Working Paper No. 550

Foreign Direct Investment and Product Quality in Host Economics

Sajid Anwar | Sizhong Sun

January 2016

Stanford
Center for International Development

John A. and Cynthia Fry Gunn Building | 366 Galvez Street, Stanford, CA 94305-6015

Foreign Direct Investment and Product Quality in Host Economies

Sajid Anwar
School of Business
University of the Sunshine Coast
Maroochydore DC, QLD 4558, Australia
Email: SAnwar@usc.edu.au
Tel: 61-7-5430-1222
&
Sizhong Sun
College of Business Law & Governance
James Cook University
Townsville, QLD 4811, Australia
Email: Sizhong.Sun@jcu.edu.au
Tel: 61-7-4781-1681

Abstract

This paper examines, both theoretically and empirically, how the presence of foreign-invested firms (i.e., foreign direct investment, FDI) affects the product quality of domestic firms. In a monopolistically competitive market with Melitz (2003) style heterogeneous firms, we show that, if consumers derive higher utility from consuming higher quality products, then despite the fact that product quality is not directly observable, one can identify the impact of FDI on product quality from its impact on firm revenue and cut-off capability. We show that the presence of foreign-invested firms affects the product quality of domestic firms through (i) a direct channel via productivity spillovers in both goods and quality production and (ii) an indirect channel via its impact on cut-off capability. The overall impact of FDI on the product quality of domestic firms depends on the relative strengths of these two contrasting effects. In the second part of the paper, using firm level data, we estimate this impact in China's beverage manufacturing industry. We find that, despite the presence of positive productivity spillovers from foreign-invested to domestic firms in goods production, a one percent increase in foreign presence decreases the expected product quality of domestic firms by more than ten percent.

Key Words: FDI, product quality, monopolistic competition, spillovers, China

JEL Codes: F12; F21; F23; L15

1. Introduction

Product quality is important to firms because it helps to maintain customer satisfaction and loyalty. Higher quality goods also contribute towards good reputation and brand recognition and expansion. For policy makers, product quality is also important in that it plays an important role in industry development. Owing to its importance, a number of studies have focused on different aspects of product quality. Flam and Helpman (1987) consider the choice of product quality within the context of a North-South model. North produces high quality differentiated goods, whereas South produces low quality differentiated goods. They show that a change in income distribution can lead to a shift in the range of goods produced by each country. In a very interesting paper, Sutton (2007) shows that trade liberalization can help a firm to shift to producing higher quality products. Inspired by the work of Melitz (2003) and Sutton (2007), Kugler and Verhoogen (2012) propose a model where product quality, output and input choices are endogenous. They argue that quality differences in inputs and outputs can account for the empirical fact that large firms charge a higher price for their products and also pay more for the inputs used.

Based on the work of Sutton (2007), among others, it can be argued that product quality is also affected by the process of globalisation. The process of rapid globalisation has coincided with an increase not only in the volume of trade in goods and services but also in foreign direct investment (FDI). A large body of the existing literature in the area of international business and international economics, including the early work of Dunning (1993), suggests that FDI-related spillovers can help to improve the quality of goods produced by domestic firms in host economies. Numerous empirical studies appear to confirm the presence of positive FDI-related spillover effects.[1] However, to the best of our knowledge, none of the available studies has formally explored the link between FDI and product quality.

One difficulty in investigating this issue is that product quality is not directly observable. Hence, most existing empirical studies utilise a proxy for quality or infer quality from information on prices and quantities. For example, Hallak (2006) uses export prices as a measure of quality. Khnadelwal (2010) measures product quality by comparing market shares

[1] It is well-known that, through forward and backward linkages, FDI can affect the quality of final goods and/or intermediate good produced by domestic firms in host economies. An excellent discussion of the related issues can be found in, among others, Javorcik (2004), Mayer and Sinani (2009) and Bajgar and Javorcik (2013).

conditional on price. While examining the impact of FDI on export quality, Harding and Javorcik (2012) measure export quality by unit value of exports. Kugler and Verhoogen (2012) use industry level Research and Development (R&D) and advertising spending to sales, suggested by Sutton (2007), as a proxy for the scope of quality differentiation. Crozet, Head and Mayer (2012) rely on expert assessments to measure the quality of French champagne.[2] By examining variations in quality adjusted prices, Johnson (2012) attempts to glean some information on quality.

Different from the existing literature, one important feature of this paper is that we attempt to examine the impact of FDI on the quality of goods produced by domestic firms without explicitly measuring product quality. In doing so, this paper makes two distinct contributions to the existing literature. First, using a theoretical model with Meiltz (2003) type heterogeneous firms, where products are quality differentiated, we show that an increase in the proportion of foreign-invested firms, which can be interpreted as an increase in FDI,[3] affects the quality of goods produced by domestic firms through two channels: (i) a direct channel via productivity spillovers from foreign to domestic firms in both goods and quality production and (ii) an indirect channel via the cut-off capability of firms, which is affected by productivity spillovers. However, the direct and the indirect channels have the opposite effect on product quality. If productivity spillovers are positive then FDI has a positive effect on the quality of goods produced by domestic firms through the direct channel. However, in this case, an increase in foreign presence lowers the cut-off capability for domestic firms, which puts downward pressure on the quality of goods produced by domestic firms by allowing relatively inefficient domestic firms to enter the industry. In other words, in the presence of positive productivity spillovers, the indirect effect is negative.

Second, we show that the impact of FDI on the quality of goods produced by domestic firms can be identified from its impact on observed firm revenue. Given that consumers derive higher utility from consuming higher quality products, firm profit maximization yields a relationship between FDI and unobserved product quality and FDI and

[2] While examining the impact of competition and debt financing on product quality in the supermarket industry, Matsa (2011a, 2011b) measures quality as product availability in the store. The quality of nursing homes is measured by a public reporting system (Werner et al., 2012) and hospital quality is inferred from patient choices (Romley and Goldman, 2011). Coad (2009) captures product quality by different product attributes. Chen and Rizzo (2012) use a physician survey to measure the quality of antidepressants. FDI and advertising can also signal product quality (Katayama and Miyagiwa, 2009 and Linnemer, 2012).

[3] In this paper, we use "foreign presence" and "FDI" interchangeably.

firm revenue, which is observable. It is these relationships that allow us to estimate the product quality impact of FDI without explicitly measuring product quality. Using firm level data from China's beverage manufacturing industry from 2005-2007, we estimate parameters of our structural model, which enables us to calculate the marginal impact of FDI on product quality. Our empirical analysis reveals that FDI has a negative and statistically significant affect on product quality of domestic firms in China's beverage manufacturing industry.

In our empirical analysis, we also distinguish between FDI in China originating from (i) Hong Kong, Macau and Taiwan (HMT) and (ii) non-HMT regions. FDI from HMT exhibits characteristics different from the non-HMT FDI. On the one hand, the HMT FDI comes from a region with a cultural background similar to that of domestic firms while, on the other hand, the non-HMT FDI generally entails more advanced technology. The empirical results suggest that the effect of an increase in the proportion of foreign-invested firms from HMT on the quality of goods produced by firms in China's beverage manufacturing industry is very different from that of the non-HMT firms because the resulting productivity spillover effect to domestic firms is quite small.

The rest of this paper is structured as follows. A review of related studies is presented in Section 2. A theoretical model, which allows one to establish the link between FDI and product quality is developed in Section 3. Section 4 discusses the empirical strategy utilised to estimate the structural parameters of the model. Section 5 discusses the data. The empirical results are presented and discussed in Section 6 and Section 7 contains some concluding remarks.

2. Review of Related Literature

In recent years a large number of theoretical and empirical studies have considered different aspects of product quality. Using non-homothetic preferences, the issue of gains from trade has been re-examined when goods are quality differentiated. It has been suggested that higher income countries produce higher quality goods. Based on models of firm heterogeneity, more recent studies have shown that firms that pay higher wages also produce higher quality products.

Copeland and Kotwal (1996) argue that, when goods are quality differentiated, there may not be any gains from trade among countries with large differences in income. Murphy and Shleifer (1997) argue that countries with a high level of human capital tend to have a comparative advantage in relatively higher quality goods. Hummels and Klenow (2005) and Khandelwal (2010), among others, suggest that current international trade is characterised by a strong quality dimension. Eswaran and Kotwal (2007) argue that some developing countries, like India, where labour is relatively cheap, tend to produce low quality products at a high cost. They suggest that this situation arises due to monopolistic provision of certain non-traded inputs. Accordingly, trade liberalization, by reducing the cost of intermediate inputs, can enhance product quality. Verhoogen (2008) shows that quality upgrading links trade and wage inequality in developing countries.

As product quality is unobservable, most empirical studies utilise a proxy for product quality. Using an export price as an indicator of quality, Hallak (2006) empirically examines the link between trade and product quality. Alcalá (2009) considers the link between comparative advantage and product quality. It is argued that lower quality is related to lower wages. Alcalá suggests that average quality within an industry is an increasing function of the wage rate. In a significant departure from previous studies, using an innovative measure of quality that involves information on both prices and quantities, Khandelwal (2010) confirms the results of earlier studies that have shown that higher income countries export higher quality goods.[4] Using the same measure of quality, the empirical work of Amiti and Khandelwal (2012) suggests that import competition can affect quality upgrading.

Dana and Fong (2011) investigate the relationship amongst product quality, reputation and market structure. Baldwin and Harrigan (2011) develop a model where competitiveness of firms depends on their quality-adjusted price. They find that, in equilibrium, higher quality goods are relatively more costly to produce but also more profitable. Lu, Ng and Tao (2012) show that outsourcing can lead to lower product quality, which in turn can be mitigated by contract enforcement. While investigating the impact of legal institutions on product quality, Essaji and Fujiwara (2012) measure product quality as the average unit price of goods and find that a country with better contracting institutions is more capable of producing better quality products. Martin (2012) finds a positive impact from trade costs on free on board unit export value, which can be explained by higher product quality. Using a measure of quality differentiation based on R&D spending suggested by Sutton (2007), Kugler and Verhoogen

[4] Using a theoretical model, Antoniades (2015) derives a similar result.

(2012) investigate the impact of quality differences in inputs and outputs on the price-plant size correlation.[5]

So far, only a few studies have explored the issue of product quality in China. While identifying the mechanisms underlying the evolutionary process of industrial development in Wenzhou (China), Sonobe, Hu and Otsuka (2004) find that, upon entry into an industry, manhy firms initially produce poor quality products. However, after some time, firms are found to be working towards quality upgrading. Yu (2010) argues that democratization in the exporting country can improve product quality. While investigating China's export sophistication, Xu (2010) measures the quality of China's exports by means of a relative price index. Manova and Zhang (2012) find that firms in China that are relatively more successful in exporting use higher quality inputs to produce higher quality products. Furthermore, Chinese firms export different quality products to different markets.

In summary, the earlier theoretical studies have not formally explored the connection between FDI and quality. In addition, earlier empirical studies have used unit values or unit-valued-based measures of product quality. This paper uses a theoretical model to establish a link between FDI and product quality. Within the context of a Melitz (2003)-type model, we show that, through two contrasting channels, an increase in the proportion of foreign-invested firms can affect the product quality of domestic firms. Using firm level data from China's beverage manufacturing industry, we estimate the structural parameters of the model. This allows us to determine the impact of variations in FDI on product quality without explicitly measuring quality.

3. The Model

In this section, using a general equilibrium model with Melitz-type heterogeneous firms, we establish a link between FDI and the optimal quality of goods produced by domestic firms. On the demand side, a representative consumer has the following constant elasticity of the substitution (CES) utility function:[6]

---

[5] Other related studies include Linder (1961), Bardhan and Kletzer (1984), Falvey and Kierzkowski (1987), Grossman and Helpman (1991), Schott (2004), Helpman (2006), Helpman, Melitz and Rubinstein (2008), Choi, Hummels and Xiang (Y. C. Choi et al., 2009), Hallak (2010), Kirchler, Fischer and Hölzl (2010), Fajgelbaum, Grossman, and Helpman (2011) and Feenstra and Romalis (2014).

[6] Most related studies (for example Crozet, Head and Mayer, 2012; Hallak, 2010, 2006; Kugler and Verhoogen, 2012) use a similar quality augmented CES utility function. The CES utility function used in this paper is slightly different from the one used by Kugler and Verhoogen, and others, in that the exponents of quality and quantity are not identical. This functional form is chosen merely to simplify the empirical calculations. Because

$$U=\left[\int_{\omega\in\Omega} Z(\omega)^{1-\rho}\, q(\omega)^{\rho}\, d\omega\right]^{\frac{1}{\rho}}$$

where ω is indexes the products; Ω is the set of all available products in the industry; q is the quantity of each product; and Z represents a product quality index.

Following Kugler and Verhoogen (2012), among others, product quality can be interpreted as product attributes that the representative consumer values. In other words, the consumer derives a higher level of utility from consuming higher quality products, *ceteris paribus*. All products are substitutes to each other $(\text{i.e., } 0<\rho<1)$ and have a constant elasticity of substitution of $\frac{1}{1-\rho}$. Consumer utility maximisation yields the following Marshallian demand function:

$$q=\Phi Z p^{\frac{1}{\rho-1}} \tag{1}$$

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

Each firm takes Φ as given as they are small in size relative to the industry. Accordingly, the impact of a change in the output of each firm on Φ is negligible. Equation (1) suggests that there is a positive relationship between product quality and demand.

3.1 Domestic market

On the production side, the industry consists of a continuum of firms, where γ is the proportion of foreign-invested firms $(0\le\gamma\le1)$.[7] In the rest of this paper, an increase in γ is interpreted as an increase in foreign presence. Upon entry into the industry, each firm incurs a fixed entry cost (f_e), which is f_e^d if the firm is domestic and f_e^f if it is a foreign-invested firm. The fixed entry cost allows firms to participate in a capability draw. The capability,

quality enters as a shift parameter in the utility function, its exponent does not play any part in any analytical result.

[7] In order to ensure consistency between the theoretical and empirical parts of this paper, we divide all firms into two categories: domestic and foreign-invested. Firms with non-zero (and up to 100 percent) foreign ownership are foreign-invested, whereas firms with zero percent foreign ownership are domestic firms. The empirical part of this paper is based on data from China where FDI mostly takes the form of partnerships with foreign firms.

denoted by λ, is drawn from an exponential distribution, with the cumulative distribution function:[8]

$$G(\lambda)=\begin{cases}1-e^{\lambda}; & \lambda \geq 0 \\ 0; & \lambda < 0\end{cases} \tag{2}$$

where we normalize the units of output such that the mean of the exponential distribution is 1.

If the capability of a firm is below a certain level, which will be derived later, then the firm exits the industry immediately. Each of the remaining firms produces a single variety of a differentiated product in each period. In stage one, each firm selects its investment in product quality. For example, firms decide their investment in (i) training quality control personnel, (ii) research and development that improves product quality, and (iii) quality control equipment, etc.

In stage two, firms set product price to maximize their per-period profit. During the production process, firms combine one unit of labour with v units of an intermediate input to produce s units of output. This can be described by the production function $F(l) = sl$, where l is labour used and s is labour productivity.[9] Labour productivity depends on firm capability. As we aim to focus on the link between foreign presence and quality of goods produced by domestic firms in host economies, we model firm productivity as follows:

$$s=\begin{cases}\lambda Z^{-\mu}; & \text{if foreign-invested firm} \\ \lambda Z^{-\mu}\,\mathrm{e}^{\alpha\gamma}; & \text{if domestic firm}\end{cases}$$

where the parameter α captures the size and the sign of the FDI-related productivity spillover effect.

A positive value of this parameter $(\text{i.e., } \alpha > 0)$ implies that the presence of foreign-invested firms enhances the productivity of domestic firms in host economies. On the other hand, $\alpha < 0$ suggests the presence of a negative productivity spillover effect to domestic firms. Firm productivity also depends on product quality (Z). Since it is relatively more

[8] The seminal work of Melitz (2003) and a number of related studies, including the recent work of Melitz and Redding (2012), assume that firm capability/productivity is drawn from a Pareto distribution. In this paper, we make use of an exponential distribution because it simplifies our empirical analysis.

[9] Note that labour and the intermediate input are the variable costs to firms.

difficult to produce high quality products, the parameter μ is positive and is assumed to be sufficiently less than unity.[10]

A large body of the existing literature in the area of international business and international economics supports the presence of positive productivity spillovers from foreign to domestic firms.[11] In the case of China, which is the focus of our empirical exercise in section 4, a number of studies have reported the presence of positive FDI-related productivity spillovers.[12]

Given that $\frac{1}{s}$ units of labour and $\frac{v}{s}$ units of the intermediate input are required to produce one unit of output, the marginal cost of production (MC) equals $\frac{w}{s}$, where w is the sum of wage rate and the intermediate input cost per unit of output. The per-period profit of a firm can be written as follows:

$$\pi = (p - w/s)q - f - C(I)$$

where π is per period profit; p is the price that firm charges; and I is the firm's investment in quality production.

We assume that the cost of investment in quality is quadratic; i.e., $C(I) = (1/2)\beta I^2$, and thus investment in quality production exhibits diminishing returns. In stage two, the firm sets a price that maximizes its per period profit, as follows:

$$\max_{\{p\}} \pi = \left(p - \frac{w}{s}\right) \Phi Z p^{1/(\rho - 1)} - f - C(I)$$

The above expression for profit is derived by substituting equation (1), i.e., the demand function, into the per period profit function. The first order condition (FOC) that maximises per period profit is as follows:

[10] This assumption also ensures that an improvement in product quality increases firm profit and the marginal productivity of capital in quality production is positive. See equations (3) and (4).

[11] For example, see Meyer and Sinani (2009) and references therein.

[12] Using firm level data from 1998 to 2005, Lin, Liu and Zhang (2009) find that domestic firms in China benefit from significant vertical spillover effects. Other recent studies that report positive productivity spillovers to domestic firms in China include Sun (2011) and Xu and Sheng (2012).

$$p=\frac{w}{\rho s}=\begin{cases}\frac{wZ^{\mu}}{\rho\lambda}, \text{ if foreign-invested firm}\\ \frac{wZ^{\mu}}{\rho\lambda e^{\alpha\gamma}}, \text{ if domestic firm}\end{cases}$$

The above conditions suggest that firms charge a higher price for higher quality products, which is consistent with empirical results presented by, among others, Johnson (2012) and Manova and Zhang (2012). Substituting this FOC into the per period profit function, the optimal per period profit $\left(\text{i.e., } \pi^*\right)$ can be derived as follows:

$$\pi^* = \frac{1-\rho}{\rho^{\rho/(\rho-1)}}\Phi Z^{1-\rho(\mu+1)/_{1-\rho}}\left(\frac{w}{s}\right)^{\rho/(\rho-1)} - f - C(I) \quad (3)$$

In stage one, each firm chooses its investment in quality production to maximize its life time profit. The product quality production function is as follows:

$$Z = (\tilde{s}k)^{\frac{1-\rho}{1-\rho(\mu+1)}} \quad (4)$$

where k is the capital stock used in quality production[13], and $\tilde{s}$ denotes the productivity of capital k in quality production.

We allow $\tilde{s}$ of domestic firms to be affected by the presence of foreign-invested firms, namely $\tilde{s}$ takes the following functional form:

$$\tilde{s}=\begin{cases}\lambda, \text{ if foreign-invested firm}\\ \lambda e^{\tilde{\alpha}\gamma}, \text{ if domestic firm}\end{cases}$$

Note that we do not impose any a priori restriction on the sign of $\tilde{\alpha}$. If $\tilde{\alpha} > 0$, the presence of foreign-invested firms generates positive spillovers to domestic firms in quality production. Quality production also depends on firm capability. Specifically, firms with higher capability produce higher quality goods.

As indicated earlier, μ is positive but sufficiently less than unity so that $1-\rho(\mu+1)$ is positive. However, $1-\rho(\mu+1) > (1-\rho)$ and hence quality production is subject to

[13] Note if the quality production function is in a more general form, namely $\bar{Z} = g(\tilde{s}k)$ where $g(\cdot)$ is an monotonically increasing function of the effective capital stock $(\tilde{s}k)$, then we can redefine the quality index as $Z = [g^{-1}(\bar{Z})]^{\frac{1-\rho}{1-\rho(\mu+1)}} = (\lambda k)^{\frac{1-\rho}{1-\rho(\mu+1)}}$ through appropriately choosing a benchmark, which leads to equation (4).

increasing returns to scale with respect to k.[14] In addition, a firm's investment in quality production exhibits an inter-temporal nature. For example, quality control equipment purchased in the current period can also be used for production in the future. The capital stock of each firm evolves as follows:

$$k' = \sigma k + I \tag{5}$$

where k' represents the next period capital stock and $1-\sigma$ is the rate of depreciation $(0<\sigma<1)$.

The firm's problem is to choose investment to maximize its life time profits. The associated Bellman equation is as follows:

$$v(k) = \max_{\{I\}} \pi^* + \delta v(k') \text{ subject to } k' = \sigma k + I$$

where 1-δ denotes the exogenous probability of exit and δ is also used as the discount rate.

The FOC that maximises profit is as follows:

$$\frac{\partial v}{\partial k'} = \frac{\beta I}{\delta}$$

Using the envelope theorem, we get

$$\frac{\partial v}{\partial k} = N + \sigma\beta I$$

where $N \equiv \frac{1-\rho}{\rho^{\rho/(\rho-1)}} \Phi \left(\frac{w}{s}\right)^{\rho/(\rho-1)} \tilde{s}$.

We then shift the last partial derivative one period forward, and combine it with the FOC and equation (5) to obtain the optimal level of investment as follows:

$$I = \frac{\delta N}{\beta(1-\sigma\delta)}$$

In the steady state, $k' = k = \frac{\delta N}{\beta(1-\sigma)(1-\sigma\delta)}$. Accordingly, the optimal level of product quality is as follows:

[14] Even though the quality production function exhibits increasing returns to scale in capital, if we plug equation (4) into equation (3), the optimal profit is linear in capital. In addition, we assume that the cost of investment in quality production is quadratic. Therefore the profit function is concave in I.

$$Z^* = \left[\frac{\tilde{s}\delta}{\beta(1-\sigma)(1-\sigma\delta)} N\right]^{\frac{1-\rho}{1-\rho(\mu+1)}} \tag{6}$$

Note that in equation (6), optimal product quality depends on the preference parameter ρ, which is not surprising as consumers derive higher utility from consuming higher quality products. The relationship between product quality and the consumer preference parameter implies that consumers in different markets (for example domestic and export markets) may have different preferences and hence product quality may vary across domestic and export markets, which also affects firm revenue in each market. Later, in our empirical exercise, we make use of this implication (i.e., firms provide products of different quality in domestic and export markets) to identify the structural parameters α and $\tilde{\alpha}$.

By substituting equation (6) into (3), the optimal per period profit as a function of firm capability can be derived as follows:

$$\pi^*(\lambda) = \left[\frac{\delta(2-\sigma\delta-\delta)}{2\beta(1-\sigma)(1-\sigma\delta)^2}\right]\left[\frac{(1-\rho)^2}{\rho^{2\rho/\rho-1}}\right]\left[\Phi^2 w^{\frac{2\rho}{\rho-1}} s^{\frac{2\rho}{1-\rho}} \tilde{s}^2\right] - f \tag{7}$$

The optimal per period profit, as given by equation (7), is a monotonically increasing function of the capability draw (λ). As $\pi^*(0) = -f < 0$, for both domestic and foreign-invested firms, there exists a cut-off capability such that $\pi^*(\lambda^*) = 0$. Let λ_d^* and λ_f^*, respectively, denote the cut-off capability of domestic and foreign firms. The cut-off capabilities can be derived by setting equation (7) to zero as follows:[15]

$$\lambda_d^* = \left[\frac{2\beta(1-\sigma)(1-\sigma\delta)^2}{\delta(2-\sigma\delta-\delta)}\right]^{\frac{1-\rho}{2}} \frac{(1-\rho)^{\rho-1}}{\rho^\rho} \Phi^{\rho-1} w^\rho e^{-[\alpha\rho+\tilde{\alpha}(1-\rho)]\gamma} f_d^{\frac{1-\rho}{2}} \tag{8}$$

$$\lambda_f^* = \left[\frac{2\beta(1-\sigma)(1-\sigma\delta)^2}{\delta(2-\sigma\delta-\delta)}\right]^{\frac{1-\rho}{2}} \frac{(1-\rho)^{\rho-1}}{\rho^\rho} \Phi^{\rho-1} w^\rho f_f^{\frac{1-\rho}{2}} \tag{9}$$

[15] Note that in equations (8) and (9), the cut-off capability is a function of aggregate demand (Φ), which is a function of the existing mass of both domestic and foreign firms through the aggregate price index. Therefore, from these two conditions, together with the free entry conditions, namely the expected value of entry being equal to the entry cost for both domestic and foreign firms, like Helpman, Melitz and Yeaple (2004), we can solve for the existing mass of both domestic and foreign firms as a function of the unknown entry cost. We can also solve for the cut-off capabilities as a function of the entry cost. Since this paper is not focused on the entry costs, we do not attempt to solve for cut-off capabilities as a function of the entry cost. Later in our empirical exercise, we use time trend/real disposable income to capture the effect of aggregate demand.

Equation (8) suggests that, when the FDI-related productivity spillover effect to domestic firms is positive (i.e., $\alpha\rho+\tilde{\alpha}(1-\rho)>0$ [16]), an increase in foreign presence (i.e., γ) reduces the cut-off capability of domestic firms.[17]

3.2 Export market

In addition to serving the domestic market, firms can also sell their products in the export market. As in the domestic market, demand in the export market can be represented by $\tilde{q}=\tilde{\Phi}\tilde{Z}\tilde{p}^{1/(\tilde{\rho}-1)}$, where tildes are used to denote export market variables. In order to export, firms must incur a fixed entry cost as follows:

$$\tilde{f}_e=\begin{cases}\tilde{f}_e^{\,d}, & \text{if domestic firm}\\ \tilde{f}_e^{\,f}, & \text{if foreign-invested firm}\end{cases}$$

where the subscript *e* denotes entry cost.

As in the domestic market, exporting firms are engaged in a two-step decision making process: in stage one firms decide how much to invest in quality production and in stage two firms set a price that maximizes their per-period profit in the export market. Exporting also involves also involves an iceberg type trading cost (τ).

Like the domestic market equilibrium, we can also work out the optimal export market price and investment in product quality as follows:

$$\tilde{p}=\left(\frac{w\tau}{\tilde{\rho}s}\right)\tilde{Z}^{\mu}=\begin{cases}\left(\frac{w\tau}{\tilde{\rho}\lambda}\right)\tilde{Z}^{\mu}, & \text{if foreign-invested firm}\\ \left(\frac{w\tau}{\tilde{\rho}\lambda e^{\alpha\gamma}}\right)\tilde{Z}^{\mu}, & \text{if domestic firm}\end{cases}$$

$$\tilde{I}=\frac{\delta\tilde{N}}{\beta(1-\sigma\delta)}$$

[16] Note that $\alpha\rho+\tilde{\alpha}(1-\rho)$ is positive when $\alpha>0$ and $\tilde{\alpha}>0$, or even if one of these two parameters is negative but the negative effect is sufficiently small such that the weighted average of α and $\tilde{\alpha}$ (the weights consist of ρ and 1-ρ) is positive.

[17] This result is consistent with Alfaro and Chen (2013). In a different context, where product quality is not explicitly considered, Alfaro and Chen have shown that entry of foreign firms increases the cut-off capability of domestic firms. Within the context of the model used in our paper, an increase in FDI increases the cut-off capability of domestic firms if the FDI-related spillover effect is negative.

where $\tilde{N} \equiv \tilde{\Phi}\left[\frac{\tau-\rho}{\tilde{\rho}^{\frac{\tilde{\rho}}{\tilde{\rho}-1}}}\right]\left(\frac{w}{s}\right)^{\frac{\tilde{\rho}}{\tilde{\rho}-1}}$.

The optimal product quality in and profit from the export market are as follows:

$$\tilde{Z}^* = \left[\frac{\tilde{s}\delta}{\beta(1-\sigma)(1-\sigma\delta)}\tilde{N}\right]^{\frac{1-\tilde{\rho}}{1-\tilde{\rho}(\mu+1)}} \quad (10)$$

$$\tilde{\pi}^*(\lambda) = \left[\frac{\delta(2-\sigma\delta-\delta)}{2\beta(1-\sigma)(1-\sigma\delta)^2}\right]\left[\frac{(\tau-\tilde{\rho})^2}{\tilde{\rho}^{2\tilde{\rho}/\tilde{\rho}-1}}\right]\left[\tilde{\Phi}^2 w^{\frac{2\tilde{\rho}}{\tilde{\rho}-1}} s^{\frac{2\tilde{\rho}}{1-\tilde{\rho}}}\tilde{s}^2\right] - f \quad (11)$$

The optimal profit is a monotonically increasing function of firm capability, which implies a cut-off capability for both domestic and foreign-invested firms in the export market as follows:

$$\tilde{\lambda}_d^* = \left[\frac{2\beta(1-\sigma)(1-\sigma\delta)^2}{\delta(2-\sigma\delta-\delta)}\right]^{\frac{1-\tilde{\rho}}{2}} \frac{(\tau-\tilde{\rho})^{\tilde{\rho}-1}}{\tilde{\rho}^{\tilde{\rho}}} \tau\tilde{\Phi}^{\tilde{\rho}-1} w^{\tilde{\rho}} e^{-[\alpha\tilde{\rho}+\tilde{\alpha}(1-\tilde{\rho})]\gamma} f_d^{\frac{1-\tilde{\rho}}{2}} \quad (12)$$

$$\tilde{\lambda}_f^* = \left[\frac{2\beta(1-\sigma)(1-\sigma\delta)^2}{\delta(2-\sigma\delta-\delta)}\right]^{\frac{1-\tilde{\rho}}{2}} \frac{(\tau-\tilde{\rho})^{\tilde{\rho}-1}}{\tilde{\rho}^{\tilde{\rho}}} \tau\tilde{\Phi}^{\tilde{\rho}-1} w^{\tilde{\rho}} f_f^{\frac{1-\tilde{\rho}}{2}} \quad (13)$$

3.3 The long-run level of FDI presence

In the long run, the free entry condition ensures that the expected value of entry is equal to the cost of entry.[18] In addition, in the steady state, the mass of new entrants equals the mass of firms that exit the industry. The domestic and foreign-invested firms that enter the industry are drawn from the same distribution. Thus the mass of new domestic entrants is equal to that of foreign-invested entrants. Let M_e denote the mass of domestic/foreign-invested entrants, M_d denote the mass of existing domestic firms, and M_f denote the mass of foreign-invested firms. We have the following relationship:

$$M_e\left(1 - G(\lambda_d^*)\right) = (1-\delta)M_d$$
$$M_e\left(1 - G(\lambda_f^*)\right) = (1-\delta)M_f$$

The above equations simply show that the mass of domestic firms that enter the industry equals the mass of domestic firms that exit. The second equation reflects the same relationship in the case of foreign-invested firms. By combining equation (2) with the above relationships, the equilibrium level of foreign presence can be defined as follows:

[18] This condition, together with the cut-off capability conditions, also allows one to solve for the mass of existing domestic and foreign firms as a function of the unknown entry costs. As our aim is to investigate the impact of foreign presence on firm product quality, we do not need to investigate the unobserved entry costs.

$$\gamma = \frac{M_f}{M_d + M_f} = \frac{1}{1 + e^{\lambda_f^* \left[1 - \left(\frac{f_d}{f_f} \right)^{\frac{1-\rho}{2}} e^{-[\alpha\rho + \tilde{\alpha}(1-\rho)]\gamma} \right]}} \tag{14}$$

Equation (14) implicitly defines a steady state level of foreign presence $(\text{i.e., } \gamma)$.[19] We linearize equation (14) at $\gamma = 0$ and solve for the steady state level of γ as follows:

$$\gamma = \frac{1}{1 + e^{\eta \Phi^{\rho-1} w^{\rho} \left(f_f^{\frac{1-\rho}{2}} - f_d^{\frac{1-\rho}{2}} \right)}} \tag{15}$$

where $\eta \equiv \left[\frac{2\beta(1-\sigma)(1-\sigma\delta)^2}{\delta(2-\sigma\delta-\delta)}\right]^{\frac{1-\rho}{2}} \left[\frac{(1-\rho)^{\rho-1}}{\rho^{\rho}}\right]$.

3.4 The estimating equations

Equation (6) and (10) show the optimal domestic and export market quality that a firm will produce. Equation (11) shows the steady state level of foreign presence, γ. The main aim of this paper is to empirically evaluate the marginal impact of foreign presence on product quality of domestic firms. However, researchers typically do not observe the data on product quality. But, it is possible to get data on firm revenue. In this section we show how to derive equations that can be estimated using typically available data. We can use the link between a firm's usually unobserved optimal product quality and typically observed sales revenue to identify the impact of foreign presence on domestic product quality. The domestic and export market revenues of a firm can be written as follows:

$$R = pq = \left[\frac{\delta(1-\rho)}{\rho^{2\rho/\rho-1}\beta(1-\sigma)(1-\sigma\delta)}\right] \Phi^2 w^{\frac{2\rho}{\rho-1}} e^{\frac{2[\alpha\rho+\tilde{\alpha}(1-\rho)]}{1-\rho}\gamma} \lambda^{\frac{2}{1-\rho}} \tag{16}$$

$$\tilde{R} = \tilde{p}\tilde{q} = \left[\frac{\delta(\tau-\tilde{\rho})^2 \tau^{2/\tilde{\rho}-1}}{\tilde{\rho}^{2\tilde{\rho}/\tilde{\rho}-1}\beta(1-\sigma)(1-\sigma\delta)}\right] \tilde{\Phi}^2 w^{\frac{2\tilde{\rho}}{\tilde{\rho}-1}} e^{\frac{2[\alpha\tilde{\rho}+\tilde{\alpha}(1-\tilde{\rho})]}{1-\tilde{\rho}}\gamma} \lambda^{\frac{2}{1-\tilde{\rho}}} \tag{17}$$

where the second equality in equations (16) and (17) is obtained by making use of the optimal price, the Marshallian demand function and the expressions for optimal product quality in domestic and export markets (i.e., equations (6) and (10)).

Equation (6) can also be written as follows:

[19] Note that we assume that due to the presence of iceberg trading cost, the usual sorting pattern that has been confirmed by a number of previous studies holds. In other words, less productive firms sell only in the domestic market and more productive firms sell in both domestic and export markets. Given this sorting pattern, cut-off capabilities of domestic and foreign-invested firms in the export market do not affect the presence of FDI in the industry.

$$Z^{\frac{1-\rho(\mu+1)}{1-\rho}} = \left[\frac{\delta(1-\rho)}{\rho^{\rho/\rho-1}\beta(1-\sigma)(1-\sigma\delta)}\right]\left[\Phi w^{\frac{\rho}{\rho-1}} e^{\frac{\alpha\rho+2\tilde{\alpha}(1-\rho)}{1-\rho}\gamma} \lambda^{\frac{2-\rho}{1-\rho}}\right]$$

(18)

where we drop the superscript * to simplify mathematical notation.

After taking the natural logarithm of both sides of equations (16) and (18), we multiply the natural logarithm of equation (18) by 2 and subtract it from the natural logarithm of equation (16). The resulting equation is as follows:

$$lnR = -ln\left(\frac{\delta(1-\rho)}{\rho^{\rho/\rho-1}\beta(1-\sigma)(1-\sigma\delta)}\right) + 2\left(\frac{1-\rho(\mu+1)}{1-\rho}\right) lnZ - 2\tilde{\alpha}\gamma - 2ln\lambda \qquad (19)$$

Equation (14) is observed only if the realized capability draw is higher than the cut-off capability (i.e., $\lambda \geq \lambda_d^*$ for domestic firms). Using equation (19), we can derive equation (20) as follows:

$$E[lnR|\lambda \geq \lambda_d^*] = -ln\left(\frac{\delta(1-\rho)}{\rho^{\rho/\rho-1}\beta(1-\sigma)(1-\sigma\delta)}\right) + 2\left(\frac{1-\rho(\mu+1)}{1-\rho}\right) E[lnZ|\lambda \geq \lambda_d^*] - 2\tilde{\alpha}\gamma - 2E[ln\lambda|\lambda \geq \lambda_d^*] \qquad (20)$$

By differentiating equation (20) with respect to γ, we can derive the marginal impact of foreign presence on the expected product quality of a domestic firm as follows:

$$\frac{\partial E[lnZ|\lambda\geq\lambda_d^*]}{\partial\gamma} = \frac{1-\rho}{1-\rho(\mu+1)}\left\{\frac{1}{2}\frac{\partial E[lnR|\lambda\geq\lambda_d^*]}{\partial\gamma} + \tilde{\alpha} + \frac{\partial E[ln\lambda|\lambda\geq\lambda_d^*]}{\partial\gamma}\right\} = \frac{1-\rho}{1-\rho(\mu+1)}\left\{\underbrace{\frac{\alpha\rho+\tilde{\alpha}(1-\rho)}{1-\rho}}_{direct\ channel} + \tilde{\alpha} + \underbrace{\frac{2-\rho}{1-\rho}\frac{\partial E[ln\lambda|\lambda\geq\lambda_d^*]}{\partial\gamma}}_{indirect\ channel}\right\} \qquad (21)$$

In equation (21), the second equality is obtained by taking natural logarithm and applying the conditional expectations operator on both sides of equation (18) and differentiating the resulting expression with respect to γ.

Using equation (21), it can be argued that FDI affects the product quality of domestic firms through two contrasting channels: (i) a direct channel via productivity spillovers in both goods and quality production and (ii) an indirect channel which involves the impact of FDI on the cut-off capability of firms. The direct and the indirect effects do not reinforce each other. In fact, if the direct effect is positive then the indirect effect is negative and vice versa. For example, in the presence of positive productivity spillovers (namely $\alpha > 0$ and $\tilde{\alpha} > 0$), the direct effect of an increase in foreign presence on product quality is positive but at the same time there is also a decrease in the cut-off capability (λ_d^*), of firms which exerts a downward pressure on product quality through the indirect channel.

Using equation (21), it is clear that the impact of a change in foreign presence on optimal product quality is proportional to the sum of its impact on the firm capability and one half of its impact on firm sales as follows:

$$\frac{\partial E[lnZ|\lambda\geq\lambda_d^*]}{\partial\gamma} \propto \left\{\frac{1}{2}\frac{\partial E[lnR|\lambda\geq\lambda_d^*]}{\partial\gamma}\right\} + \tilde{\alpha} + \frac{\partial E[ln\lambda|\lambda\geq\lambda_d^*]}{\partial\gamma} \quad (22)$$

As $\left[\frac{1-\rho}{1-\rho(\mu+1)}\right] > 1$, it can be argued that the impact of an increase in foreign presence on optimal quality of goods produced by domestic firms is greater than its impact on the firm capability and one half of its impact on firm revenue.

In the following, we derive explicit expressions for the impact of foreign presence on firm sales revenue and capability. Using the exponential distribution given in equation (2), we can find the probability density function of the left truncated distribution for domestic firms as follows:

$$\tilde{g}\left(\lambda\middle|\lambda\geq\lambda_d^*\right) = \begin{bmatrix} e^{\lambda_d^*-\lambda}; & \lambda\geq\lambda_d^* \\ 0; & \lambda<\lambda_d^* \end{bmatrix} \quad (23)$$

where $\tilde{g}(\cdot)$ is the density of the left truncated exponential distribution.

The conditional expectation of λ is therefore as follows:

$$E[ln\lambda|\lambda\geq\lambda_d^*] = e^{\lambda_d^*}\int_{\lambda_d^*}^{\infty} e^{-\lambda}ln\lambda d\lambda = e^{\eta}\int_{\eta}^{\infty} e^{-\lambda}ln\lambda d\lambda + (\rho-1)\eta\left(e^{\eta}\int_{\eta}^{\infty} e^{-\lambda}ln\lambda d\lambda - ln\eta\right)ln\Phi + \rho\eta\left(e^{\eta}\int_{\eta}^{\infty} e^{-\lambda}ln\lambda d\lambda - ln\eta\right)ln\mathrm{w} - [\alpha\rho+\tilde{\alpha}(1-\rho)]\eta\left(e^{\eta}\int_{\eta}^{\infty} e^{-\lambda}ln\lambda d\lambda - ln\eta\right)\gamma + \frac{1-\rho}{2}\eta\left(e^{\eta}\int_{\eta}^{\infty} e^{-\lambda}ln\lambda d\lambda - ln\eta\right)ln\mathrm{f_d} \quad (24)$$

The second equality in equation (18) is obtained by using a first order Taylor expansion about $(\Phi, w, f_d, \gamma) = (1,1,1,1)$. Equations (16) and (24) can then be used to derive the conditional expectation of firm revenue as follows:

$$E[lnR|\lambda\geq\lambda_d^*] = \tilde{B}_0 + \tilde{B}_1 ln\Phi + \tilde{B}_2 ln\mathrm{w} + \tilde{B}_3\gamma + \tilde{B}_4 ln\mathrm{f_d} \quad (25)$$

where $\tilde{B}_0 = ln\left(\frac{\delta(\tau-\tilde{\rho})^2\tau^{2\tilde{\rho}/\tilde{\rho}-1}}{\tilde{\rho}^{2\tilde{\rho}/\tilde{\rho}-1}\beta(1-\sigma)(1-\sigma\delta)}\right) + \frac{2}{1-\rho}e^{\eta}\int_{\eta}^{\infty} e^{-\lambda}ln\lambda d\lambda,$

$\tilde{B}_1 = 2\left[1 - \eta\left(e^{\eta}\int_{\eta}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\eta\right)\right]$,

$\tilde{B}_2 = -\frac{2\rho}{1-\rho}\left[1 - \eta\left(e^{\eta}\int_{\eta}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\eta\right)\right]$,

$\tilde{B}_3 = \frac{2[\alpha\rho+\tilde{\alpha}(1-\rho)]}{1-\rho}\left[1 - \eta\left(e^{\eta}\int_{\eta}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\eta\right)\right]$, and

$\tilde{B}_4 = \eta\left(e^{\eta}\int_{\eta}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\eta\right)$.

Using equations (22) and (24) to (25), we can derive the impact of foreign presence on product quality of domestic firms as follows:

$$\frac{\partial E[lnZ|\lambda \geq \lambda_d^*]}{\partial \gamma} \propto \frac{1}{2}\frac{\partial E[lnR|\lambda \geq \lambda_d^*]}{\partial \gamma} + \tilde{\alpha} + \frac{\partial E[ln\lambda|\lambda \geq \lambda_d^*]}{\partial \gamma} =$$
$$\frac{\alpha\rho + \tilde{\alpha}(1-\rho)}{1-\rho}\left[1 - \eta\left(e^{\eta}\int_{\eta}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\eta\right)\right] +$$
$$\tilde{\alpha} - [\alpha\rho + \tilde{\alpha}(1-\rho)]\eta\left(e^{\eta}\int_{\eta}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\eta\right) \qquad (26)$$

Equation (26) suggests that the relationship between foreign presence and quality of goods produced by domestic firms in the domestic market can be evaluated by separately estimating the impact of foreign presence on (i) the total revenue of domestic firms in the domestic market, (ii) quality production, and the (iii) the cut-off level of productivity, which determines entry to the industry.

Equation (26) shows that, as long as the FDI-related productivity spillover effect is positive, an increase in foreign presence decreases the cut-off level of capability, which contributes to a decrease in product quality. This follows from the fact that, due to the positive spillover effect, domestic firms that were originally relatively inefficient are able to enter the industry. Entry of new firms increases the level of competition in the market. If the competition effect is sufficiently strong, then despite the positive spillover effect, an increase in foreign presence can reduce firm revenue and hence the product quality. These results can also be presented in the form of three propositions as follows:

Proposition 1: The presence of foreign-invested firms in a host country affects the quality of goods produced by domestic firms through two contrasting channels: a direct channel via productivity spillovers in both goods and quality production and an indirect channel involving the impact of foreign presence on the cut-off capability of domestic firms.

Proposition 2: The marginal impact of foreign presence on product quality of domestic firms can be identified through its impact on the firm (a) revenue, (b) quality production, and (c) cut-off capability.

Proposition 3: In the presence of positive productivity spillovers from foreign to domestic firms, an increase in foreign presence reduces the cut-off level of capability of domestic firms.

Note that in order to identify the impact of FDI on product quality of domestic firms, using equation (26), one needs to estimate $\tilde{\alpha}$. However equation (25) by itself is not sufficient to identify $\tilde{\alpha}$. In order to identify $\tilde{\alpha}$, we turn our attention to export market revenue. From equations (17) and (12) and the fact that a domestic firm exports only if $\lambda > \tilde{\lambda}_d^*$, we can derive the conditional expectation of export market revenue as follows:

$$E\left[ln\tilde{R}\middle|\lambda \geq \tilde{\lambda}_d^*\right] = \tilde{C}_0 + \tilde{C}_1 ln\widetilde{\Phi} + \tilde{C}_2 ln\mathrm{w} + \tilde{C}_3\gamma + \tilde{C}_4 ln\mathrm{f_d} \quad (27)$$

where $\tilde{C}_0 = ln\left(\frac{\delta(\tau-\tilde{\rho})^2\tau^{2/\tilde{\rho}-1}}{\tilde{\rho}^{2\tilde{\rho}/\tilde{\rho}-1}\beta(1-\sigma)(1-\sigma\delta)}\right) + \frac{2}{1-\tilde{\rho}} e^{\tilde{\eta}} \int_{\tilde{\eta}}^{\infty} e^{-\lambda} ln\lambda d\lambda,$

$\tilde{C}_1 = 2\left[1 - \tilde{\eta}\left(e^{\tilde{\eta}} \int_{\tilde{\eta}}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\tilde{\eta}\right)\right],$

$\tilde{C}_2 = -\frac{2\tilde{\rho}}{1-\tilde{\rho}}\left[1 - \tilde{\eta}\left(e^{\tilde{\eta}} \int_{\tilde{\eta}}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\tilde{\eta}\right)\right],$

$\tilde{C}_3 = \frac{2[\alpha\tilde{\rho}+\tilde{\alpha}(1-\tilde{\rho})]}{1-\tilde{\rho}}\left[1 - \tilde{\eta}\left(e^{\tilde{\eta}} \int_{\tilde{\eta}}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\tilde{\eta}\right)\right],$

$\tilde{C}_4 = \tilde{\eta}\left(e^{\tilde{\eta}} \int_{\tilde{\eta}}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\tilde{\eta}\right)$, and

$\tilde{\eta} \equiv \left[\frac{2\beta(1-\sigma)(1-\sigma\delta)^2}{\delta(2-\sigma\delta-\delta)}\right]^{\frac{1-\tilde{\rho}}{2}} \left[\frac{(\tau-\tilde{\rho})^{\tilde{\rho}-1}}{\tilde{\rho}^{\tilde{\rho}}}\right]\tau.$

With knowledge of preference parameters (ρ and $\tilde{\rho}$), the point estimates of equations (25) and (27) allow us to recover the point estimates of α and $\tilde{\alpha}$.

4. Estimation Strategy

In section 3, using a theoretical model, we were able to show that foreign presence affects the quality of goods produced by domestic firms through both direct and indirect channels. The purpose of this section is to present an empirical example of the use of this theoretical model. Equation (26) shows that in order to compute the marginal impact of foreign presence on domestic product quality, we need to estimate the underlying structural parameters: α, $\tilde{\alpha}$ and ρ. Once we know α, $\tilde{\alpha}$ and ρ, it is possible to derive the point estimates of the marginal impact of foreign presence on domestic product quality, without explicitly using data on product quality. However, note that we are unable to identify the parameter μ, which reflects our contention that higher quality products are more difficult to produce and hence we are able to estimate the impact of foreign presence on product quality only up to a positive scalar.[20]

The empirical analysis presented in this section is based on data from China's beverage manufacturing industry over the period 2005-2007. The beverage manufacturing industry is a good example of monopolistic competition. By estimating the underlying structural parameters, it is possible to evaluate the marginal impact of foreign presence on domestic product quality up to a scalar without explicitly using data on product quality. However, before empirical estimation, the strategy used to identify the relevant structural parameters needs to be outlined.

We start with the preference parameter ρ. In order to identify this parameter, we utilise the relationship between the total variable cost and firm revenue, implied by profit maximization, as follows:

$$TVC = \left(q + \tau\tilde{q}\right)MC = q\rho p + \tau\tilde{q}\frac{\tilde{\rho}\tilde{p}}{\tau} = \rho R + \tilde{\rho}\tilde{R} \tag{28}$$

where TVC is the total variable cost, MC denotes the marginal cost of production, R is firm revenue from sales in domestic market. A tilde is used to distinguish the export market variables and parameters such as price, revenue and the export market preference parameter.

By regressing total variable cost against sales revenue from domestic and export markets, we can recover the underlying preference parameters. We then estimate equations (25) and (27), i.e., the determinants of firm revenue in the domestic and export markets respectively, where we are interested in the coefficient of foreign presence. However foreign presence (i.e., FDI inflow) can be endogenous. For example, FDI tends to flow into industries where domestic firms have higher revenue. In order to account for possible endogeneity, we also estimate the determinants of foreign presence, i.e., equation (15). We first linearize

[20] The scalar being $\frac{1-\rho}{1-\rho(\mu+1)}$. In other words, we are able to estimate equation (22).

equation (11) using a first order Taylor approximation about $(\Phi, w, f_d, f_f) = (1,1,1,1/2)$, which yields the following equation:

$$\gamma = \widetilde{D}_0 + \widetilde{D}_1 ln\Phi + \widetilde{D}_2 ln\mathrm{w} + \widetilde{D}_3 ln\mathrm{f_d} + \widetilde{D}_4 ln\mathrm{f_f} \qquad (29)$$

where $\widetilde{D}_0 = \frac{1}{1+e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}} - \frac{e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\eta 2^{\frac{\rho-1}{2}}}{\left[1+e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\right]^2}\frac{1-\rho}{2} ln2,$

$$\widetilde{D}_1 = \frac{e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\eta\left(1-2^{\frac{\rho-1}{2}}\right)}{\left[1+e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\right]^2}(\rho-1),$$

$$\widetilde{D}_2 = \frac{e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\eta\left(1-2^{\frac{\rho-1}{2}}\right)}{\left[1+e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\right]^2}\rho,$$

$$\widetilde{D}_3 = \frac{e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\eta}{\left[1+e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\right]^2}\frac{1-\rho}{2}, \text{ and}$$

$$\widetilde{D}_4 = -\frac{e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\eta 2^{\frac{\rho-1}{2}}}{\left[1+e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\right]^2}\frac{1-\rho}{2}.$$

In equations (25), (27) and (29), the aggregate demand (Φ) is the representative consumer's income normalised by the price index, i.e., $\Phi \equiv \frac{Y}{\int_{\omega\in\Omega} p(\omega)^{\rho/(\rho-1)} Z(\omega) d\omega}$. Later in the empirical exercise, we measure aggregate demand as $ln\Phi = \theta_0 + \theta_1 t$, where *t* denotes time, to account for the fact that aggregate demand changes over time. Similarly, we measure aggregate demand in the export market ($\widetilde{\Phi}$) as $ln\widetilde{\Phi} = \tilde{\theta}_0 + \tilde{\theta}_1 t$.

While domestic firms may be able to observe their fixed cost of production (f_d), the researcher can only partly observe this cost. In this paper, we use the value of fixed assets to measure the fixed cost as $ln\text{f}_{\text{d}} = \theta_2 lnA + \tilde{\varepsilon}_1$ for domestic firms and $ln\text{f}_{\text{f}} = \theta_3 lnA_f + \tilde{\varepsilon}_2$ for foreign-invested firms, where *A* is the value of fixed assets, the subscripts *d* and *f* denote domestic and foreign firms respectively, and $\tilde{\varepsilon}_1$and $\tilde{\varepsilon}_2$ denote the unobserved components of fixed production cost, which are drawn from an exogenous probability distribution.

From equations (25), (27), (28) and (29), together with the aggregate demand and the fixed production cost equations, the empirical model involving a system of four equations can be presented as follows:

$$TVC = \rho R + \tilde{\rho}\tilde{R} + \varepsilon_1 \tag{30}$$

$$lnR = B_0 + B_1 t + B_2 ln\text{w} + B_3 \gamma + B_4 lnA + \varepsilon_2 \tag{31}$$

$$ln\tilde{R} = C_0 + C_1 t + C_2 ln\text{w} + C_3 \gamma + C_4 lnA + \varepsilon_3 \tag{32}$$

$$\gamma = D_0 + D_1 t + D_2 ln\text{w} + D_3 lnA + D_4 lnA_f + \varepsilon_4 \tag{33}$$

where $B_0 = ln\left(\frac{\delta(1-\rho)}{\rho^{2\rho/\rho-1}\beta(1-\sigma)(1-\sigma\delta)}\right) + \frac{2}{1-\rho} e^{\eta} \int_{\eta}^{\infty} e^{-\lambda} ln\lambda d\lambda + 2\theta_0 \left[1 - \eta\left(e^{\eta}\int_{\eta}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\eta\right)\right]$,
$\bar{B} = 1 - \eta\left(e^{\eta}\int_{\eta}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\eta\right)$, $B_1 = 2\theta_1 \bar{B}$, $B_2 = -\frac{2\rho}{1-\rho}\bar{B}$, $B_3 = \frac{2[\alpha\rho + \tilde{\alpha}(1-\rho)]}{1-\rho}\bar{B}$,
$B_4 = \theta_2(1-\bar{B})$, $C_0 = ln\left(\frac{\delta(\tau-\rho)^2 \tau^{2/\tilde{\rho}-1}}{\rho^{2\tilde{\rho}/\tilde{\rho}-1}\beta(1-\sigma)(1-\sigma\delta)}\right) + \frac{2}{1-\tilde{\rho}} e^{\tilde{\eta}} \int_{\tilde{\eta}}^{\infty} e^{-\lambda} ln\lambda d\lambda + 2\tilde{\theta}_0 \left[1 - \tilde{\eta}\left(e^{\tilde{\eta}}\int_{\tilde{\eta}}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\tilde{\eta}\right)\right]$, $\bar{C} = 1 - \tilde{\eta}\left(e^{\tilde{\eta}}\int_{\tilde{\eta}}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\tilde{\eta}\right)$, $C_1 = 2\tilde{\theta}_1 \bar{C}$, $C_2 = -\frac{2\tilde{\rho}}{1-\tilde{\rho}}\bar{C}$, $C_3 = \frac{2[\alpha\tilde{\rho} + \tilde{\alpha}(1-\tilde{\rho})]}{1-\tilde{\rho}}\bar{C}$, $C_4 = \theta_2(1-\bar{C})$,

$D_0 = \frac{1}{1+e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}} - \frac{e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\eta 2^{\frac{\rho-1}{2}}}{\left[1+e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\right]^2}\frac{1-\rho}{2} ln2 + \frac{e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\eta\left(1-2^{\frac{\rho-1}{2}}\right)}{\left[1+e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\right]^2}(\rho-1)\theta_0$, $\bar{D} = \frac{e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\eta}{\left[1+e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\right]^2}$, $D_1 = \bar{D}\left(1-2^{\frac{\rho-1}{2}}\right)(\rho-1)\theta_2$, $D_2 = \left(1-2^{\frac{\rho-1}{2}}\right)\rho\bar{D}$, $D_3 = \frac{1-\rho}{2}\theta_2\bar{D}$, and

$D_4 = -\frac{1-\rho}{2} 2^{\frac{\rho-1}{2}}\theta_3\bar{D}$;

ε_1 is the error term which captures the measurement error;

$\varepsilon_2 = \eta \left(e^{\eta} \int_{\eta}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\eta \right) \tilde{\varepsilon}_1$; $\varepsilon_3 = \tilde{\eta} \left(e^{\tilde{\eta}} \int_{\tilde{\eta}}^{\infty} e^{-\lambda} ln\lambda d\lambda - ln\tilde{\eta} \right) \tilde{\varepsilon}_1$;

and $\varepsilon_4 = \frac{e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\eta}{\left[1+e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\right]^2} \frac{1-\rho}{2} \tilde{\varepsilon}_1 - \frac{e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\eta 2^{\frac{\rho-1}{2}}}{\left[1+e^{\eta\left(2^{\frac{\rho-1}{2}}-1\right)}\right]^2} \frac{1-\rho}{2} \tilde{\varepsilon}_2$.

Since equations (31), (32), and (33) are derived using the first order Taylor approximation, the error terms contain higher order residuals of the explanatory variables, which may lead to significant correlation between the explanatory variables and the error terms. Therefore, in our later empirical exercise, we employ the instrumental variable approach to estimate equations (31), (32), and (33). The pool of excluded instruments include two-year lags of explanatory variables, the number of firms in the four-digit industries other than the industry to which a firm belongs, firm age, and three dummy variables that measure the impact of ownership and location (i.e., whether a firm is privately owned or state and collectively owned, and whether a firm is located in Western China or in Central China). As predetermined variables, the lags are expected to be uncorrelated with the error terms. In addition, since the market structure is assumed to be monopolistically competitive with each firm being small relative to the market, firms do not consider the number of firms in the other four-digit industries (i.e., the number of firms is not correlated with the error terms). We do not expect that the three dummy variables and firm age will affect the profit maximizing behaviour of firms and hence these variables are unlikely to be correlated with the error terms.

Later in our empirical exercise, we also test for the relevance (whether the excluded instruments are correlated with the endogenous explanatory variables) and validity (whether the excluded instruments are uncorrelated with the error terms) of the excluded instruments, and decide which excluded instruments are to be used in the estimation. More specifically, we choose the excluded instruments such that (i) in a Lagrange multiplier under-identification test, the null hypothesis that the equation is underidentified (namely excluded instruments are irrelevant) is rejected at the five per cent level of significance and (ii) in a test of over-identifying restrictions, the null hypothesis that the instruments are valid instruments and are correctly excluded from the estimated equation is not rejected at the five per cent level of significance.

Equations (30) to (33) are reduced form equations, derived from the theoretical model in Section 3. The identification of equations (30) to (33) lies in the firm-year and industry-year variations of the variables from the dataset, which allows us to estimate the reduced form coefficients. From the reduced form coefficients, we can work out the underlying structural parameters (α and $\tilde{\alpha}$), which in turn allows us to compute the impact of a change in foreign presence on firm revenue and cut-off capability. As a result, except for a positive scalar that is greater than 1 $\left[\text{i. e}, \frac{1-\rho}{1-\rho(\mu+1)}\right]$, we are able to compute the impact of a change in foreign presence on the unobserved product quality.

The preference parameters (ρ and $\tilde{\rho}$) can be obtained by estimating equation (30). The structural parameters α and $\tilde{\alpha}$ are embedded in the coefficients of equations (31) and (32) in a nonlinear fashion. With the knowledge of preference parameters, we can recover α and $\tilde{\alpha}$, as follows:

$$\begin{cases} \alpha = -\dfrac{B_3}{B_2} - \tilde{\alpha}\dfrac{1-\rho}{\rho} \\ \tilde{\alpha} = \dfrac{\frac{B_3}{B_2} - \frac{C_3}{C_2}}{\frac{1-\tilde{\rho}}{\tilde{\rho}} - \frac{1-\rho}{\rho}} \end{cases}$$

where the relevant standard errors can be computed using the delta method.

5. The Data

Equations (30) to (33) are estimated by using firm level data from China's beverage manufacturing industry (two-digit industry) from 2005 to 2007. All data are sourced from China's National Bureau of Statistics (NBS).[21] Before attempting to estimate the relevant structural parameters, we first clean the dataset by excluding firms that (i) employ fewer than eight workers as they may not have reliable accounting systems (Jefferson, et al., 2008) and (ii) report negative net values of fixed assets, wage, output, and value added. The dependent and explanatory variables are constructed using the cleaned dataset. The total variable cost (TVC) is the sum of a firm's total wage payment and the cost of intermediate inputs, which is deflated to year 2005 by the producer price index for manufactured goods from *China Statistical Yearbook 2008*. The domestic and export sales revenues are reported in the dataset and are also deflated to year 2005. The variable w, which represents the sum of the wage and

[21]A number of existing studies are based on data from the same source. For example, Hu, Jefferson and Qian (2005), Jefferson, Rawski and Zhang (2008), Sun (2009), and Anwar and Sun (2013).

intermediate goods cost per worker, is simply the sum of total wages paid and the cost of intermediate goods divided by the number of employees. A is the deflated value of the annual net average fixed assets, from which we can partly observe the fixed cost incurred by firms.

Foreign presence $\left(\text{i.e., } \gamma\right)$ is initially measured as the share of the number of foreign-invested firms in four-digit industries. In the two-digit beverage manufacturing industry, there are 13 four-digit industries. The data exhibit significant variation across four-digit industries. Such cross-industry variation, together with the cross-time variation, allows us to estimate the reduced form coefficients of equations (31), (32) and (33).

Table 1 presents the summary statistics. There appears to be significant variation in the data form the two-digit beverage manufacturing industry. For example, the average revenue from domestic sales is 67,501.46 thousand Yuan with a standard deviation of 351,934.40 thousand Yuan, which is more than five times higher than the average value. In the case of export market revenue, there is even more variation. The standard deviation exceeds by 10 times the size of the mean, suggesting that the sample contains some very large firms. A small proportion of domestic firms (approximately 1.1 percent) reported zero sales. Using the sales figures, we calculated the value of the Herfindahl index at the two digit industry level. The calculated value of this index, which measures the size of firms in relation to the industry, is 0.0029. As the value of the Herfindahl index is very low, China's beverage manufacturing industry can be categorised as a monopolistically competitive industry.

--- insert Table 1 about here ---

Furthermore, foreign presence in China's beverage manufacturing industry, as measured by the proportion of the number of foreign-invested firms, is significant. On average, the number of foreign-invested firms accounts for approximately 14% of total number of firms in a four-digit industry. In addition, compared to foreign presence originating from HMT region, within the beverage manufacturing industry, foreign presence originating from non-HMT regions is almost twice as large.

6. Empirical Results

As discussed in Section 4, we estimate equation (30) using the ordinary least squares estimator, and equations (31) to (33) by the generalized method of moments (GMM) estimator with instrumental variables (IV). The IV GMM estimation is carried out using the statistical routine developed by Baum, Schaffer and Stillman (2007) in Stata 13. As described in Section 4, the excluded instruments are chosen so that the underidentification test rejects the null hypothesis that the equation is underidentified (namely the excluded instruments are irrelevant) and the overidentificaiton test fails to reject the null hypothesis that the excluded instruments are valid at the five per cent level of significance. In addition, we also test whether the endogenous explanatory variables are indeed endogenous.

In the case of equation (31), the excluded instruments are the two-year lags of w, γ, $\ln A$, and whether a firm is located in Western China. In the case of the underidentification test, the estimated value of the Kleibergen-Paap rk *LM* statistic is 487.54 with a *p*-value of less than 0.005, which allows us to reject the null hypothesis at the five per cent level of significance. In the case of the overidentification test, the Hansen *J* statistic is 0.12 with a *p*-value of 0.73. The endogeneity test yields a χ^2 statistic of 42.66 with a *p*-value of less than 0.00005, suggesting that the endogenous variables are indeed endogenous. Similarly, the excluded instruments in estimating equation (32) are the two-year lags of w, γ, $\ln A$, firm age, whether a firm is privately owned, whether a firm is located in Western China, and whether a firm is located in Central China. The tests for equation (32) yield Kleibergen-Paap rk *LM* statistic of 57.81 ($p < 0.0005$), a Hansen *J* statistic of 2.06 (*p*-value being 0.73), and χ^2 statistic in the case of the endogeneity test of 14.04 (*p*-value being 0.003). In the case of equation (33), we found that the number of firms in the four-digit industries other than the industry to which a firm belongs, firm age, whether a firm is privately owned, whether a firm is located in Western China, and whether a firm is located in Central China are the appropriately excluded instruments, with a Kleibergen-Paap rk *LM* statistic of 19.64 (*p*-value 0.0002), a Hansen *J* statistic of 3.82 (*p*-value 0.15), and the χ^2 statistic for endogeneity test being 83.82 ($p < 0.00005$).

The estimated results concerning the impact of foreign presence from all sources on product quality of domestic firms in China’s beverage manufacturing industry are reported in column 1 of Table 2. In column 2 of the same table, the estimates of the impact of foreign presence from all sources except Hong Kong, Macau and Taiwan (HMT) regions are reported. The estimated results pertaining to the impact of foreign presence from HMT region are presented in column 3 of Table 2.

6.1 Impact of FDI on product quality

The estimated value of α reported in column 1 of Table 2 in is 6.374, with a *p*-value of 0.03. This suggests that a one per cent increase in foreign presence from all sources increases the productivity of domestic firms in China's beverage manufacturing industry by more than six per cent. As the estimated value is positive, the presence of foreign firms in China's beverage manufacturing industry generates positive productivity spillovers to domestic firms in goods production. In the case of quality production, it appears that foreign presence generates a negative impact, with the estimated value of $\tilde{\alpha}$ being-10.025. However, this estimated value is only significant at the ten per cent level. Using the estimated values of ρ, α, and $\tilde{\alpha}$, we can calculate the marginal impact of foreign presence on the cut-off capability for domestic firms as $\partial ln\lambda_d^*/\partial\gamma = -[\alpha\rho + \tilde{\alpha}(1-\rho)] = -0.643 < 0$. Therefore, *ceteris paribus*, an increase in foreign presence results in a lower cut-off capability, which encourages some domestic firms that were initially not able to enter the industry to enter the industry. This contributes to a decrease in expected capability and expected product quality in the industry. It should be kept in mind that, although the firm capability is lower, owing to the increased foreign presence and positive spillovers in production, the domestic firms are relatively more productive.

--- insert Table 2 about here ---

As shown in equation (21), foreign presence affects the expected quality of goods produced by domestic firms through two channels: (i) a direct channel via its impacts on both the goods and quality production and (ii) an indirect channel via the average cut-off capability. The estimated results presented in Table 2 suggest that foreign presence decreases the cut-off capability of domestic firms in China's beverage manufacturing industry, which allows relatively less capable domestic firms to enter the industry. Increased competition due to entry of domestic firms puts a downward pressure on product quality through the firm capability channel.

The point estimate of the coefficient of foreign presence in the domestic revenue equation (i.e., B_3) in Table 2 is -0.6489, which is significant at the one per cent level. This suggests that a one per cent increase in foreign presence reduces the domestic market revenue of the domestic firms in China's beverage manufacturing industry by 0.6489 per cent. On the one hand, through an increase in productivity, an increase in foreign presence increases the revenue of domestic firms. However, on the other hand, a decrease in the cut-off capability, due to the positive productivity spillover effect, encourages the entry of new firms which, through an increase in competition, puts a downward pressure on the revenue of domestic firms. The results presented in Table 2 suggest that the competition effect dominates the productivity effect and hence the impact of an increase in foreign presence on the revenue of domestic firms in China's beverage manufacturing industry is negative and highly significant.

In summary, the impact of an increase in foreign presence on the product quality of domestic firms from both channels (captured by the average cut-off capability and revenue) is negative. In other words, using data from China's beverage manufacturing industry, we are able to estimate the impact of an increase in foreign presence on the (i) average cut-off capability, (ii) revenue from domestic market, and (iii) quality production of domestic firms. From these three point estimates, we can identify $\frac{1}{2}\frac{\partial E[lnR|\lambda\geq\lambda_d^*]}{\partial\gamma}+\tilde{\alpha}+\frac{\partial E[ln\lambda|\lambda\geq\lambda_d^*]}{\partial\gamma}$ as -11.1069 (labelled as *dlnzdγ* in Table 2), which is significant at the five per cent level. However, as indicated in equation (21), the impact of foreign presence on product quality equals $\frac{1-\rho}{1-\rho(\mu+1)}\left\{\frac{1}{2}\frac{\partial E[lnR|\lambda\geq\lambda_d^*]}{\partial\gamma}+\tilde{\alpha}+\frac{\partial E[ln\lambda|\lambda\geq\lambda_d^*]}{\partial\gamma}\right\}$. Unfortunately, we are unable to estimate the parameter μ . Because $\frac{1-\rho}{1-\rho(\mu+1)}>1$, based on our computations, without using any data on product quality, we can argue that the impact of an increase in foreign presence on the quality of goods produced by domestic firms in China's beverage manufacturing industry is greater than -11.1069.

6.2 Estimation of other parameters

Table 2 also reports the point estimates of other structural parameters. The estimated values of the utility function parameter in the domestic and export markets (i.e., ρ and $\tilde{\rho}$), respectively, are 0.6506 and 0.5702. These estimated values are significant at the one percent level. Based on these values, the elasticity of substitution in domestic and export markets, respectively, are 2.86 and 2.32. Compared to some existing studies, these estimated elasticities are small. However, the two-digit beverage manufacturing industry considered in this paper contains both alcoholic and non-alcoholic beverage manufacturing firms and substitution between these two types of beverage is expected to be small.

In the estimated domestic market revenue equation (i.e., ln*R* equation in Table 2), all point estimates are significant at the one per cent level. In the case of the export market revenue equation ($ln\tilde{R}$ equation in Table 2), only the coefficient of *w* (i.e., C_2) is significant at the one per cent level. As far as the estimated coefficients of the foreign presence equation (i.e., γ in Table 2) are concerned, the point estimates of D_0, D_3 and D_4 (which represent, respectively, the constant and the effect of fixed assets of domestic and foreign-invested firms on foreign presence) are significant at the one percent level. However, the estimated values of D_1 and D_2 are statistically insignificant.

6.3 Robustness check

The results presented in Table 2 are derived by measuring foreign presence as a proportion of the number of foreign-invested firms from all sources within the four-digit industries. As a robustness check, we also estimate equations (30) to (33) after disaggregating the foreign presence variable into two groups: (i) foreign presence originating from Hong Kong, Macau, and Taiwan (HMT) region and foreign presence originating from non-HMT region. The estimated results based on these two classifications are reported in columns 2 and 3 of Table 2. These disaggregated results suggest that an increase in foreign presence from HMT and non-HMT regions also leads to a decrease in the average cut-off capability. In addition, based on the resulted presented in columns 2 and 3 of Table 2, we can argue that the impact of an increase in foreign presence from non-HMT regions on the quality of goods produced by domestic firms in China's beverage manufacturing industry is greater than -14.1437, which is significant at the ten per cent level. As shown in column 3 of Table 2, an increase in foreign presence from HMT region leads to a much larger decrease in quality of goods produced by domestic firms in China's beverage manufacturing industry; the actual effect is greater than -39.6929, which is significant at the five per cent level. Hence, we can conclude with a high level of confidence that that the impact of FDI on the quality of goods produced by domestic firms in China's beverage manufacturing industry is negative.

In addition to measuring foreign presence as the proportion of the number of foreign-invested firms in the industry, we also measure foreign presence as a proportion of the (i) assets and (ii) output of foreign-invested firms in a four-digit industry. Using these two alternative measures of foreign presence, equations (30) to (33) were re-estimated; these results not reported here are available upon request. Our results re-confirm the negative relationship between the product quality of domestic firms and foreign presence in China's manufacturing industry but the estimated effect is statistically insignificant. We believe that the proportion of foreign-invested firms in the industry is a more accurate measure of foreign presence compared to, for example, the proportion of assets or output shares because an increase in the proportion of foreign-invested firms implies an increase in the assets/output share, but not vice versa.

As discussed in Section 4, the aggregate demands in the domestic and export markets are, respectively, measured as $ln\Phi = \theta_0 + \theta_1 t$ and $ln\widetilde{\Phi} = \tilde{\theta}_0 + \tilde{\theta}_1 t$. One may question the appropriateness of using this measure. However, because our dataset covers only three years and two-year lags of explanatory variables are used as excluded instruments in the estimation process, irrespective of how the aggregate demand is measured, the domestic and export market aggregate demand appears in our model as two constant terms. Consequently, our estimated results are robust with respect to any measure of aggregate demand.

7. Concluding Remarks

Using a theoretical model (where the domestic market consists of domestic and foreign-invested firms, productivity spillovers occur from foreign-invested firms to domestic firms, domestic firms sell their product in both domestic and export markets, and product quality across the two markets is not identical) this paper argues that the presence of foreign firms can impact the quality of goods produced by domestic firms in host economies.

We show that an increase in the proportion of foreign-invested firms, which can also be interpreted as an increase in foreign direct investment (FDI), affects product quality in host economies through two channels: (i) a direct channel via productivity spillovers in both goods and quality production and (ii) an indirect channel via its impact on the cut-off capability of firms. The overall impact of foreign presence on product quality depends on the direction and relative strengths of these two contrasting effects. If the effect thorough the direct channel is positive, the indirect channel effect is necessarily negative. In the presence of positive productivity spillovers (a positive direct channel effect), an increase in foreign presence results in a decrease in the cut-off capability of domestic firms, which allows some relatively inefficient domestic firms to enter the industry, thereby contributing to a decrease in product quality (a negative indirect channel effect).

The second contribution of this paper is its empirical analysis using firm level data from China's beverage manufacturing industry. The theoretical model used in this paper involves monopolistic competition so that the beverage manufacturing industry, which exhibits some features of monopolistic competition, appears to be a reasonable choice. We also separately investigate the impact of FDI originating from Hong Kong, Macau and

Taiwan (HMT) and from non-HMT regions on product quality. As data on product quality are unavailable, by estimating the underlying structural parameters, we estimate the impact of an increase in the proportion of foreign-invested firms on the quality of goods produced by domestic firms in China's beverage manufacturing industry. Empirical estimation suggests that presence of foreign firms leads to a positive spillover effect of 6.3740 in goods production and a negative spillover effect of 10.026 in quality production. We find that a one per cent increase in the proportion of foreign-invested firms in the industry decreases the domestic market revenue of domestic firms by 0.6489 per cent. In overall terms, our empirical estimates indicate that a one per cent increase in foreign presence leads to, on average, a more than ten per cent decrease in the product quality of domestic firms in China's beverage manufacturing industry. It is interesting to note that even though, the productivity spillover effect is positive, entry of new but lower capability firms in the industry leads to a decline in product quality.

References

Alcalá, F. 2009. "Comparative Advantage across Goods and Product Quality," *The BBVA Foundation Working Papers.* The BBVA Foundation, 1-56.

Alfaro, L. and Chen. M.X. 2013. "Market Relocation and Knowledge Spillover: The Gains from Multinational Production," *Harvard Business School Working Papers.*

Amiti, M. and Khandelwal, A.K. 2012. "Import Competition and Quality Upgrading." *Review of Economics and Statistics*, 95(2), 476-90.

Antoniades, A.. 2015. "Heterogeneous Firms, Quality, and Trade." *Journal of International Economics*, 95(2), 263-73.

Anwar, S. and Sizhong S. 2013. "Foreign Entry and Firm R&D: Evidence from Chinese Manufacturing Industries." *R&D Management*, 43(4), 303-17.

Bajgar, B. and Javorcik, B.S. 2013. "Exporters' Stargate: Suppling Multinationals and Entry into New Markets," *CESifo-Delphi Conference on The Economics of Firm Exporting, 26-27 April 2013.*

Baldwin, R. and Harrigan, J. 2011. "Zeros, Quality, and Space: Trade Theory and Trade Evidence." *American Economic Journal: Microeconomics,* 3(2), 60-88.

Bardhan, P. and Kletzer, K.. 1984. "Quality Variations and the Choice between Foreign and Indigenous Goods or Technology." *Journal of Development Economics*, 14(3), 323-30.

Baum, C.F, Schaffer, M.E. and Stillman, S. 2007. "Ivreg2: Stata Module for Extended Instrumental Variables/2sls, Gmm and Ac/Hac, Liml, and K-Class Regression," *Boston College Department of Economics, Statistical Software Components S425401.*

Chen, J. and J. A. Rizzo. 2012. "Pricing Dynamics and Product Quality: The Case of Antidepressant Drugs." *Empirical Economics,* 42(1), 279-300.

Choi, Y. C.; D. Hummels and C. Xiang. 2009. "Explaining Import Variety and Quality: The Role of the Income Distribution." *Journal of International Economics and Finance*, 77(2), 265-75.

Coad, A. 2009. "On the Distribution of Product Price and Quality." *Journal of Evolutionary Economics*, 19(4), 589-604.

Copeland, B.R. and Kotwal, A. 1996. "Product Quality and the Theory of Comparative Advantage." *European Economic Review*, 40(9), 1745-60.

Crozet, M.; K. Head and T. Mayer. 2012. "Quality Sorting and Trade: Firm-Level Evidence for French Wine." *Review of Economic Studies*, 79(2), 609-44.

Dana, J. D. and Y. F. Fong. 2011. "Product Quality, Reputation, and Market Structure." *International Economic Review*, 52(4), 1059-76.

Dunning, J. H. 1993. *Multinational Enterprises and the Global Economy*. Wokingham: Addison-Wesley.

Essaji, A. and Fujiwara, K. 2012. "Contracting Institutions and Product Quality." *Journal of Comparative Economics*, 40(2), 269-78.

Eswaran, M. and Kotwal, A. 2007. "Quality-Enhancing Trade Liberalization." *Journal of Development Economics*, 83(2), 549-61.

Fajgelbaum, P.; G. M. Grossman and E. Helpman. 2011. "Income Distribution, Product Quality, and International Trade." *Journal of Political Economy*, 119(4), 721-65.

Falvey, R.E. and Kierzkowski, H. 1987. "Product Quality, Intra-Industry Trade and (Im)Perfect Competition," H. Kierzkowski, *Protection and Competition in International Trade.* Oxford: Basil Blackwell,

Feenstra, R.C. and Romalis, J. 2014. "International Prices and Endogenous Quality." *The Quarterly Journal of Economics*.

Flam, H. and Helpman, E. 1987. "Vertical Product Differentiation and North-South Trade." *The American Economic Review*, 77(5), 810-22.

Grossman, G.M. and Helpman, E. 1991. *Innovation and Growth in the Global Economy*. Cambridge, Mass: MIT Press.
Hallak, J. C. 2010. "A Product-Quality View of the Linder Hypothesis." *Review of Economics and Statistics*, 92(3), 453-66.
____. 2006. "Product Quality and the Direction of Trade." *Journal of International Economics*, 68(1), 238-65.
Harding, T. and Javorcik, B.S. 2012. "Fdi and Export Upgrading." *The Review of Economics and Statistics*, 94(4), 964-80.
Helpman, E.. 2006. "Trade, Fdi, and the Organization of Firms." *Journal of Economic Literature*, 44(3), 589-630.
Helpman, E., Melitz, M.J. and Yeaple. SR.. 2004. "Export Versus Fdi with Heterogeneous Firms." *American Economic Review*, 94(1), 300-16.
Helpman, E., Melitz, M.J. and Rubinstein, Y. 2008. "Estimating Trade Flows: Trading Partners and Trading Volumes." *The Quarterly Journal of Economics*, 123(2), 441-87.
Hu, A. G. Z.; G. H. Jefferson and J. Qian. 2005. "R&D and Technology Transfer: Firm-Level Evidence from Chinese Industry." *Review of Economics and Statistics*, 87(4), 780-86.
Hummels, D. and Klenow, P.J. 2005. "The Variety and Quality of a Nation's Exports." *American Economic Review*, 95(3), 704-23.
Javorcik, B.S. 2004. "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages." *American Economic Review*, 94(3), 605-27.
Jefferson, G. H.; T. G. Rawski and Y. Zhang. 2008. "Productivity Growth and Convergence across China's Industrial Economy." *Journal of Chinese Economic and Business Studies*, 6(2), 121-40.
Johnson, R.C. 2012. "Trade and Prices with Heterogeneous Firms." *Journal of International Economics*, 86(1), 43-56.
Katayama, S. and K. Miyagiwa. 2009. "Fdi as a Signal of Quality." *Economics Letters*, 103(3), 127-30.
Khandelwal, A. 2010. "The Long and Short (of) Quality Ladders." *The Review of Economic Studies*, 77(4), 1450-76.
Kirchler, E., Fischer, F. and Hölzl, E. 2010. "Price and Its Relation to Objective and Subjective Product Quality: Evidence from the Austrian Market." *Journal of Consumer Policy*, 33(3), 275-86.
Kugler, M. and E. Verhoogen. 2012. "Prices, Plant Size, and Product Quality." *Review of Economic Studies*, 79(1), 307-39.
Lin, P., Liu, Z. and Zhang, Y. 2009. "Do Chinese Domestic Firms Benefit from Fdi Inflow?: Evidence of Horizontal and Vertical Spillovers." *China Economic Review*, 20(4), 677-91.
Linder, S. 1961. *An Essay on Trade and Transformation*. Stockholm: Almqvist & Wiksell.
Linnemer, L. 2012. "Dissipative Advertising Signals Quality: Static Model with a Continuum of Types." *Economics Letters*, 114(2), 150-53.
Lu, Y.; T. Ng and Z. G. Tao. 2012. "Outsourcing, Product Quality, and Contract Enforcement." *Journal of Economics & Management Strategy*, 21(1), 1-30.
Manova, K. and Zhang, Z.W. 2012. "Export Prices across Firms and Destinations." *Quarterly Journal of Economics*, 127(1), 379-436.
Martin, J. 2012. "Markups, Quality, and Transport Costs." *European Economic Review*, 56(4), 777-91.
Matsa, D. A. 2011a. "Competition and Product Quality in the Supermarket Industry." *Quarterly Journal of Economics*, 126(3), 1539-91.

____. 2011b. "Running on Empty? Financial Leverage and Product Quality in the Supermarket Industry." *American Economic Journal-Microeconomics*, 3(1), 137-73.
Melitz, M.J. and Redding, S.J. 2012. "Heterogeneous Firms and Trade,," *NBER Working Paper 18652*.
Melitz, M.J. 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica*, 71(6), 1695-725.
Meyer, K.E. and Sinani, E. 2009. "When and Where Does Foreign Direct Investment Generate Positive Spillovers: A Meta-Analysis." *J Int Bus Stud*, 40(7), 1075-94.
Murphy, K.M. and Shleifer, A.. 1997. "Quality and Trade." *Journal of Development Economics*, 53(1), 1-15.
Romley, J.A. and Goldman. D.P.. 2011. "How Costly Is Hospital Quality? A Revealed-Preference Approach." *Journal of Industrial Economics*, 59(4), 578-608.
Schott, P.K. 2004. "Across-Product Versus within-Product Specialization in International Trade." *The Quarterly Journal of Economics*, 119(2), 647-78.
Sonobe, T., Hu, D.H. and Otsuka, K. 2004. "From Inferior to Superior Products: An Inquiry into the Wenzhou Model of Industrial Development in China." *Journal of Comparative Economics*, 32(3), 542-63.
Sun, S. 2011. "Foreign Direct Investment and Technology Spillovers in China's Manufacturing Sector." *The Chinese Economy*, 44(2), 25-42.
____. 2009. "How Does Fdi Affect Domestic Firms' Exports? Industrial Evidence." *World Economy*, 32(8), 1203-22.
Sutton, J. . 2007. "Quality, Trade and the Moving Window: The Globalization Process." *Economic Journal*, 117, F469-F98.
Verhoogen, E. A. 2008. "Trade, Quality Upgrading, and Wage Inequality in the Mexican Manufacturing Sector." *Quarterly Journal of Economics*, 123(2), 489-530.
Werner, R. M. Norton, E.C., Konetzka, R.T and Polsky, D. 2012. "Do Consumers Respond to Publicly Reported Quality Information? Evidence from Nursing Homes." *Journal of Health Economics*, 31(1), 50-61.
Xu, B. 2010. "The Sophistication of Exports: Is China Special?" *China Economic Review*, 21(3), 482-93.
Xu, X.P. and Sheng, Y. 2012. "Productivity Spillovers from Foreign Direct Investment: Firm-Level Evidence from China." *World Development*, 40(1), 62-74.
Yu, M. 2010. "Trade, Democracy, and the Gravity Equation." *Journal of Development Economics*, 91(2), 289-300.

Table 1: Summary Statistics

Variable Name	Sample Size	Mean	Standard Deviation	Min	Max
Domestic sales revenue (*R*) in thousand Yuan	9,659	67,501.46	351,934.40	0	19,500,000.00
Export revenue (R_x) in thousand Yuan	9,659	2,609.79	31,191.55	0	1,756,489.00
total variable cost (*TVC*)	9,659	51,405.28	244,330.70	57.45	13,300,000.00
Wage and intermediate inputs per worker (ln*w*) in thousand Yuan per worker	9,659	5.15	1.00	1.01	8.97
Fixed assets - annual net average (ln*A*)	9,659	8.63	1.62	1.58	16.02
Fixed assets annual net average of FDI firms ($\ln A_f$)*	9659	10.57	0.95	9.01	12.09
Foreign presence as measured by γ	9,659	0.14	0.12	0.02	0.48
of which from non-HMT regions	9,659	0.09	0.08	0	0.31
of which from HMT	9,659	0.05	0.04	0	0.20

Note: HMT refers to Hong Kong, Macau and Taiwan; * is the mean fixed assets annual net average of foreign-invested firms in the four digit industries.
Source: NBS, 2005-2007.

Table 2: The Estimation Results									
	[1]			[2]			[3]		
	Estimated Coefficient	Standard Error	*z*-value	Estimated Coefficient	Standard Error	*z*-value	Estimated Coefficient	Standard Error	*z*-value
TVC									
ρ	0.6506***	0.0016	409.24	0.6506***	0.0016	409.24	0.6506***	0.0016	409.24
ρ_x	0.5702***	0.0182	31.33	0.5702***	0.0182	31.33	0.5702***	0.0182	31.33
$\ln R$									
B_0	1.8912***	0.1964	9.63	1.8904***	0.1966	9.62	1.8987***	0.1961	9.68
B_2	0.6565***	0.0295	22.24	0.6560***	0.0295	22.22	0.6572***	0.0295	22.29
B_3	-0.6489***	0.1602	-4.05	-0.8967***	0.2253	-3.98	-1.9319***	0.5178	-3.73
B_4	0.5630***	0.0164	34.41	0.5621***	0.0163	34.43	0.5631***	0.0164	34.31
$ln\tilde{R}$									
C_0	2.1064	1.4066	1.50	2.1755	1.3906	1.56	1.9165	1.4338	1.34
C_2	1.1298***	0.1814	6.23	1.1231***	0.1805	6.22	1.1414***	0.1823	6.26
C_3	1.3379	1.1878	1.13	1.5432	1.6826	0.92	5.6670	3.8408	1.48
C_4	0.0378	0.0868	0.44	0.0398	0.0864	0.46	0.0378	0.0870	0.43
γ									
D_0	-1.5190***	0.0889	-17.08	-0.9622***	0.0639	-15.06	-0.5873***	0.0300	-19.61
D_1	0.0067	0.0053	1.26	0.0059	0.0038	1.56	0.0007	0.0018	0.40
D_2	0.0099	0.0207	0.48	0.0009	0.0146	0.06	0.0091	0.0069	1.32
D_3	-0.0352***	0.0128	-2.74	-0.0280***	0.0091	-3.07	-0.0084*	0.0043	-1.95
D_4	0.1791***	0.0136	13.15	0.1204***	0.0097	12.42	0.0626***	0.0045	13.79
α	6.3740**	2.9668	2.15	8.1616**	4.1451	1.97	22.5333**	9.7583	2.31
$\tilde{\alpha}$	-10.0260*	5.4398	-1.84	-12.6494*	7.5910	-1.67	-36.4772**	17.9257	-2.03
dlnzdγ	-11.1069**	5.4800	-2.03	-14.1437*	7.6447	-1.85	-39.6929**	17.7583	-2.24
Equation	Obs	R-sq		Obs	R-sq		Obs	R-sq	
TVC	9659	0.9793		9659	0.9793		9659	0.9793	
lnR	2150	0.5935		2150	0.5936		2150	0.5947	
$ln\tilde{R}$	182	0.0444		182	0.0452		182	0.0422	
γ	8986	-0.1389		8986	-0.1404		8986	-0.2439	

Notes: Column [1] shows the empirical results for FDI from all sources; Column [2] shows the empirical results when FDI from only non-HMT sources is considered; and column [3] shows the empirical results when FDI from only HMT region is considered; ***, **, * denote significance at the 1, 5, and 10 per cent levels respectively; $dlnzd\gamma \equiv \frac{1}{2}\frac{\partial E[lnR|\lambda\geq\lambda_d^*]}{\partial\gamma} + \tilde{\alpha} + \frac{\partial E[ln\lambda|\lambda\geq\lambda_d^*]}{\partial\gamma}$, and $\frac{\partial E[lnZ|\lambda\geq\lambda_d^*]}{\partial ln\gamma} \propto dlnzd\gamma$.