176)
Herfindale index			-0.0187
			(0.0166)
Export share * Herfindale index			0.0865***
			(0.0313)
Log(GDP)	-0.0701	-0.132	-0.132
	(0.0530)	(0.0864)	(0.0864)
Log(GDP per capita)	0.0435	0.0962	0.0960
	(0.0534)	(0.0888)	(0.0888)
Log(remoteness)	-0.0229	0.0858	0.0846
	(0.0684)	(0.0945)	(0.0944)
Year fixed effects	yes	yes	yes
Product-destination fixed effects	yes	yes	yes
Number of products * destinations	212,835	125,158	125,158
Observations	4,267,715	2,090,001	2,090,001
R^2	0.720	0.711	0.711

Note : The dependent variable is the logarithm of the unit price of exports. Log(TFP), log(capital/labor), log(labor), and log(wage) are at a one-year lag. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1