Anwar, Sajid, and Sun, Sizhong (2018) *Foreign direct investment and export quality upgrading in China's manufacturing sector.* International Review of Economics & Finance, 54. pp. 289-298.

http://dx.doi.org/ 10.1016/j.iref.2017.09.009

Foreign Direct Investment and Export Quality Upgrading in China's Manufacturing Sector

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Abstract

Using a Melitz-type theoretical model of firm heterogeneity, we show that (i) the presence of foreign firms within an industry affects the industry export quality and (ii) the industry export quality is directly related to the industry export price. As the industry export price can be approximated by the industry export unit value, our work provides a rigorous theoretical justification for several empirical studies that use export unit value as a proxy for export quality. We then convert our theoretical model-based structural relationships into a system of equations. Using industry level panel data from China's manufacturing sector, and measuring the industry export quality by the industry export unit value, we find that an increase in foreign presence in China's manufacturing sector contributes to a significant increase in China's export quality. We also distinguish between foreign presence in China originating from the Hong Kong, Macao and Taiwan (HMT) and non-HMT regions. We find that foreign presence in China's manufacturing sector that originates from the HMT region leads to a much larger increase in China's export quality. The main empirical result is found to be robust with respect to alternative measures of foreign presence and aggregate demand.

Key Words: Export unit value, export quality, FDI, productivity spillovers, China

1. Introduction

Export quality is an important issue in international business and finance. Earlier research confirms that (i) higher quality goods are sold at higher prices[1] and (ii) high income countries tend to export higher quality products.[2] Generally speaking, most developing countries do not produce and export high quality products. But these countries often import high quality goods from developed countries that tend to be costly, which can contribute to balance of payments problem. Export quality upgrading can help the developing countries to increase their export revenue thereby reducing the severity of balance of payments problem. One way to improve the export quality is to gain access to advanced technology. However, it may not be possible for most developing countries to pay for such technology. An indirect method of gaining access to advanced technology is inward foreign direct investment (FDI).

In recent decades there has been a significant increase in world-wide FDI flows. It is well-known that, through productivity spillover effects, FDI can potentially improve the export performance of firms located in developing countries. Based on the cross-country data, the empirical work of Harding and Javorcik (2012) shows that FDI can also lead to export quality upgrading. However, Harding and Javorcik do not formally establish a link between FDI and export quality upgrading. Using data on Romanian firms, they suggest that domestic firms that supply inputs to multinational firms are more likely to enter the export market. As far as the case of China is concerned, the empirical work of Wang and Wei (2008) suggests that FDI is not linked to China's increasing export sophistication. Xu (2010) argues that earlier studies on China's export sophistication are subject to measurement bias as these studies have not taken product quality into account.[3] Using cross-country panel data, Zhu and Fu (2013) argue that FDI can contribute to export sophistication. In summary, none of the existing studies have formally considered the link between FDI and export quality and only a handful of empirical studies have considered the case of China. Another unresolved issue in the related literature is the appropriateness of the use of export unit value as a proxy for export quality. Specifically, there is a lack of robust theoretical justification for this proxy.

[1] For example see Hallak and Sivadasan (2009), Kugler and Verhoogen (2012) and references therein. Kugler and Verhoogen also show that quality differences in inputs and outputs can account for the empirical fact that large firms charge a higher price for their products. Bajgar and Javorcik (2013), among others, show that FDI can improve the quality of final goods and/or inputs produced by domestic firms in host economies.

[2] For example, see Hallak and Schott (2008) and Khandelwal (2010).

[3] Manova and Zhang (2012) suggest that Chinese domestic firms that are relatively more successful in export market tend to use higher quality inputs, which allows them to export higher quality products.

This paper makes two distinct contributions to the existing literature. First, using a Melitz-type theoretical model, we show that the presence of foreign firms within an industry affects the industry export quality. We also show that the industry export quality is directly related to the industry export price, which provides a theoretical justification for a number of empirical studies, such as Harding and Javorcik (2012), where export unit value is used as a measure of product quality.[4] Thus our theoretical model shows that the impact of foreign presence on the unobserved industry export quality can be identified from its impact on the industry export price (which can be proxied by the observed industry export unit value). In the presence of positive spillover effects, an increase in foreign presence improves the firm productivity, which allows them to produce higher quality products. However, the positive spillover effect also enables the firms with lower capability to enter the industry. These firm produce relatively low quality products and hence the overall impact on industry quality cannot be easily determined and therefore empirical investigation is desirable.

Second, using industry level panel data from China's manufacturing sector over the 2005 to 2007 period, we empirically evaluate the impact of the presence of foreign firms on industry export quality in China, where the industry export quality is proxied by the export unit value. China is an interesting case study because it remains the largest recipient of FDI among developing countries and so far only a handful of studies have considered the issue of product quality in China. We believe that analysis of the impact of FDI on China's export quality is important from both academic research and policy making perspectives. We also distinguish between foreign investment in China originating from (i) the Hong Kong, Macau and Taiwan (HMT) and (ii) non-HMT regions.

Our empirical results suggest that an increase in foreign presence in China's manufacturing sector leads to significant industry export quality upgrading. We find that an increase in foreign presence originating from the HMT region leads to a relatively large increase in the industry export quality. Furthermore, an increase in the average wage rate increases the industry export quality directly but its indirect effect through an increase in foreign presence originating from the HMT region is statistically insignificant.

[4] Khandelwal (2010) and Amiti and Khandelwal (2013) use quality adjusted prices but their modified measure does not change the basic results that high income countries export higher quality goods.

The rest of this paper is structured as follows. A brief review of related literature is presented in Section 2. A theoretical model which allows one to establish the link between FDI and industry export quality and export price is developed in Section 3. This section also includes a discussion of the empirical strategy used in this paper. Section 4 reports the data used in our empirical analysis. The empirical results are presented and discussed in Section 5. The last section concludes the paper.

2. Review of Related Literature

A number of studies have examined various aspects of export quality. For example, both Schott (2004) and Hummels and Klenow (2005) show that country characteristics affect export quality. Using an open economy model, Acharyya and Jones (2001) examine the link between export quality and income distribution. Bandyopadhyay and Acharyya (2006) examine the relationship between input sector liberalization and product quality, which has implications for export orientation. They show that input sector liberalization alone may not induce quality innovation and export orientation. Yeaple (2005) shows that a decrease in trade costs can increase the market share of firms that export. Firms that export are more productive and hence produce higher quality products. Using a theoretical model involving quality differentiation, Verhoogen (2008) shows that exchange rate devaluation encourages relatively more productive firms to upgrade product quality and increase exports. Using data from Mexico, Verhoogen provides empirical support for his theoretical predictions. In a very interesting study, Schott (2008) argues that firms from developed countries competing with Chinese firms may be better off if they move up the quality ladder and simply hand over the market for exports of relatively less sophisticated goods to Chinese firms. Schott shows that the presence of foreign firms, through a positive spillover effect, helps to improve the quality of Chinese exports.

Bustos (2011) argues that free trade agreements encourage domestic firms to invest in new technologies, which contributes towards export quality upgrading. By matching French champagne quality assessment data with exports, Crozet, Head and Mayer (2012) investigate the link between quality and exports. They find that export quality and price are positively related. Amiti and Khandelwal (2013) show that lower import tariffs can contribute to export quality upgrading.[5] Using firm level data from France, Bernini, Guillou and Bellone (2015) explore the relationship between financial leverage and export quality. They find that firms that have higher leverage tend to export lower quality products. Brambilla and Potro (2016) argue that the cost of production of high quality goods is also high. High quality goods are exported to high income countries and firms that produce high quality goods tend to pay higher wages. Early studies on China include Sonobe, Hu and Otsuka (2004). They report that, upon entry into an industry, a large number of firms initially produce low quality products. However, over time there is some evidence of export quality upgrading.

The brief literature review presented in this section highlights the fact that export quality is an important issue and only a few existing studies have considered the issue of China's export quality. Also a number of studies use export unit value as a proxy for export quality but a rigorous theoretical justification has not been provided.

3. Analytical Framework

In this section, we present a theoretical model that can be used to examine the link between the presence of foreign firms within a host country industry and the industry export quality. We start by describing the behaviour of a representative consumer in the export market (i.e., the foreign market). The preferences of the representative consumer in the foreign market can be described by means of a constant elasticity of substitution (CES) utility function as follows:

$$U = \left[\int_{\omega\in\Omega} x(\omega)^{1-\rho} q(\omega)^{\rho} d\omega\right]^{1/\rho} \tag{1}$$

where ω is the index of product variety; Ω is the set of all available varieties in the market; x is product quality; and q is the quantity consumed.

Utility maximization subject to the usual budget constraint leads to the following demand function.

$$q = \Phi x p^{1/(\rho-1)} \tag{2}$$

where p is the price of a variety; $\Phi \equiv \frac{Y}{\int_{\omega\in\Omega} p(\omega)^{\rho/(\rho-1)} x(\omega) d\omega}$ measures the aggregate demand level; and Y is consumer income.

[5] Other related studies include Hallak and Schott (2008), Choi, Hummels and Xiang (2009), Hallak (2010), Fajgelbaum, Grossman, and Helpman (2011), Johnson (2012), and Antràs and Yeaple (2013), Feenstra and Romalis (2012), and Fan, Li and Yeaple (2015).

Each firm is small relative to the market and hence its actions have a negligible impact on aggregate demand (Φ). In other words, each firm takes aggregate demand as given.

On the production side, the industry consists of a continuum of firms, where γ is the proportion of foreign-invested firms $(0 < \gamma < 1)$. Upon entry to the industry, each firm incurs a fixed cost (f), which enables it to participate in a capability (λ) draw.[6] The capability is drawn from a Pareto distribution with the cumulative distribution function, $G(\lambda)$, as follows:

$$G(\lambda) = \begin{cases} 1 - (1/\lambda)^{\beta}; & \lambda > 1 \\ 0; & \leq 1 \end{cases}$$

In the cumulative distribution function, by choosing the units of measurement appropriately, the minimum value of the firm capability is normalized to unity. Firms within the industry produce for both domestic and foreign markets. Selling in the foreign market (i.e., exporting) involves a fixed export cost (f_e) and a melting iceberg trading cost τ, where $\tau > 1$ units of the output have to be shipped in order for 1 unit to arrive in the foreign market.

In addition to the fixed cost, each firm incurs a variable cost of production, which involves the use of labour. The variable cost is determined by the production function $F(l) = sl$, where l is the labour used and s is the average productivity of labour. The labour productivity depends on the firm capability (λ) and product quality (x). Furthermore, the presence of foreign firms in the industry gives rise to an externality to both domestic and foreign firms. The labour productivity is therefore endogenously determined by the following relationship, where σ is positive.

$$s = \tilde{s}x^{-\sigma} = \begin{cases} \lambda e^{\tilde{\alpha}\gamma} x^{-\sigma}; & \text{if foreign} - \text{invested firm} \\ \lambda e^{\alpha\gamma} x^{-\sigma}; & \text{if domestic firm} \end{cases} \quad (3)$$

In equation (3), firm capability has a positive effect on labour productivity. This implies that the workers employed by highly capable firms are also relatively more productive. The productivity of workers also depends on product quality. Everything else being equal, it is relatively more difficult for the workers to produce higher quality goods. Accordingly, a 1% increase in product quality results in a σ% decrease in labour productivity.

The parameters α and $\tilde{\alpha}$, respectively, capture the extent to which the presence of foreign firms affects the productivity of domestic and foreign firms. We assume that the presence of the foreign firms in the industry leads to FDI-linked productivity spillovers to

[6] The fixed cost can also be interpreted as the market access cost (Melitz and Redding, 2014). If the capability is below a certain cut-off level then the firm immediately exits the industry.

both domestic and foreign firms. When α ($\tilde{\alpha}$) is positive, domestic (foreign) firms benefit from the presence of foreign firms. In contrast, $\alpha < 0$ ($\tilde{\alpha} < 0$) implies that foreign presence is harmful to domestic (foreign) firms. In the absence of the spillover effects $\alpha = 0$ ($\tilde{\alpha} = 0$). Some existing empirical studies have reported negative FDI-related productivity spillovers to domestic firms in host economies. The specification of the spillovers used in this paper can accommodate all possibilities.

A large body of the existing empirical studies has investigated the issue of productivity spillovers from FDI with mixed results. The empirical analysis presented in this paper is based on firm and industry level data from China. In the case of China, a number empirical studies have reported positive productivity spillovers from FDI (for example, see Sun, 2011 and Xu and Sheng, 2012).

The production function, $F(l) = sl$, implies that $1/s$ units of labour are required to produce one unit of the final good. Accordingly, w/s is the marginal cost (MC) of production, where w is the wage rate.

Firms are assumed to be engaged in a two-stage game. In stage one, firms choose profit maximising product quality. In stage two, firms set profit maximising price. Note that in stage one, firms are faced with a trade-off. On the one hand, higher product quality boosts demand, as shown in equation (2). On the other hand, higher quality goods are relatively more difficult to produce and hence the marginal cost of production is higher. Furthermore, the fixed cost associated with producing higher quality products is also higher. The fixed cost (fixed with respect to the quantity produced) is a quadratic function of product quality (i.e., δx^2 where $\delta > 0$).

Based on the information provided so far, the profit of a firm in the export market can be written as $\pi = (p - \tau w/s)q - f_e - \delta x^2$, where π is the per period profit; and p is the price that the firm charges. This profit function can be used to determine the optimal product quality in stage one. Given the product quality, in stage two, the firm sets its profit maximising export market price as follows, where the demand function in the export market (i.e., equation 2) has been substituted into the profit equation.

$$\max_{\{p\}} \pi = \left(p - \frac{\tau w}{s}\right) \Phi x p^{1/(\rho-1)} - f_e - \delta x^2 \tag{4}$$

Profit maximisation yields the optimal price as follows:

$$p = \frac{\tau w}{\rho s} \tag{5}$$

In stage one, the firm sets the optimal product quality as follows:

$$\max_{\{x\}} \pi = (1-\rho)\rho^{\frac{\rho}{1-\rho}}\tau^{\frac{\rho}{\rho-1}}\Phi w^{\frac{\rho}{\rho-1}}\tilde{s}^{\frac{\rho}{1-\rho}}x^{\frac{1-(1+\sigma)\rho}{1-\rho}} - f_e - \delta x^2 \quad (6)$$

The optimisation problem presented in equation (6) yields the optimal product quality as follows:

$$x = (2\delta)^{\frac{1-\rho}{1-\rho+\sigma\rho}}[1-(1+\sigma)\rho]^{\frac{1-\rho}{1-\rho+\sigma\rho}}\rho^{\frac{\rho}{1-\rho+\sigma\rho}}\tau^{\frac{-\rho}{1-\rho+\sigma\rho}}\Phi^{\frac{1-\rho}{1-\rho+\sigma\rho}}w^{\frac{-\rho}{1-\rho+\sigma\rho}}\tilde{s}^{\frac{\rho}{1-\rho+\sigma\rho}} \quad (7)$$

Using the optimal export market price and quality, the optimal profit can be written as follows:

$$\pi^* = A\tau^{\frac{-2\rho}{1-\rho+\sigma\rho}}\Phi^{\frac{2(1-\rho)}{1-\rho+\sigma\rho}}w^{\frac{-2\rho}{1-\rho+\sigma\rho}}\tilde{s}^{\frac{2\rho}{1-\rho+\sigma\rho}} - f_e \quad (8)$$

where $A = \left\{\frac{1-\rho}{2[1-(1+\sigma)\rho]\delta^2} - 1\right\}2^{\frac{2(1-\rho)}{1-\rho+\sigma\rho}}\delta^{\frac{3-3\rho+\sigma\rho}{1-\rho+\sigma\rho}}[1-(1+\sigma)\rho]^{\frac{2(1-\rho)}{1-\rho+\sigma\rho}}\rho^{\frac{2\rho}{1-\rho+\sigma\rho}}$.

Depending on the capability, λ, both domestic and foreign firms can potentially sell in the export market. However, a firm will export only if the export market profit is positive $\left(\text{i.e., } \pi^* > 0\right)$. As the optimal profit is a monotonically increasing function of the firm capability, $\pi^*(\lambda = 0) = -f_x < 0$, there exit a cut-off cabability below which a firm would not be able to export. Using the capability cumulative probability density function, the cut-off capabilities of foreign and domestic firms that will export are as follows:

$$\lambda_f^* = Ne^{-\tilde{\alpha}\gamma} \quad (9)$$

$$\lambda_d^* = Ne^{-\alpha\gamma} \quad (10)$$

where $N = A^{-\frac{1-\rho+\sigma\rho}{2\rho}}\tau\Phi^{\frac{\rho-1}{\rho}}wf_e^{\frac{1-\rho+\sigma\rho}{2\rho}}$; the subscripts f and d, respectively, are used to distinguish foreign and domestic firms and an asterisk denotes the cut-off capability.

We now turn our attention to the domestic market, where firms face a similar profit maximisation problem. Using the expressions for the optimal profit, we can derive the cut-off capabilities of both domestic and foreign firms that will sell in the domestic markets as follows:[7]

$$\tilde{\lambda}_f^* = \tilde{N}e^{-\tilde{\alpha}\gamma} \quad (11)$$

$$\tilde{\lambda}_d^* = \tilde{N}e^{-\alpha\gamma} \quad (12)$$

where $\tilde{N} = \tilde{A}^{-\frac{1-\rho+\sigma\rho}{2\rho}}\tilde{\Phi}^{\frac{\rho-1}{\rho}}wf^{\frac{1-\rho+\sigma\rho}{2\rho}}$; $\tilde{\lambda}$ is the cut-off capability for selling in the domestic market.

[7] Note that a firm that is able to export is also able to sell in the domestic market. However, due to the cost of exporting, a firm that can sell in the domestic market may not be able to export.

Equations (9) to (12) represent four cut-off capabilities that generate the sorting pattern which can also be found in previous studies (e.g., see Helpman, 2006 and Melitz, 2003). However, none of the available studies has explicitly explored the link between the presence of foreign firms, measured by γ in this paper, and the firm cut-off capability. For example, if the realized capability of a domestic firm is lower than $\tilde{\lambda}_d^*$ then it will immediately exit the industry. If the realized capability of a firm is between $\tilde{\lambda}_d^*$ and λ_d^* then the firm will only serve the domestic market. If the realized capability of a domestic firm is higher than λ_d^* then the firm will serve both domestic and export markets. In addition, equations (10) and (12) suggest that an increase in foreign presence $(\text{i.e., } \gamma)$ decreases the cut-off capability of domestic firms as long as the spillover effect from foreign presence to domestic firms is positive $(\text{i.e., } \alpha > 0)$. This follows from the fact that in the presence of a positive productivity spillover effect, an increase in foreign presence enhances the productivity of domestic firms. It is also interesting to note that a decrease in the fixed cost leads to a decrease in the cut-off capability of both domestic and foreign firms, which encourages entry into the industry.

Equation (7) is the firm level optimal export quality, which can be used to derive an expression for the industry export quality, as follows:[8]

$$X = (1-\gamma)\int_{\lambda_d^*}^{\infty} x dG(\lambda) + \gamma \int_{\lambda_f^*}^{\infty} x dG(\lambda)$$

$$= \frac{\beta}{\beta - \frac{\rho}{1-\rho+\sigma\rho}} \hat{N} N^{\frac{\rho}{1-\rho+\sigma\rho}-\beta}\left[(1-\gamma)e^{\alpha\beta\gamma} + \gamma e^{\tilde{\alpha}\beta\gamma}\right] \qquad (13)$$

where $\hat{N} = (2\delta)^{\frac{1-\rho}{1-\rho+\sigma\rho}}[1-(1+\sigma)\rho]^{\frac{1-\rho}{1-\rho+\sigma\rho}}\rho^{\frac{\rho}{1-\rho+\sigma\rho}}\tau^{\frac{-\rho}{1-\rho+\sigma\rho}}\Phi^{\frac{1-\rho}{1-\rho+\sigma\rho}}w^{\frac{-\rho}{1-\rho+\sigma\rho}}$ and X is the industry export quality.

Substituting equation (7) into the optimal price equation (5), making use of the probability density function and aggregating over the firms that export leads to the industry export price as follows:[9]

$$P = (1-\gamma)\int_{\lambda_d^*}^{\infty} p dG(\lambda) + \gamma \int_{\lambda_f^*}^{\infty} p dG(\lambda)$$

$$= \frac{\beta}{\beta + \frac{\rho}{1-\rho+\sigma\rho}} \bar{N} N^{-\frac{1-\rho}{1-\rho+\sigma\rho}-\beta}\left[(1-\gamma)e^{\alpha\beta\gamma} + \gamma e^{\tilde{\alpha}\beta\gamma}\right] \qquad (14)$$

[8] Using the probability density function, this involves aggregating over the firms that export (See Melitz, 2003).

[9] See Melitz (2003).

where $\overline{N} = 2^{\frac{\sigma(1-\rho)}{1-\rho+\sigma\rho}}\delta^{\frac{\sigma(1-\rho)}{1-\rho+\sigma\rho}}[1-(1+\sigma)\rho]^{\frac{\sigma(1-\rho)}{1-\rho+\sigma\rho}}\rho^{\frac{\rho-1}{1-\rho+\sigma\rho}}\tau^{\frac{1-\rho}{1-\rho+\sigma\rho}}\Phi^{\frac{\sigma(1-\rho)}{1-\rho+\sigma\rho}}w^{\frac{1-\rho}{1-\rho+\sigma\rho}}$ and P is the industry export price.

Equations (13) and (14) suggest that the impact of FDI on industry export quality can be identified from its impact on the industry export price. In other words

$$\frac{\partial X}{\partial \gamma} = \frac{\partial P}{\partial \gamma} \tag{15}$$

In empirical studies, the industry export unit value (i.e., the total industry export value divided by the quantity exported by the industry) can be used as a proxy for industry export price. Thus, equation (15) provides a theoretical justification for the empirical studies that use export unit value as a proxy for export quality.

The capabilities both domestic and foreign firms are drawn from a Pareto distribution, and firms exit the industry immediately if their realized capability is less than the cut-off level as given in equations (11) and (12). Since both domestic and foreign firms are drawn from the same distribution, the mass of new domestic entrants equals the mass of new foreign entrants. Let M_e denote the mass of domestic/foreign entrants, M_d denote the mass of existing domestic firms, and M_f denote the mass of foreign firms. In the long run, the mass of the successful new entrants (i.e., $M_e\left(1-\int_{\tilde{\lambda}_d^*}^{\infty} dG(\lambda)\right)$ domestic firms and $M_e\left(1-\int_{\tilde{\lambda}_f^*}^{\infty} dG(\lambda)\right)$ foreign firms) is equal to the mass of the existing firms that exit due to other factors such as the unfavourable technological shocks. We can derive the equilibrium level of foreign presence as follows:

$$\gamma = \frac{M_f}{M_f + M_d} = \frac{M_e\left(1-\int_{\tilde{\lambda}_f^*}^{\infty} dG(\lambda)\right)}{M_e\left(1-\int_{\tilde{\lambda}_f^*}^{\infty} dG(\lambda)\right) + M_e\left(1-\int_{\tilde{\lambda}_d^*}^{\infty} dG(\lambda)\right)}$$

$$= \frac{1-\int_{\tilde{\lambda}_f^*}^{\infty} dG(\lambda)}{2-\int_{\tilde{\lambda}_f^*}^{\infty} dG(\lambda)-\int_{\tilde{\lambda}_d^*}^{\infty} dG(\lambda)} \tag{16}$$

Equation (16) shows that the equilibrium level of foreign presence is a function of the domestic aggregate demand ($\tilde{\Phi}$), the wage rate (w), and the fixed cost of production (f).

Using equation (13), it is possible to examine the impact of an increase in foreign presence on industry export quality. It is clear from equation (13) that in the absence of FDI-related productivity spillovers, foreign presence has no effect on industry export quality. In the presence of positive spillover effect, an increase in foreign presence increases the productivity of all firms. The firms that are already in the industry are therefore able to produce higher quality products. However, the positive spillover effect also enables some firms with lower capability that were not in the industry to enter the industry. Upon entry to the industry, these firms produce relatively low quality products and hence it may not be possible to determine the overall impact of an increase in foreign presence on industry export quality. Accordingly, empirical investigation is desirable.

As far as the empirical part of this paper is concerned, our aim is to estimate the impact of the presence of foreign-invested firms on the unobserved industry export quality, which as shown in equation (15), can be identified from its impact on the industry export price. The industry export price can in turn be proxied by the unit value of export, which is observable in our dataset. Based on equation (14), the export unit value can be viewed as a function of the aggregate demand in the foreign market (Φ), the wage rate (*w*), presence of foreign firms (γ), and the cost of exporting (i.e., τ and f_e). Estimation of this relationship will allow us to infer the impact of foreign presence on the industry export quality. Nevertheless, it is conceptually possible that presence of foreign firms (i.e., the FDI) affects the export unit value. This is possible as FDI tends to flow into industries where the export unit value is high. To accommodate for possible endogeneity of foreign presence, we simultaneously estimate equation (16), which is a function of the domestic aggregate demand ($\tilde{\Phi}$), the wage rate (*w*), and the fixed cost of production (*f*). Accordingly, we operationalise equations (14) and (16) by using the following simultaneous equation model[10].

$$\ln(\mathrm{v}_{jt}) = c_0 + c_1 t + c_2 \ln(w_{jt}) + c_3 \ln(k_{jt}) + c_4 \gamma_{jt} + \varepsilon_{jt} \qquad (17)$$

$$\gamma_{jt} = d_0 + d_1 t + d_2 ln(w_{jt}) + d_3 ln(k_{jt}) + \eta_{jt} \qquad (18)$$

where v_{jt} is the export unit value (total export value divided by the total export quantity) of industry *j* and time *t*; *k* is the average fixed assets of the industry; *cs* and *d*s are unknown population regression coefficients; and $\mathcal{E}$ and η are two correlated error terms that are jointly distributed as follows:

$$\binom{\varepsilon}{\eta} \sim N\left[\mathbf{0}, \begin{pmatrix} \Sigma_{11}^2 & \Sigma_{21} \\ \Sigma_{21} & \Sigma_{22}^2 \end{pmatrix}\right]$$

Equations (17) and (18) form a seemingly unrelated regression (SUR) model, where foreign presence (*γ*) and export unit value (*v)* are the dependent variables. Note that the industry-time variations are utilized to identify the model. In equations (17) and (18), we capture the aggregate demand in domestic and export markets by means of log-linear time-

[10] The empirical model here is motivated by the theoretical model with heterogenous firms. Nevertheless, for the purpose of illustrating the imapct of FDI on firm export product quality, a theoretical model with representative firms will achieve the same goal. We thank the reviwer for pointing this out.

trends (i.e., $ln\Phi_{jt} = \theta_0 + \theta_1 t$ and $ln\widetilde{\Phi}_{jt} = \theta_2 + \theta_3 t$).[11] The ice-berg trading cost (τ) is treated as constant because this cost is not expected to change over our sample period of 2005 to 2007.[12]

In order to capture the industry fixed costs in domestic and foreign markets, we make use of log-linear relationships with respect to the average industry capital stock as follows: $ln\text{f}_{jt} = \theta_4 + \theta_5 lnk_{jt}$ and $ln\text{f}_{xjt} = \theta_6 + \theta_7 lnk_{jt}$, where the θs are the associated coefficients. Fixed assets, such as the production plants and assembly lines, are the main components of the fixed cost of production. For example, the fixed cost in the shoe manufacturing industry is likely to be less than the fixed cost in the heavy machinery industry. However, the average industry fixed assets in the shoe manufacturing industry are not surprisingly lower than those of the heavy machinery industry. The industry average fixed assets can also be viewed as a proxy for the average firm size in the industry, which affects the fixed cost of exporting.

4. The Data

The empirical analysis presented in this paper is based on industry level data from China's manufacturing sector over the 2005 to 2007 period[13]. The data are sourced from China's National Bureau of Statistics (NBS) and the UN Comtrade database.

The NBS provide firm level data that is used to construct the industry level wage rates (*w*), fixed assets (*k*), and foreign presence (γ) variables. Specifically, the firm level data were classified into four digit industries according to China's national industry classification method. We first converted China's national industry classification into the international standard industrial classification for all economic activities. We then calculated foreign presence as the share of the output of foreign-invested firms in the four digit industries. In addition, we also distinguished between foreign presence originating from the Hong Kong, Macau, and Taiwan (HMT) and from non-HMT regions. This allowed us to separately

[11] The specifications take into account the fact that the aggregate demand in domestic and export markets changes over time. In our empirical exercise, we also use the GDP to capture the aggregate demand.

[12] One factor that affects the variable trading cost is the geographical distance, which does not vary across time. In addition, even though different export markets will have different variable trading costs (due to variations across geographical locations), we assume that firms in each industry, on average, do not systematically export to different markets and hence the aggregate variable trading costs, on average, remain the same across industries.

[13] Even though there are firm-level data available, the unavailability of key variable, namely the export product quality, makes it infeasible to directly estimate the impact of FDI presence on export quality upgrading at the firm level. Therefore, we aggregate to the industry level, where we observe the export unit value that can be used to proxy for the export quality. Future research can try to identify this impact at the firm level. We thank the reviewer for pointing this out.

estimate the impact of FDI (i.e., the presence of foreign firms) originating from the HMT and non-HMT regions on export upgrading in China's manufacturing sector. Owing to the extent of cultural differences, foreign investment in China originating from the HMT region is viewed as fundamentally different from non-HMT regions.[14]

The NBS dataset reports only the total salary expenses and number of employees for each firm. This information was used to calculate the average annual wage paid by each firm. We then calculated the mean of the firm average wage in a four-digit industry. The natural logarithm of this variable, ln(w), appears in our SUR model. Similarly, we calculated the average of firm net fixed assets in a four-digit industry. The natural logarithm of this variable, ln(k), appears in equations (17) and (18). The wage rates and net fixed assets values were deflated to 2005 prices, respectively, using the producer price index and fixed assets investment index.

The export unit value (v) was constructed from the data sourced from the UN Comtrade. The original commodity level data were organised in the Harmonization System 2002 (HS 2002) classification. Using the corresponding table available at the United Nations Statistics Division,[15] we converted the HS 2002 classification into the CPC Ver.1.1 classification, which was then converted into the ISIC Rev.3.1, and finally to the ISIC Rev.3. The UN Comtrade data report the export value and export quantity (net weight).[16] The unit value was calculated as the ratio of the export value to the export quantity. The export values that were in US dollars were converted into Chinese Yuan using the nominal exchange rate (sourced from World Development Indicators at the World Bank) and then deflated to 2005 prices using the producer price index from China's NBS.

--- Insert Table 1 about here ---

The industry level data used in this paper covers 92 four-digit industries over three years (2005 to 2007). Table 1 presents the summary statistics. There is lots of variation in the data. Some industries are heavily foreign-invested and both the HMT and non-HMT regions account for significant foreign presence in China. Empirical results based on SUR are presented and discussed in section 5.

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[14] A good analysis of China's FDI polices and priorities can be found in Wang and Wei (2008) and Sun (2009).

[15] http://unstats.un.org/unsd/cr/registry/regot.asp

[16] Note a possible measurement issues here. In some industries, for example in the case of food manufacturing, the optimal quantity produced is based on the weight or volume of the product but this does not apply to all industries. For example, in the case of the car manufacturing industry, firms do not make decisions on optimal quantity produced based on the weight.

5. Empirical Results

The estimated results are presented in Table 2, where the top panel reports the regression results for the export unit value equation (i.e., equation 17), the middle panel reports the regression results for the foreign presence (i.e., equation 18), and the bottom panel presents the relevant diagnostic testing results.

--- insert Table 2 about here ---

The results presented in Table 2 suggest that China's export unit value is declining over time, which appears to be consistent with real life where most manufacturing sector goods (e.g., the electronic products, clothing and footwear) imported from China and sold in Western countries (e.g., Australia and the US) are declining in price. The decline in China's export unit value is most likely driven by technological progress, which has resulted in a decrease in marginal cost of production.

Table 2 shows that the industry average wage rate has a positive and statistically significant impact on the industry export unit value. As the wage rate is an important component of the marginal cost of production, it is not surprising that an increase in the wage rate increases the export unit value (i.e., the export price). The impact of the industry average fixed assets (k) on export unit value is statistically insignificant at the five per cent level, suggesting that fixed assets do not exert significant impact on the industry export price.

The estimated coefficient of foreign presence (γ) in equation (17) is the main focus of our empirical analysis. As shown in equation (15), the impact of foreign presence on industry export quality can be identified from its impact on the industry export price. The estimated results presented in the top panel of Table 2 show that an increase in foreign presence in China's manufacturing sector increases China export unit value (and hence the industry export quality). It is, however, interesting to note that an increase in foreign presence originating from HMT region has a relatively large impact on China's export unit value (see the results presented in column 3 of Table 2) – the estimated coefficient in the case of FDI originating from HMT region is 4.8697 whereas the corresponding value for the impact of FDI from non-HMT region is 2.6468. The estimated results are highly significant.

We now turn our attention to the estimated results presented in the middle panel of Table 2, where foreign presence is the dependent variable. These results suggest that an increase in the wage rate leads to a significant increase in foreign presence in China's manufacturing sector. However, it is interesting to note that the increase in the wage rate leads to a larger increase in foreign presence originating from the non-HMT region (see the results presented in column 2 of Table 2). An increase in the wage rate can be viewed as an increase in human capital. It is well-known that human capital is an important determinant of FDI and hence the presence of foreign firms. However, the average industry wage in China's manufacturing sector appears to be relatively less important to foreign firms originating from the HMT region (the estimated coefficient in column 3 of Table 2 is insignificant).

Foreign presence in China's manufacturing sector exhibits a slightly declining time trend, which is only marginally significant at the five per cent level (and this effect is insignificant when foreign presence is measured by the output share of foreign-invested firms originating from the HMT region in column 3). The estimated coefficient of the fixed assets, which is a proxy for the fixed cost of production, is negative and significant, suggesting that an increase in the fixed cost of production prevents FDI inflows, *ceteris paribus*.

In summary, the results presented in Table 2 suggest that an increase in foreign presence results in an increase in China's export unit value (and hence the industry export quality). This result continues to hold when we distinguish between foreign presence originating from non-HMT and HMT regions, respectively, in columns 2 and 3 of Table 2. We can therefore conclude that foreign presence in China's manufacturing sector is contributing to export quality upgrading.

5.1 Robustness check

In order to establish robustness of our empirical results, equations (17) and (18) were re-estimated using the share of (i) assets of foreign-invested firms within the industry, (ii) employment of foreign-invested firms within the industry, and (iii) the number of foreign firms within the industry. The SUR estimation results, presented in Table 3, are qualitatively similar to those presented in Table 2. It can therefore be argued that our estimated results are robust to alternative measures of foreign presence.

--- insert Table 3 about here ---

In equations (17) and (18), we attempt to capture the aggregate demand in domestic and foreign markets by a log-linear time trend. In order to check whether or not our empirical findings are sensitive to this assumption, we re-estimated equations (17) and (18) using China's real GDP as a proxy for aggregate demand in the domestic market and the world real GDP (excluding China) as a proxy for aggregate demand in the foreign market. The real GDP data were sourced from the World Development Indicators, and are in constant 2010 US dollars. The results presented in the top panel of Table 4 show that foreign presence in China's manufacturing sector has a positive and statistically significant impact on China's export unit value and this result continues to hold for foreign presence originating from both the HMT and non-HMT regions. Of course, the estimated values change but it is clear that our main empirical result is also robust to an alternative measure of aggregate demand.

6. Conclusion and Policy Implications

Using a Melitz-type theoretical model, we show that the industry export quality is affected by the presence of foreign firms within the industry. We also show that there is a direct relationship between the industry export quality and industry export price. As the industry export price can be approximated by the industry export unit value, our theoretical result provides a rigorous justification for several empirical studies that use export unit value as a proxy for export quality.

In the second part of this paper, we convert the structural relationship between foreign presence and export quality into a system of simultaneous equations, which is appropriate because foreign presence can be regarded as an endogenous variable. The industry average wage rate and average fixed assets along with a time trend are also included in the model, which is estimated using industry level panel data for the 2005 to 2007 period from China's manufacturing sector. While using the industry export unit value as a proxy for industry export quality, the model is estimated by the seemingly unrelated regression (SUR) technique. The empirical results show that foreign presence in China's manufacturing sector makes a positive and statistically significant impact on the industry export quality. This result continues to hold when we distinguish between foreign presence originating from the Hong Kong, Macau and Taiwan (HMT) and non-HMT regions. We find that foreign presence originating from the HMT region leads to a much larger increase in China's manufacturing sector export quality. The main result is found to be robust with respect to alternative measures of foreign presence in China's manufacturing sector as well as to an alternative measure of aggregate demand. Our empirical results also suggest that an increase in industry average wage leads to a significant increase in the industry export quality.

At present, the Chinese firms are not known for exporting high quality products. The main attraction of the Chinese products is cheaper price. With continuing growth in the Chinese economy, the focus is slowly shifting towards the export of high value-added products and hence more attention needs to be paid to product quality. The policy makers in China are already taking steps to transform the Chinese economy from an export oriented economy to a domestic consumption based economy. The next step in China's economic transformation is the shift towards the production of higher quality products. In order to succeed both policy makers and the Chinese consumers (by insisting on higher quality) would have to play their role.

Acknowledgments

The authors are extremely grateful to an anonymous reviewer for very detailed comments and suggestions on an earlier draft. However, the authors are responsible for all remaining errors and omissions.

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Table 1: Summary Statistics

Variables	Observations	Mean	Std. Dev.	Min	Max
ln(*v*)	276	3.3944	1.8620	-1.3758	8.6110
ln(*w*)	276	2.8151	0.2178	2.2603	3.5712
ln(*k*)	276	9.9866	0.9726	8.4100	13.2565
Foreign presence (total) (γ)	276	0.3559	0.2036	0	0.9485
Foreign presence from non-HMT regions	276	0.2309	0.1494	0	0.7992
Foreign presence from HMT region	276	0.1345	0.0996	0	0.4589

Table 2: SUR Estimation Results									
	[1]			[2]			[3]		
	Coef.	z	p > z	Coef.	z	p > z	Coef.	z	p > z
Dependent variable: Export unit value (ln (*v*))									
t	-0.5667	-5.1	0.000	-0.5831	-5.1	0.000	-0.6111	-5.49	0.000
ln (*w*)	5.2679	11.52	0.000	5.3462	11.23	0.000	5.8026	13.01	0.000
ln (*k*)	0.0853	0.93	0.355	0.0158	0.17	0.865	0.0923	0.99	0.323
γ	2.5491	6.06	0.000	2.6468	4.48	0.000	4.8697	5.69	0.000
Constant	-12.0525	-9.99	0.000	-11.2506	-9.04	0.000	-13.2854	-10.69	0.000
Dependent variable: Foreign presence (γ)									
t	-0.0311	-1.97	0.049	-0.0238	-2.05	0.04	-0.0072	-0.92	0.36
ln (*w*)	0.2830	4.47	0.000	0.2430	5.24	0.000	0.0384	1.22	0.221
ln (*k*)	-0.0491	-3.81	0.000	-0.0210	-2.23	0.026	-0.0271	-4.26	0.000
Constant	0.1115	0.65	0.518	-0.1955	-1.55	0.122	0.3116	3.64	0.000
Equation	Obs	R^2	χ^2	Obs	R^2	χ^2	Obs	R^2	χ^2
ln (*v*)	275	0.4667	240.64	275	0.4366	213.14	275	0.4593	233.56
γ	275	0.0862	25.95	275	0.0916	27.73	275	0.0633	18.57

Notes: Column [1] shows the regression results when foreign presence is measured by the output share of all foreign-invested firms in China; Column [2] shows the regression results when foreign presence is measured by the output share of foreign-invested firms from the non-HMT region; and Column [3] shows the regression results when foreign presence is measured by the output share of foreign-invested firms from the HMT region. HMT stands for Hong Kong, Macau and Taiwan.

Table 3: SUR Estimation Results with Alternative Measures of FDI									
	[1]			[2]			[3]		
	Coef.	*z*	*p* > *z*	Coef.	*z*	*p* > *z*	Coef.	*z*	*p* > *z*
Dependent variable: Export unit value (ln (*v*))									
t	-0.6176	-5.51	0.000	-0.5879	-5.54	0.000	-0.4980	-4.73	0.000
ln (*w*)	5.6141	12.39	0.000	5.1562	11.81	0.000	4.7966	10.98	0.000
ln (*k*)	0.0878	0.93	0.351	0.1893	2.08	0.037	0.2277	2.54	0.011
γ	2.3754	5.34	0.000	3.4040	7.96	0.000	5.5901	8.8	0.000
constant	-12.9216	-10.42	0.000	-12.8598	-11.04	0.000	-12.5305	-11.02	0.000
Dependent variable: Foreign presence (γ)									
t	-0.0120	-0.79	0.429	-0.0171	-1.14	0.253	-0.0265	-2.69	0.007
ln (*w*)	0.1580	2.6	0.009	0.2448	4.09	0.000	0.2134	5.41	0.000
ln (*k*)	-0.0537	-4.35	0.000	-0.0673	-5.54	0.000	-0.0479	-5.97	0.000
constant	0.4856	2.93	0.003	0.3207	1.97	0.049	0.1364	1.27	0.205
Equation	Obs	R^2	χ^2	Obs	R^2	χ^2	Obs	R^2	χ^2
ln (*v*)	275	0.4523	227.15	275	0.5088	284.8	275	0.5282	307.93
γ	275	0.069	20.37	275	0.1165	36.27	275	0.1511	48.94

Notes: In Column [1], FDI is measured as the share of the assets of foreign-invested firms in the four-digit industries; In Column [2], FDI is measured as the share of the employment in foreign-invested firms in the four-digit industries; In Column [3], FDI is measured as the share of number of foreign-invested firms in the four-digit industries.

Table 4: SUR Estimation Results with Alternative Measures of Aggregate Demand									
	[1]			[2]			[3]		
	Coef.	*z*	*p* > *z*	Coef.	*z*	*p* > *z*	Coef.	*z*	*p* > *z*
Dependent variable: Export unit value (ln (*v*))									
GDP	-15.4714	-5.09	0.000	-15.9188	-5.09	0.000	-16.6853	-5.48	0.000
ln (*w*)	5.2635	11.51	0.000	5.3414	11.22	0.000	5.7985	13	0.000
ln (*k*)	0.0857	0.93	0.353	0.0162	0.17	0.862	0.0927	0.99	0.321
γ	2.5518	6.06	0.000	2.6508	4.49	0.000	4.8729	5.7	0.000
constant	49.1547	4.13	0.000	51.7280	4.24	0.000	52.7235	4.42	0.000
Dependent variable: Foreign presence (γ)									
GDP	-0.2485	-1.98	0.048	-0.1896	-2.06	0.039	-0.0574	-0.92	0.356
ln (*w*)	0.2835	4.48	0.000	0.2433	5.25	0.000	0.0385	1.23	0.22
ln (*k*)	-0.0491	-3.82	0.000	-0.0211	-2.23	0.025	-0.0271	-4.26	0.000
constant	0.3934	1.92	0.054	0.0195	0.13	0.896	0.3766	3.72	0.000
Equation	Obs	R^2	χ^2	Obs	R^2	χ^2	Obs	R^2	χ^2
ln (*v*)	275	0.4665	240.51	275	0.4364	213.01	275	0.4590	233.38
γ	275	0.0864	26	275	0.0918	27.78	275	0.0633	18.59

Notes: Column [1] shows the regression results when foreign presence is measured by the output share of all foreign-invested firms in China; Column [2] shows the regression results when foreign presence is measured by the output share of foreign-invested firms from non-HMT regions; and Column [3] shows the regression results when foreign presence is measured by the output share of foreign-invested firms from the HMT region. HMT stands for Hong Kong, Macau and Taiwan.