Firm efficiency and Input market integration:
Trade *versus* FDI

Michele Imbruno[*]

Abstract

This paper highlights the crucial role played by international access to intermediate inputs to explain the firm-level performance, via two channels simultaneously: trade and FDI. We develop a simple theoretical model showing that trade integration of input market entails an efficiency improvement within firms able to import (gains from input switching) and an efficiency decline within other firms (losses from domestic input availability), whereas FDI integration of input market implies non-importers' efficiency enhancement (gains from input switching) and some ambiguous effects on importers' efficiency (due to additional losses from foreign input availability). Using firm-level data from Chinese manufacturing sector over the period 2002-2006, we find some results coherent with our theoretical predictions.

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[*] IMT Institute for Advanced Studies, Lucca (Italy); GEP, University of Nottingham (UK). E-mail address: michele.imbruno@imtlucca.it.

1. Introduction

Understanding the relationship between global economic integration and economic growth is always a big issue amongst academic and policy debates. A large strand of international economics literature focuses on the microeconomic linkage between economic performance and international openness via different channels, such as trade and foreign direct investment (FDI). More specifically, many studies highlight the crucial role played by international access to intermediate inputs to explain the change in firm-level productivity.

International trade literature shows theoretically that trade barriers removal can lead to productivity improvement because firms can have access to higher number of input varieties, higher quality of intermediate inputs from abroad or they can even learn new technologies by using foreign inputs (Ethier, 1982; Markusen, 1989; Grossman and Helpman, 1991). Schor (2004) explores empirically the impact of a fall in tariffs on intermediate inputs (input tariffs) within Brazilian manufacturing sector, by considering also the import competition effect arising from a reduction in tariffs on final output (output tariffs) – given that less protection from foreign competition can push domestic firms to reduce their inefficiencies – and she finds that firms increase their productivity thanks to both sides of tariff liberalization. Similar findings have been documented by Goldberg, et al. (2010) and Khandelwal and Topolova, (2011) for India[1]. Using Indonesian data, Amiti and Konings (2007) are able to discriminate the input tariff effect between importers and non-importers, and they document that the former benefit relatively more in productivity than the latter in line with the theory, attributing the lower productivity gains of non-importers to some positive spillover effects from importers. Defever, Imbruno and Kneller (2012) provide evidence that official non-

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[1] Futher empirical studies explore directly the firm-level relationship between imports and productivity (such as Kasahara and Rodrigue, 2008; Halpern, Koren and Szeidl, 2011; Bas and Strauss-Khan, 2011) and conclude that importers' productivity gap respect to other firms is due to both self-selection mechanism and post-import effects.

importers within Chinese manufacturing sector actually gain from input trade liberalization because they can indirectly access foreign inputs through trade intermediaries.

International business literature argues that firms can also increase their efficiency thanks to a reduction in FDI barriers, since they can use more or better intermediate inputs produced by foreign-owned input suppliers (vertical spillover from inward FDI via forward linkages). However, other studies also highlight that within-firm productivity gains from inward FDI can be related to some learning or competition effects from foreign-owned competitors within the same sector (horizontal spillover) or some technical support from their foreign-owned customers (vertical spillover via backward linkages). While some few papers develop theoretical frameworks in order to incorporate spillover channels from FDI (such as Rodriguez-Claire (1996) and Markusen and Venables (1999)), a large quantity of empirical evidences have been provided which however lead to mixed results. For instance, by examining FDI spillovers through horizontal, backward and forward leakages simultaneously, Driffield, Munday and Roberts (2002) find more robust evidence of positive forward vertical spillover within UK manufacturing sector, whereas Javorcik (2004) finds stronger evidence of positive backward spillover amongst Lithuanian firms. Using data over the period 1998-2001, Liu et al. (2009) document that Chinese firms increase their performance mainly through vertical spillover from FDI, i.e. via both forward and backward linkages with multinationals (MNEs) located within country[2]. It is worth noting that both Rodriguez-Claire (1996) and Markusen and Venables (1999)' s theoretical studies focus on FDI in final good sector – assuming no trade and no FDI within intermediate good sector – and the related spillover effects on domestic input suppliers via backward linkages, which in turn affect domestic final good producers via forward linkages. In other words, they show

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[2] See Gorg and Greenway (2004) for an empirical literature survey.

that the presence of foreign-owned final good producers can determine an increase in the demand of local intermediate inputs such that more local input suppliers enter the market. That means more input varieties (also) for domestic-owned final good producers, which implies firm-level efficiency gains. Conversely, to the best of our knowledge, no theoretical attention has been paid to FDI in intermediate good sector and the spillover effects on domestic final good producers via forward linkages, by allowing for trade in intermediate goods as well. Our work attempts to fill this gap in the theoretical literature, highlighting new interesting insights to be explored empirically.

In the last decade, the "new new trade theory", born through the seminal work of Melitz (2003), starts to emphasize that firms are heterogeneous in productivity and only some of them are able to export (self-selection mechanism): consequently trade openness can lead to aggregate productivity gains within sector – even if firm-level performance remains constant – thanks to some business reallocation towards the more productive firms. Recent theoretical studies extend Melitz (2003) model to import behaviour and trade in intermediate inputs in order to show that the aggregate productivity within final good sector can increase thanks to efficiency improvement within firms able to access to foreign inputs as well as to some reallocation effects across firms (Gibson and Graciano (2011), Kasahara and Lapham (2013), Imbruno (2011)). Moreover, by taking into account both trade and FDI channels, Helpman, Melitz and Yeaple (2004) – HMY (2004) henceforth – demonstrate theoretically that the least productive firms can serve only the domestic market, the most productive firms are also able to serve the foreign market through establishing an affiliate abroad (i.e. horizontal FDI), whereas firms with intermediate productivity can serve the international market only by exporting. Consequently, a reduction in FDI barriers could entail an increase in aggregate productivity through a reallocation mechanism, similarly to a reduction in trade barriers. Harrison et al. (2012) explore empirically the impact of several international reforms – output

tariff, input tariff, (output) FDI and licensing – on Indian manufacturing sector's aggregate productivity, by disentangling productivity change linked to learning effect within firm and productivity change linked to reallocation effects across firms. They document that aggregate productivity gains found from output tariff cut, input tariff reduction and (output) FDI liberalization are mainly due to within-firm improvements, rather than some reallocation mechanism.

The current paper aims at studying how international integration of intermediate input market via both trade and FDI channels can affect firm-level efficiency, by considering that only some firms are able to import. First, we develop a theoretical model through extending HMY (2004)'s framework to the intermediate good sector and assuming that all firms within final good sector can easily access all inputs domestically produced – i.e. all intermediate goods arising from both domestic-owned suppliers and foreign-owned suppliers located within country (which correspond to FDI-makers within intermediate good sector) – while only importers can have access to additional intermediates produced abroad – i.e. inputs stemming from exporters within intermediate good sector. Through this simple model, we are able to show that input trade liberalization would determine an efficiency enhancement for importers because they are able to switch the worst domestic inputs with best ones from abroad, as well as a decrease in efficiency for non-importers due to a fall in domestic input availability; whereas input FDI liberalization would lead to some efficiency gains for non-importers linked to input switching effects, while the related impact on importers' efficiency appears to be ambiguous given that they also suffer additional losses from foreign input availability. Then, we attempt to investigate also empirically this issue by using firm-level data from Chinese manufacturing sector over the period 2002-2006 and the results turn out to be quite coherent with our theoretical predictions.

From theoretical point of view, our work seems to complement a recent study by Alfaro and Chen (2013), since they also extend HMY (2004)'s model in order to disentangle a firm-level efficiency effect of FDI openness. In particular, they show that (output) FDI can determine an increase in firm-level performance thanks to some horizontal knowledge spillovers, in addition to some industry-level productivity effect from reallocation mechanism as highlighted by HMY (2004). They also check empirically these predictions by using firm-level data across 60 countries over the period 2002-2007, estimating that 64% of aggregate productivity gains from FDI are due to the spillover effect, while the remaining 36% is linked to reallocation effect. Unlike their work, ours mainly emphasizes the effect of input FDI on firm-level efficiency, i.e. vertical spillover via forward linkages, in addition to the input tariff effect. From empirical side, our study is very close to Du, Harrison and Jefferson (2012)' evidence since they investigate the joint impact of trade tariffs, FDI and taxes on firm performance in China over the period 1998-2007. In particular, they focus relatively more on productivity spillovers from FDI (i.e. horizontal and vertical spillovers via both backward and forward linkages) by controlling also for trade policies (output tariffs, input tariffs and backward tariffs) and tax-related incentives for FDI. Their main results show that all productivity spillovers from FDI are generally positive, although horizontal spillovers occur only for domestic-owned firms, forward spillovers only for foreign-owned firms and backward spillovers for all firms. However, they also highlight that both positive vertical spillovers are much larger and evident for all firms after China's entry to WTO (i.e. from the year 2002). Unlike their study, we focus more on the productivity effect from different channels of international access to foreign inputs (both trade and FDI channels) over the post-WTO liberalization period only (time over which many trade and FDI barriers have been drastically removed), by discriminating between firms able to import from other firms since they can be affected in dissimilar way, as shown in our theoretical framework.

The rest of the paper is organized as follows. Section 2 presents the theoretical model. Section 3 reports the empirical evidence. Section 4 concludes.

2. Theory

This section sets up a two-country theoretical model to study the impact of international openness to heterogeneous intermediate inputs on firm-level efficiency, via two channels: trade and foreign direct investment (FDI).

2.1.   Setup of the model

There are two symmetric countries with same number of final consumers L, each endowed with one unit of labour inelastically supplied at common wage rate w. Each country has three sectors: a *final homogeneous good sector h*, where symmetric firms produce under perfect competition and constant returns to scale by using labour; a *final differentiated good sector y*, where firms homogenous in productivity produce their output under monopolistic competition and increasing returns to scale by using labour and differentiated intermediate inputs (as Krugman (1980) and Etheir (1982)); and an *intermediate differentiated good sector m*, where firms heterogeneous in productivity produce their output under monopolistic competition and increasing returns to scale through using labour only (as Melitz (2003)). By considering the main purpose of our study, we assume no FDI is allowed within final good sector as well as free trade in final goods. Moreover, only a given fraction ψ_y^M of firms within differentiated final good sector is assumed to be able to import intermediate inputs (through for instance a random allocation of import licences). Consequently, firms within intermediate good sector can decide to serve only a fraction of foreign market by export channel – which

is associated with an additional fixed cost proportional to the share of foreign market served[3] $\psi_y^M f$ and a variable trade cost (i.e. input tariff) τ_m – or alternatively the whole foreign market by FDI channel – which is associated with a higher fixed cost $f_I > f$.

2.1.1. Consumer preferences

In each country, a representative consumer has Cobb-Douglas preferences for the two composite goods arising from the two final good sectors respectively, so that a fraction β of income wL is spent on differentiated varieties y and a fraction $(1-\beta)$ on homogenous varieties h, as well as Constant Elasticity of Substitution (CES) preferences for varieties within differentiated good sector. More specifically, the utility function is:

$$U = Q_h^{1-\beta} Q_y^{\beta}$$

where Q_h is the aggregate consumption in homogeneous goods and Q_y is the aggregate consumption in differentiated goods, which in turn takes the following form:

$$Q_y = \left[\int_{y \in Y} q_y(y)^{\frac{\sigma-1}{\sigma}} dy \right]^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where $q_y(y)$ is the quantity consumed for each differentiated variety y, and $\sigma = \dfrac{1}{1-\rho} > 1$

denotes the elasticity of substitution between any two products within the set of all final differentiated varieties available Y. Therefore, while the demand for final homogenous good is $Q_h = \dfrac{(1-\beta)wL}{P_h}$, where P_h is the related price, the demand for a particular final differentiated variety y is given by:

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[3] A similar assumption has been made by Arkolakis (2010), by arguing that the foreign entry market cost turns out to be higher in markets with a higher share of potential buyers.

$$q_y(y) = \left[\frac{p_y(y)}{P_y}\right]^{-\sigma} \frac{R_y}{P_y} \tag{2}$$

where $R_y = \beta w L$ is the total spending in final goods which corresponds to the aggregate revenue within final good sector, $p_y(y)$ is the price of the variety y and P_y is the aggregate price index of all final differentiated available, which is dual to (1):

$$P_y = \left[\int_{y \in Y} p_y(y)^{1-\sigma} dy\right]^{\frac{1}{1-\sigma}} \tag{3}$$

2.1.2. *Final homogenous good sector*

In each country, symmetric firms produce homogenous varieties h under perfect competition and constant returns to scale through using labour only. In particular, one unit of output is assumed to be produced by one unit of labour so that the price of final homogenous variety P_h equals the wage rate w, and the related output is assumed to be freely traded so that wage equalization occurs across countries. We use this homogenous good as *numeraire* and normalize the related price to one, which automatically implies that the wage rate also equals one everywhere ($P_h = w = 1$)[4].

2.1.3. *Final differentiated good sector*

In each economy, there is a continuum of final good firms which are homogeneous in productivity φ_y (as in Krugman (1980)) and produce a differentiated variety y under monopolistic competition and increasing returns to scale by using labour for fixed costs and combining intermediate inputs m available arising from heterogeneous firms within

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[4] Similar assumptions have been used by other studies, such as Helpman, Melitz and Yeaple (2004).

intermediate sector. More specifically, final good technology is represented by the following CES production function

$$q_y = \varphi_y \left[\int_{m \in M} x_m(m)^{\frac{\sigma-1}{\sigma}} dm \right]^{\frac{\sigma}{\sigma-1}} \tag{4}$$

where q_y is the firm-level output, x_m is the quantity used for each differentiated input variety, and $\sigma = \dfrac{1}{1-\rho} > 1$ denotes the elasticity of substitution between any two inputs within the set of all intermediate differentiated varieties available M[5]. Thus, in each country, the final good firm-level demand for a particular intermediate differentiated variety m is given by:

$$x_m(m) = \left[\frac{p_m(m)}{P_m} \right]^{-\sigma} \frac{q_y}{\varphi_y} \tag{5}$$

where $p_m(m)$ is he price of the input variety m and P_m is the aggregate price index of all intermediate differentiated available, which is dual to q_y / φ_y in (4):

$$P_m = \left[\int_{m \in M} p_m(m)^{1-\sigma} dm \right]^{\frac{1}{1-\sigma}} \tag{6}$$

while the final good firm's total cost to serve the home market is:

$$c_y = \frac{P_m}{\varphi_y} q_y$$

It is worth noting that the marginal cost $mc_y = \dfrac{P_m}{\varphi_y}$ is endogenous and can be different across firms since it is increasing in price index of all intermediate inputs available P_m – which in turn is endogenous and can be different across firms – in addition to be decreasing in firm

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[5] The elasticity of input substitution is assumed to be the same as the elasticity of output substitution to save further notation and make the model as simple as possible.

productivity φ_y – which is however exogenous and common across all final good firms in our model. Each firm sets its price to maximize the profits subject to its residual demand (2):

$$p_y = \frac{P_m}{\rho \varphi_y} \tag{7}$$

In the interest of simplicity, we assume no FDI is allowed within final good sector as well as free trade in final goods so that each final good firm is able to serve the whole foreign market (i.e. no further variable cost to trade final goods). Consequently, final good firm-level total profit function is

$$\pi_y = \frac{2R_y}{\sigma} \left(\frac{P_y \rho \varphi_y}{P_m} \right)^{\sigma-1}$$

where the number 2 refers to the number of countries involved in international trade.

Moreover, we assume that while all final good firms can easily access all intermediate inputs produced domestically $M_D = M + M_I$ – i.e. all intermediates produced by both domestic-owned (M) and foreign-owned (M_I) input suppliers located within country – only a fixed fraction of them $\psi_y^M \in [0,1]$ are able to access an additional set of foreign intermediate inputs M_X by trade channel (through for instance a random allocation of import licenses). Therefore, the price index of intermediate inputs available (from equation (6)) for non-importers is

$$P_m^D = \left[\int_{m \in M} p_m(m)^{1-\sigma} dm + \int_{m \in M_I} p_m(m)^{1-\sigma} dm \right]^{\frac{1}{1-\sigma}} \tag{8}$$

whereas for importers is:

$$P_m^M = \left[\int_{m \in M} p_m(m)^{1-\sigma} \, dm + \int_{m \in M_I} p_m(m)^{1-\sigma} \, dm + \int_{m \in M_X} p_m^X(m)^{1-\sigma} \, dm \right]^{\frac{1}{1-\sigma}} \qquad (9)$$

where $p_m(m)$ is the price for each input variety produced within country $m \in M_D = M + M_I$

and $p_m^X(m)$ is the price paid for each imported input variety $m \in M_X$.

As in Melitz (2003), we assume that a firm has to pay a labour-intensive fixed cost to start up

a business f_e, therefore the expected average profit $\tilde{\pi}_y$ should be high enough to cover it, i.e.

the free entry condition for the final good sector is:

$$\tilde{\pi}_y = \left(1 - \psi_y^M\right)\pi_y^D + \psi_y^M \pi_y^M = f_e \qquad (10)$$

By considering that the average expected profit can be alternatively written as $\tilde{\pi}_y = \dfrac{R_y}{\sigma N}$,

from (10) we can highlight the exogenous number of final good firms located within each

country, i.e. the number of final differentiated varieties produced domestically:

$$N = \frac{R_y}{\sigma f_e}$$

While the price index of all final differentiated varieties available within country ($2N$) can be

written as:

$$P_y = \left(2N\right)^{\frac{1}{1-\sigma}} \left(\frac{P_m^H}{\rho \varphi_y} \right)$$

where P_m^H stands for the price index of intermediate inputs paid on average by all final good

producers:

$$P_m^H = \left[\left(1 - \psi_y^M\right)\left(P_m^D\right)^{1-\sigma} + \psi_y^M \left(P_m^M\right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}} \qquad (11)$$

2.1.4. Intermediate differentiated good sector

By plugging (2) and (7) into (5), we can realize that the final good firm-level demand for each intermediate variety is basically linked to some variables which are common across importers and non-importers:

$$x_m^D = x_m^M = x_m = p_m^{-\sigma} 2 R_y P_y^{\sigma-1} \rho^{\sigma} \varphi_y^{\sigma-1}$$

Thus, the demand for each intermediate variety by all final good firms located within a country is $q_m(m) = N x_m$, which can be easily written as follows[6]:

$$q_m(m) = \left[\frac{p_m(m)}{P_m^H} \right]^{-\sigma} \frac{R_m}{P_m^H} \tag{12}$$

where R_m is the total spending in intermediate goods which corresponds to the aggregate revenue within intermediate good sector.

The intermediate good technology assumes there is a continuum of firms heterogeneous in productivity φ_m which produce a differentiated variety under monopolistic competition and increasing returns to scale by using only labour. In particular, their linear production function is:

$$q_m = \varphi_m l$$

where q_m is firm level output and l denotes the labour units used.

By considering that the production of each variety m also requires a labour-intensive fixed cost f, the intermediate good firm's total cost to serve the home market is:

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[6] Through plugging (15) into (18) and by allowing for that the aggregate expenditure in final goods (i.e. aggregate revenues within final good sector) actually equals the aggregate expenditure in intermediate goods (i.e. aggregate revenues within intermediate good sector) increased by the mark-up: $R_m = \rho R_y$.

$$c_m = f + \frac{q_m}{\varphi_m}$$

Unlike in the final good sector, the marginal cost $mc_m = \frac{1}{\varphi_m}$ is exogenous, but is still

different across intermediate good firms, since it is inversely related only to firm productivity

φ_m, which in turn has been assumed to be constant but heterogeneous amongst firms (as in

Melitz (2003)). By facing the residual demand curve (12), each intermediate good firm sets

the domestic price

$$p_m(\varphi_m) = \frac{1}{\rho \varphi_m} \tag{13}$$

by yielding the following profit from home market

$$\pi_m(\varphi_m) = \frac{R_m \left(P_m^H \rho \varphi_m \right)^{\sigma-1}}{\sigma} - f \tag{14}$$

An intermediate good firm within each economy can also serve a given share ψ_y^M of foreign

final good firms by export channel – since we have assumed that only some final good

producers are able to import – by paying additional fixed cost proportional to the share of

importers $\psi_y^M f$ and facing per-unit iceberg variable trade cost $\tau_m > 1$[7]. For this reason, a

firm will set a higher export price and obtain a relatively lower profit from the international

market compared to the domestic one:

$$p_m^X(\varphi_m) = \frac{\tau_m}{\rho \varphi_m} = \tau_m p_m(\varphi_m) \tag{15}$$

$$\pi_m^X = \frac{\tau_m^{1-\sigma} \psi_y^M R_m \left(P_m^H \rho \varphi_m \right)^{\sigma-1}}{\sigma} - \psi_y^M f \tag{16}$$

Alternatively, an intermediate good firm can also decide to serve all foreign final good firms through FDI channel, i.e. establishing an affiliate abroad, by facing only an additional fixed cost, which however is assumed to be higher than domestic one $f_I > f$, similarly to HMY (2004). Thus, through FDI channel, an intermediate good firm will charge abroad the same price as the domestic price, obtaining however a relatively lower profit compared with the home market:

$$p_m^I (\varphi_m) = p_m (\varphi_m) \tag{17}$$

$$\pi_m^I (\varphi_m) = \frac{R_m \left(P_m^H \rho \varphi_m \right)^{\sigma-1}}{\sigma} - f_I \tag{18}$$

Furthermore, intermediate good firms enter the market by paying a fixed cost of entry f_e to draw their productivity φ_m from the Pareto cumulative distribution $G(\varphi_m) = 1 - (\varphi_m)^{-k}$, where $k > 1$, and then decide whether to exit the market or to stay. An input supplier will stay in the home market till its profit is positive: thus, through setting the equation (14) equals to zero (*Domestic Zero Profit Condition (D-ZPC)*), we can highlight the survival productivity threshold φ_m^D, i.e. the minimum level of productivity to survive. Similarly, an input supplier will serve the foreign market via trade channel only if the export profit is positive: through setting the equation (16) equals to zero (*Export Zero Profit Condition (X-ZPC)*), the export productivity threshold φ_m^X, i.e. the minimum level of productivity required to export, can be highlighted. Moreover, an input supplier will serve the foreign market through establishing an affiliate abroad only if the FDI profit is relatively larger than the export profit: by setting the equation (18) equal to the equation (16) (*FDI Zero Profit Condition (I-ZPC)*), we can

determine the FDI productivity threshold φ_m^I, i.e. the minimum level of productivity required to invest abroad. Finally, by allowing for that in each period there is an exogenous probability of exit δ, an input supplier will take into account the possibility to enter the market only if the expected value of profits is higher than the sunk fixed cost of entry f_e. Consequently, the free entry cutoff φ_m^D arises from the following *Free Entry Condition (FEC)*:

$$\left[1 - G\left(\varphi_m^D\right)\right]\frac{\widetilde{\pi}_m}{\delta} = f_e$$

where $1 - G\left(\varphi_m^D\right)$ is the probability of survival and $\widetilde{\pi}_m$ is per-period expected profits of surviving firms:

$$\widetilde{\pi}_m = \int_{\varphi_m^D}^{\infty} \pi_m(\varphi_m)\frac{g(\varphi_m)}{1 - G\left(\varphi_m^D\right)}d\varphi_m + \int_{\varphi_m^X}^{\varphi_m^I} \pi_m^X(\varphi_m)\frac{g(\varphi_m)}{1 - G\left(\varphi_m^D\right)}d\varphi_m + \int_{\varphi_m^I}^{\infty} \pi_m^I(\varphi_m)\frac{g(\varphi_m)}{1 - G\left(\varphi_m^D\right)}d\varphi_m$$

which in turn can simply be written as $\widetilde{\pi}_m = \left(\dfrac{\sigma - 1}{1 + k - \sigma}\right)\Delta_m$, where

$\Delta_m = f + \psi_m^X \psi_y^M f + \psi_m^I f_I$ is the average fixed cost paid by all intermediate good firms located within a country since $\psi_m^X = \dfrac{G\left(\varphi_m^I\right) - G\left(\varphi_m^X\right)}{1 - G\left(\varphi_m^D\right)}$ is the probability of exporting (or fraction of exporters) and $\psi_m^I = \dfrac{1 - G\left(\varphi_m^I\right)}{1 - G\left(\varphi_m^D\right)}$ denotes the probability of investing abroad (or portion of FDI-makers) within intermediate good sector. From all four conditions above, the uniqueness of equilibrium $\left(\varphi_m^D, \varphi_m^X, \varphi_m^I, \widetilde{\pi}_m\right)$ can be found, and both export cutoff φ_m^X and FDI cutoff φ_m^I can be written as function of survival cutoff φ_m^D:

$$\varphi_m^X = \tau_m \varphi_m^D$$

$$\varphi_m^I = \left[\frac{f_I - \psi_y^M f}{f\left(1 - \psi_y^M \tau_m^{1-\sigma}\right)} \right]^{\frac{1}{\sigma-1}} \varphi_m^D$$

Notice that $\varphi_m^I > \varphi_m^X > \varphi_m^D$ as long as $f_I > \tau_m^{\sigma-1} f$ and $\tau_m > 1$, i.e. the fixed cost related to FDI is sufficiently higher than the costs of exporting, which in turn are relatively higher than the domestic costs of production. From **Figure 1,** we can see that the least productive intermediate good firms will produce only for the home market (i.e. all firms whose productivity φ_m ranges between φ_m^D and φ_m^X), the most productive ones will also serve the whole foreign market by FDI channel (i.e. all firms whose productivity φ_m is higher than φ_m^I), while the remaining intermediate good firms (i.e. all firms whose productivity φ_m ranges between φ_m^X and φ_m^I) will serve a share of foreign market by export channel.

From *D-ZPC*, we can easily write the price index of intermediates paid on average by all final good firms located within a country P_m^H as function of survival cutoff φ_m^D

$$P_m^H = \left(\frac{R_m}{\sigma f} \right)^{\frac{1}{1-\sigma}} \frac{1}{\rho \varphi_m^D} \tag{19}$$

However, it is worth noting that importers' price index of intermediate inputs P_m^M turns out to be lower than non-importers' price index of intermediate inputs P_m^D, since they are related to the price index of intermediate inputs produced by domestic-owned suppliers P_m as follows[8]:

$$P_m^D = P_m \left[1 + \left[\frac{f_I - \psi_y^M f}{f\left(1 - \psi_y^M \tau_m^{1-\sigma}\right)} \right]^{\frac{\sigma-k-1}{\sigma-1}} \right]^{\frac{1}{1-\sigma}} \tag{20}$$

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[8] More details are provided in Appendix.

$$P_m^M = P_m \left[1 + \tau_m^{-k} + \left[\frac{f_I - \psi_y^M f}{f\left(1 - \psi_y^M \tau_m^{1-\sigma}\right)} \right]^{\frac{\sigma-k-1}{\sigma-1}} \left(1 - \tau_m^{1-\sigma}\right) \right]^{\frac{1}{1-\sigma}} \tag{21}$$

By plugging (20) and (21) into (11), P_m can also be related to P_m^H in the following way:

$$P_m = \left(\frac{\Delta_m}{f} \right)^{\frac{1}{\sigma-1}} P_m^H$$

Finally, from the average profit level and productivity thresholds, the mass of domestic-owned intermediate good firms located in each country can be derived:

$$M = \frac{R_m}{\sigma \Delta_m \left(\dfrac{k}{1+k-\sigma} \right)}$$

Therefore, the mass of all input suppliers located within a country – i.e. both domestic-owned and foreign-owned – which corresponds to the set of input varieties available for non-importers within final good sector is

$$M_D = M + M_I = \left(1 + \psi_m^I\right) M$$

where $M_I = \psi_m^I M$ denotes the mass of FDI-makers within intermediate good sector. Whereas, the mass of all input suppliers competing within a country which corresponds to the set of input varieties available for importers within final good sector is

$$M_M = M + M_I + M_X = \left(1 + \psi_m^I + \psi_m^X\right) M$$

where $M_X = \psi_m^X M$ denotes the mass of exporters within intermediate good sector.

2.2. Firm efficiency and international integration of intermediate input market

2.2.1. Trade integration of intermediate input market

Following a fall in input tariff τ_m, while export cutoff decreases $\frac{\partial \varphi_m^X}{\partial \tau_m} > 0$, both survival

cutoff and FDI cutoff increase $\frac{\partial \varphi_m^D}{\partial \tau_m} < 0$, $\frac{\partial \varphi_m^I}{\partial \tau_m} < 0$ within intermediate good sector: indeed,

while the fraction of exporters (or input supplier's probability of exporting) increases

$\frac{\partial \psi_m^X}{\partial \tau_m} < 0$, both fraction of survivors (or input supplier's probability of survival) and fraction

of FDI-makers (or input supplier's probability of investing abroad) decrease $\frac{\partial \psi_m^{in}}{\partial \tau_m} > 0$,

$\frac{\partial \psi_m^I}{\partial \tau_m} > 0$. Therefore, the least productive input suppliers are forced to exit the home market,

some pure domestic input suppliers start to export, and some input suppliers having affiliates

abroad decide to serve the foreign market through trade channel, by shutting down their

foreign affiliates. That implies an increase in aggregate productivity within intermediate good

sector due to some reallocation effects, which entails a fall in the price index of intermediates

on average paid by all final good firms located within a country $\frac{\partial P_m^H}{\partial \tau_m} > 0$. In other words,

final good firms on average increase their efficiency because they are able to replace the

worst domestic inputs with better imported foreign inputs (gains from input switching).

However, we are able to show that these gains concern importers only, since non-importers

actually suffer some efficiency losses from reduction in input tariff because of a decrease in

input availability: indeed, non-importers' price index of intermediates increases $\frac{\partial P_m^D}{\partial \tau_m} < 0$.

Testable prediction 1: *Following input trade integration, firm efficiency on average increases. However, while firms able to access intermediate inputs produced abroad (importers) enjoy some efficiency gains from input switching mechanism, the other firms (non-importers) suffer some efficiency losses from a decrease in domestic input availability.*

2.2.2. FDI integration in intermediate input market

A fall in fixed cost of FDI f_I determines a decrease in FDI cutoff $\dfrac{\partial \varphi_m^I}{\partial f_I} > 0$, and an increase

in both survival cutoff and export cutoff $\dfrac{\partial \varphi_m^D}{\partial f_I} < 0$, $\dfrac{\partial \varphi_m^X}{\partial f_I} < 0$ within intermediate good

sector: indeed, while the fraction of FDI-makers (or input supplier's probability of investing

abroad) rises $\dfrac{\partial \psi_m^I}{\partial f_I} < 0$, both fraction of survivors (or input supplier's probability of survival)

and fraction of exporters (or input supplier's probability of exporting) decline $\dfrac{\partial \psi_m^{in}}{\partial f_I} > 0$,

$\dfrac{\partial \psi_m^X}{\partial f_I} > 0$. Thus, the least productive input suppliers are forced to exit the home market, the

least productive export suppliers leave the international market, and the most productive

export suppliers decide to establish affiliates abroad. That implies some reallocation effects

within intermediate good sector again, which lead to an increase in aggregate productivity of

input suppliers, and therefore a fall in the price index of intermediates on average paid by all

final good firms located within a country $\dfrac{\partial P_m^H}{\partial f_I} > 0$. In other words, final good firms on

average increase their efficiency because they are able to replace the worst domestic inputs

with better inputs from new foreign-owned suppliers within country (gains from input

switching). However, we are able to show that these gains concern certainly non-importers,

and maybe also importers: indeed, while non-importers' price index of intermediates

decreases $\dfrac{\partial P_m^D}{\partial f_I} > 0$, the change in importers' price index of intermediates turns out to be

ambiguous $\dfrac{\partial P_m^M}{\partial f_I} = ?$, since importers simultaneously lose the possibility to access some

foreign inputs by trade channel.

Testable prediction 2: *Following input FDI integration, firm efficiency on average increases. However, while non-importers enjoy some efficiency gains from input switching mechanism, the effect on importers turns out to be ambiguous since they also suffer some additional efficiency losses from foreign input availability.*

3. Evidence

This section explores empirically the effect on firm-level productivity of international input market integration, through both trade and FDI channels simultaneously, within Chinese manufacturing sector over the years 2002-2006. For the purpose of our analysis, this country over the period mentioned above can be considered a very relevant case, since through the entry to WTO in December 2001, China reduced gradually both trade and FDI barriers as agreed within WTO accession protocol.

3.1. Data

Firm-level data are from two sources: the Chinese Annual Survey of Industrial Firms (CASIF), carried out by the National Bureau of Statistics in China (NBSC) – which includes information about all state-owned firms and private firms whose annual sales are above 5

million RMB (i.e. about 700 thousand USD), such as output, sales, fixed assets, intermediate inputs, number of employees, ownership status, location and industry – and the database of Chinese Customs Trade Statistics (CCTS), managed by the General Administration of Customs of China – which provides information about all international trade transactions, such firm name, code of imported or exported product, source or destination country, FOB value, quantity and unit value, custom regime, etc. By merging the data above, we obtain a single unbalanced panel of Chinese manufacturing firms with both production and trade information, through which we compute our dependent variable, i.e. firm-level total factor productivity (TFP) by using Olley-Pakes (1996) technique, as well as one of our main explanatory variables, i.e. *industry-level input foreign direct investment* FDI^m_{jt}, constructed as a weighted average of multinationals' domestic sales in total domestic sales in upstream sectors

$$FDI^m_{jt} = \sum_k w^{2002}_{kj} * \left(\frac{MNE\_domsales_{kt}}{ALL\_domsales_{kt}} \right) \qquad (22)$$

where the term w^{2002}_{kj} refers to input weights calculated from the Chinese input-output table for 2002, more specifically it is the share of inputs purchased by industry j from industry k in total inputs used by industry j. Therefore, FDI^m_{jt} proxies the extent of intermediate inputs sourced by firms arising from foreign-owned input suppliers located within country: an increase in FDI^m_{jt} entails a higher access to (foreign) inputs through FDI channel.

Moreover, the dataset has been integrated with tariff data downloaded from WITS[9] database, in order to compute our second main explanatory variable, i.e. *industry-level input tariff* τ_{jt}^{m}, calculated as a weighted average of output tariffs τ_{kt}^{y} in upstream sectors

$$\tau_{jt}^{m} = \sum_{k} w_{kj}^{2002} * \tau_{kt}^{y} \tag{23}$$

Thus, τ_{jt}^{m} proxies the extent of intermediate inputs sourced by firms arising from input suppliers located abroad: a decrease in τ_{jt}^{m} entails higher access to foreign inputs through trade channel. **Figure 2** displays the time evolution of both input tariff and input FDI in China over the period 2002-2006 and we can clearly notice that the international access to intermediate inputs increased through both trade and FDI channels.

3.2. Empirical strategy

In order to examine the relationship between firm-level efficiency and international integration of (intermediate) input market through both trade and FDI channels, and more specifically whether it is different between importers and non-importers as highlighted in theoretical section, we estimate the following baseline specification:

$$\ln TFP_{it} = \beta_1(1 - FM_{it})\tau_{jt}^{m} + \beta_2(FM_{it})\tau_{jt}^{m} + \beta_3(1 - FM_{it})FDI_{jt}^{m} + \beta_4(FM_{it})FDI_{jt}^{m} + \phi_i + \phi_t + \varepsilon_{it} \tag{24}$$

where $\ln TFP$ is the log of measured total factor productivity of firm i, in industry j at time t; τ^{m} is the industry-level input tariff; FDI^{m} is the industry-level input FDI; FM is a dummy variable taking value one if a firm directly import intermediate inputs, and zero otherwise; ϕ_i and ϕ_t denote firm fixed effects and time dummies respectively and ε is the

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error term. According to our theoretical predictions, we expect that a fall in input tariff entails an increase in importers' efficiency on the one hand ($\beta_2 < 0$), since they are able to replace the worst domestic inputs with better ones from abroad (*gains from input switching*), and a decline in non-importers' efficiency on the other hand ($\beta_1 > 0$), because of a decrease in domestic inputs available (*losses from input availability*). Moreover, we also expect that an increase in the relative presence of foreign-owned input suppliers located within country would imply some efficiency gains from input switching for non-importers ($\beta_3 > 0$), whereas input FDI's effect on importers' efficiency turns out to be ambiguous since the access to some foreign inputs becomes less costly ($\beta_4 > 0$) at the expenses of a fall in foreign input availability ($\beta_4 < 0$).

To rule out any effect that the process of input market integration may have on firm productivity through importer status of the firm or the probability of survival we restrict the sample to a balanced panel of firms that do not change their importer status over time. We end up to a sample of 9,608 firms, 14.5% of which are directly involved in import activity. **Table 1** displays the summary statistics of the main variables in the first year of our analysis (2002) as well as about their change over the whole period (2002-2006). As we can see, firms in our final sample on average faces an input tariff rate around 7.1% in 2002, which however decreased by about 1.6 percentage points over the entire period, while the input FDI extent was around 16.7% which on average increased by 2.4 percentage points. This evident increase in international openness of intermediate input market via both trade and FDI channels is in turn associated with an improvement in average efficiency of firms, since their TFP increased on average by 11.8% over the same period.

3.3. Results

Our main findings are reported in **Table 2,** where the errors have been always corrected for clustering at the firm level. We first regress TFP (in log) on input tariff and input FDI only in order to see how all firms' efficiency is on average affected by input market integration via both trade and FDI channels simultaneously. In line with our expectations, the column 1 displays that a fall in input tariff of 10 percentage points increases firm productivity by about 10.4%, while an increase in input FDI of 10 percentage points entails firm productivity's enhancement by about 14.6%.

The results concerning our baseline econometric equation (presented in the column 2) show that importers increase relatively less their productivity compared to non-importers from input FDI openness (12.3% versus 15.1%): therefore, it seems that all firms enjoy efficiency gains from input FDI due to some potential input switching effects, however these gains turn out to be lower for importers respect non-importers maybe because they also suffer some relevant losses from foreign inputs availability as pointed out within our theoretical framework. Moreover, the positive effect of input trade liberalization on TFP appears to be much higher for importers compared to non-importers (i.e. 21.7% versus 8.9%). Despite these results are quite in line with other empirical studies, such as Amiti and Konings (2007)'s evidence on Indonesia, they seem only partially coherent with our theoretical predictions: i.e. while importers' larger TFP gains reflect our theoretical story that these firms have a higher chance to replace the worst domestic inputs with better foreign inputs becoming more efficient, non-importers' smaller TFP gains from input tariff reduction are not contemplated within our theoretical framework, since non-importers are expected to lose in performance.

However, Defever, Imbruno and Kneller (2012) argue that some non-importers are actually invisible importers, i.e. some firms look like non-importers in the data, because they are not

directly involved in import activity, but they can however access inputs produced abroad thanks to trade intermediaries. For this reason, following their study, in the column 3, we interact all our variables of interest with a variable capturing the extent of indirect imports of intermediate inputs within sector in 2002, which is constructed as the weighted average of wholesale share of imports in upstream sectors using again the Chinese input-output table:

$$WS_{j,2002}^m = \sum_k w_{kj}^{2002} * \left(\frac{INDIRECT\_imports_{kj}^{2002}}{TOTAL\_imports_{kj}^{2002}} \right)$$

The average value of this variable is around 0.151, i.e. in 2002, about 15.1% of imported foreign inputs used for Chinese manufacturing production have been acquired through trade intermediaries. There is relevant variation in the extent of input trade intermediation across sectors. For example, sectors such as Medicines (20.3%) and Chemicals (22.3%) use more intensively the indirect import channel, whereas Food (7.8%) and Textiles (13.3%) adopt relatively more the direct import channel.

First, we can notice that the effects of input tariff liberalization are still in line with Defever, Imbruno and Kneller (2012)'s main findings despite input FDI has been also accounted for: i.e. following input tariff cut, while importers' TFP increases regardless of the presence of input trade intermediaries within sector, non-importers' TFP enhances only if input trade intermediation within sector is relatively high, otherwise it can even decline. The value of trade intermediation $WS_{j,2002}^m$ for which the input tariff effect passes from negative to positive is 0.131 (13.1%). This can be considered as an evidence that firms able to import directly or indirectly can enjoy some efficiency gains from input trade openness thanks to input switching effects, whereas the other firms suffer efficiency losses due to decrease in input varieties available. Moreover, it is worth noting that while importers' TFP gains from input FDI are independent of the presence of input wholesalers within sector, the effect of input

FDI on non-importers' performance might be still positive and even larger if the industry-level input trade intermediation is relatively low, or negative if the extent of indirect imports of intermediate inputs is quite high. The value of wholesaling import share for which input FDI effect changes sign is around 0.391 (39.1%). The latter results confirm the hypothesis that following input FDI openness, while firms unable to access at all intermediate inputs produced abroad would obtain the largest efficiency benefits linked to input switching mechanism, firms able to import (directly or indirectly) can enjoy smaller gains or suffer even losses in efficiency (due to a decrease in foreign inputs availability). Therefore, by accounting for the role of wholesalers in importing inputs, the results seem to be more coherent with our theoretical predictions.

To summarize, in sectors where the share of input trade intermediation is

- below 13%, non-direct importers gain from input FDI and lose from input trade

- between 13% and 39%, non-direct importers gain from both input FDI and input trade

- above 39%, non-direct importers gain from input trade and lose from input FDI.

Notice that the Chinese manufacturing sector on average lies within the second range. In particular, for the mean value of indirect importing (0.151), the mean change in input tariffs (-1.6 percentage points) and the mean change in input FDI (+2.4 percentage points) as described in **Table 1,** our results estimate that non-direct importers' TFP increased on average by 4.8%. More specifically, about 1/5 of these TFP gains were from input trade channel and the remaining 4/5 came from input FDI channel. Conversely, direct importers' productivity gains seem to be not directly linked to trade intermediation within sector, however their TFP gains from input market integration via both trade and FDI become more visible as the role of wholesalers is accounted for. Our results estimate some TFP gains from

input market integration around 12.1% for direct-importers: about 1/3 of these benefits were due to the trade channel and 2/3 occurred via FDI channel.

These findings are quite robust as we control for other relevant industrial-level variables in column 4 – such as the output tariff and output FDI, which respectively capture the competition effect arising from imports and FDI occurring within the same industry of firms – and other firm characteristics in column 5 – such as exporter and foreign ownership dummies, which capture other international statuses of firms that can affect productivity. Finally, we wonder whether these results concern only foreign-owned firms because they are more likely to import from their multinational network (intra-firm trade) or to have much closer leakages with foreign-owned input suppliers (for instance, some foreign-owned firms can be even the owner of some input suppliers located in China). For this reason, we restrict our sample to Chinese-owned firms only in column 6: while the findings about non-importers remain unchanged, Chinese-owned importers' seem to gain solely from input FDI.

Finally, in the **Table 3**, we attempt to address the potential endogeneity problem of our main explanatory variables: input tariff and input FDI. If the most productive sectors lobby for lowering input tariffs, the predominant negative relationship documented between input tariffs and firm productivity may be biased due to this reverse causality. Similarly, the main positive linkage between input FDI and firm performance could be due to the fact that only the sectors with high productivity firms are able to adopt a higher technology embodied in intermediate inputs produced by foreign-owned suppliers. We use the instrumental variable approach to estimate the difference model of the specification in column 5 and 6 of the Table 2. Changes in input tariffs (and their interactions) have been instrumented through Indian input tariffs levels over the first years of India's accession to WTO, by considering that both China and India are emerging economies and the initial WTO commitments to reduce tariffs are more likely to be similar between these two countries, whereas Indian input tariffs are not

directly related to changes in Chinese firms' productivity[10]. Changes in input FDI (and its interactions) have been instrumented by the weighted average of FDI restrictiveness indexes computed by OECD for China in upstream sectors, by allowing for that these indexes can influence directly the presence of foreign-owned firms within sectors and are more likely to be exogenous respect with Chinese firms' performance[11]. The FDI restrictiveness index focuses on four types of measures: equity restrictions, screening and approval requirements, restrictions on foreign key personnel, and other operational restrictions (such as limits on purchase of land or on repatriation of profits and capital)[12]. Moreover, we also include the Indian output tariffs to measure the trade protection and therefore the level of lobbying across sectors and time: larger output tariff means stronger lobby for international protection within sector on the one hand, and less stringent international restrictions in upstream sectors (i.e. lower trade and FDI barriers to intermediate inputs)[13]. The instruments pass standard tests for their validity including both weak identification[14] and overidentification tests[15] for both the whole sample (column 1) and the subsample of Chinese-owned firms (column 2). The endogeneity test always rejects the null hypothesis that our instrumented variables are exogenous[16].

Overall, the results in Table 3 appear to be in line with the former findings, although the magnitude of the coefficients turns out to be larger. Firms not engaged in direct imports keep benefitting from an input FDI enhancement and losing from reduction in input tariff if the

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[10] Notice that this instrument has been computed as the weighted average of Indian output tariffs in upstream sectors, where the weights are from the Chinese input-output table and Indian output tariffs are from the first five years available from WITS database after India's accession to WTO in 1995, i.e. for the years 1996, 1997, 2000, 2001 and 2002.

[11] Since the data are available only for three years (1997, 2003 and 2006), in order to keep all years in our sample and the highest variation of the FDI index over time, we have assumed that 2002 index was as 1997 index, 2004 index was as 2003 index and 2005 index was as 2006 index.

[12] See Kalinova et al. (2010) for more details.

[13] See Kalinova et al. (2010) for more details.

[14] Kleibergen-Paap rk Wald F statistic is above the critical values listed in the Table 1 of Stock and Yogo (2005) in all specifications (it ranges from 40.64 and 30.96).

[15] The p-value of Hansen J-statistic ranges from 0.107 to 0.244.

[16] The p-value of Endogeneity statistic is 0.000 across all specifications.

presence of import intermediation within sector is relatively low. While reverse effects are found for these firms again if wholesalers play a relevant role into importing inputs within sector. Finally, while direct importers increase their performance thanks to input FDI and regardless of the presence of trade agents as before, now we document that these firms benefit from input tariff reduction only if trade intermediation within sector is relatively low, otherwise they can even lose in performance: i.e. trade intermediaries seem to reallocate foreign inputs (produced abroad) from direct importers to the other manufacturing firms within sector. However, all these effects on direct-importers would vanish as we focus on Chinese-owned firms only.

4. Conclusion

This paper aims at studying theoretically and empirically the impact on firm-level efficiency of international openness to foreign intermediate inputs through both trade and FDI channels. In particular, by extending Helpman. Melitz and Yeaple (2004)'s theoretical framework to intermediate good sector and using data from Chinese manufacturing firms, this paper shows that *i)* trade integration of intermediate input market would generate some efficiency gains for importers – linked to potential input switching effects – and some efficiency losses for non-importers – due to a fall in domestic input availability – whereas *ii)* FDI integration of intermediate input market can determine efficiency improvement for firms unable to import at all – thanks to potential input switching effects – while importers' efficiency can either increases or decreases – because of additional efficiency losses linked to a decline in foreign input availability.

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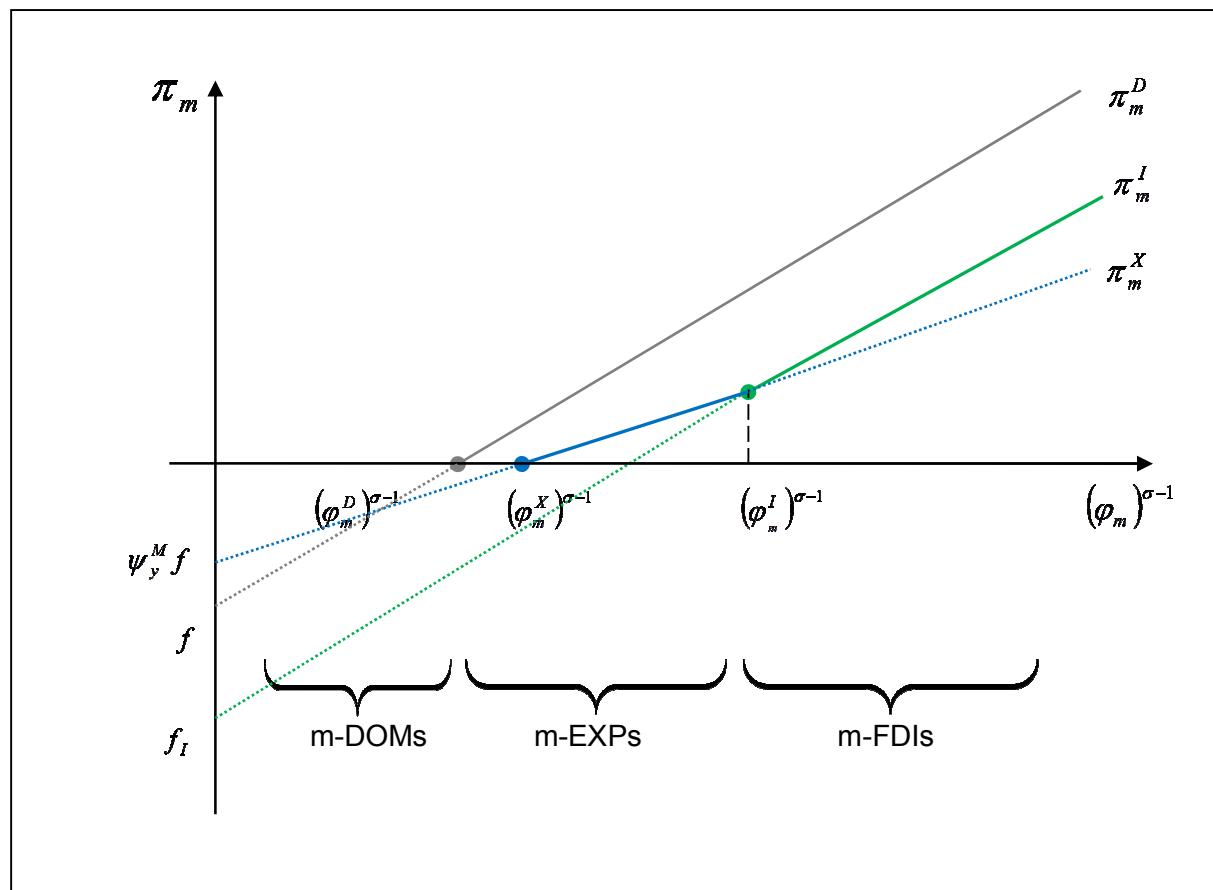**Figure 1- Intermediate good sector: Exports versus Horizontal FDI**

Figure 2 – Industry-level Input tariff and input FDI over time
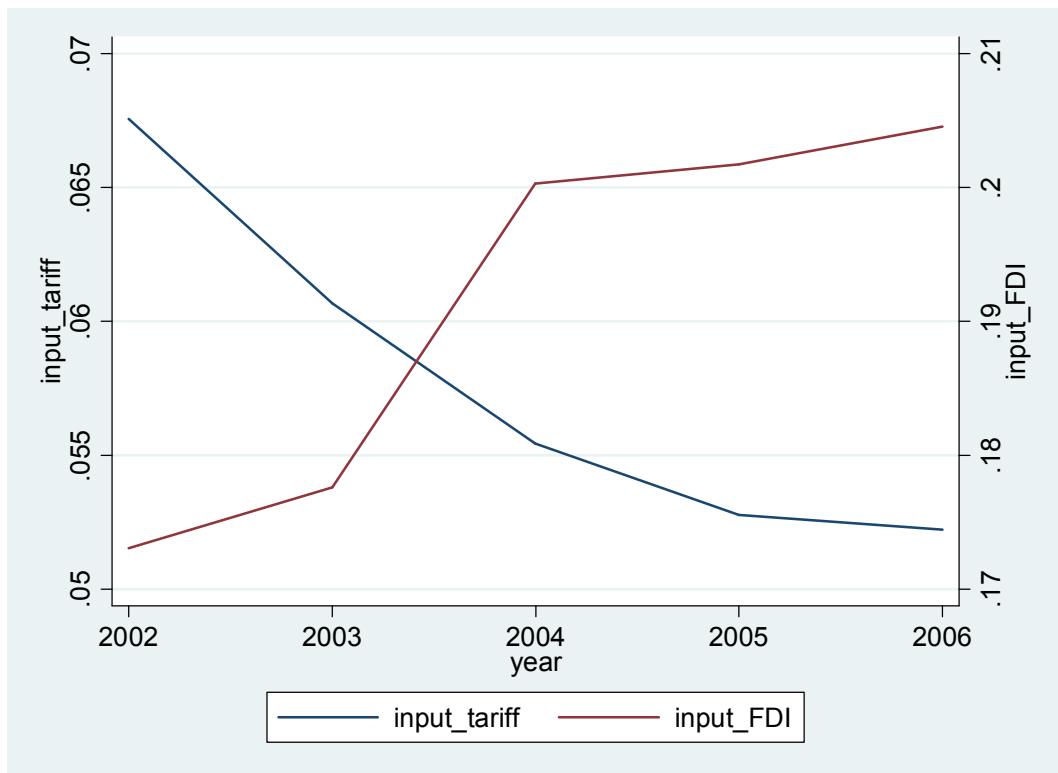
Table 1 – Summary statistics (balanced panel of 9,608 firms)

Variables	level in 2002		change over 2002-2006	
	Mean	Std. Dev.	Mean	Std. Dev.
FM	0.1451	0.3522	0.0000	0.0000
$\ln TFP$	0.6448	0.2983	0.1183	0.3463
τ^m	0.0713	0.0265	-0.0165	0.0125
FDI^m	0.1671	0.1184	0.0240	0.0375

Table 2 - Input tariff, input FDI and Firm efficiency

Dependent variable: *ln TFP* (O&P)	(1) All firms	(2) All firms	(3) All firms	(4) All firms	(5) All firms	(6) Chinese-owned firms
Input tariff	-1.045***					
	(0.254)					
Input FDI	1.465***					
	(0.0660)					
Non-direct-importers						
Input tariff		-0.889***	4.158***	5.497***	5.488***	6.290***
		(0.267)	(0.896)	(0.921)	(0.921)	(0.985)
Input tariff*Input WS$_{2002}$			-31.77***	-36.06***	-36.01***	-41.16***
			(5.426)	(5.433)	(5.434)	(5.672)
Input FDI		1.515***	2.593***	2.526***	2.517***	3.199***
		(0.0775)	(0.353)	(0.353)	(0.353)	(0.399)
Input FDI*Input WS$_{2002}$			-6.632***	-6.551***	-6.506***	-9.499***
			(1.980)	(1.975)	(1.975)	(2.179)
Direct-importers						
Input tariff		-2.175***	-5.086***	-4.299**	-4.385**	-3.865
		(0.398)	(1.831)	(1.827)	(1.828)	(3.857)
Input tariff*Input WS$_{2002}$			17.97	17.94	18.49	18.92
			(11.37)	(11.29)	(11.29)	(27.76)
Input FDI		1.226***	1.635***	1.696***	1.700***	1.758*
		(0.110)	(0.508)	(0.503)	(0.504)	(1.036)
Input FDI*Input WS$_{2002}$			-2.167	-2.673	-2.697	-1.365
			(2.946)	(2.908)	(2.915)	(6.044)
Output tariff				-0.437***	-0.436***	-0.489***
				(0.0697)	(0.0697)	(0.0755)
Output FDI				0.0869***	0.0863***	0.102***
				(0.0274)	(0.0274)	(0.0331)
Exporter dummy					0.0118	0.0315***
					(0.00758)	(0.00924)
Foreign ownership dummy					0.0127	
					(0.0168)	
Firm Fixed effects	√	√	√	√	√	√
Time dummies	√	√	√	√	√	√
Observations	46977	46977	46977	46977	46977	36460
R-squared	0.060	0.060	0.062	0.063	0.063	0.059
Number of firms	9559	9559	9559	9559	9559	7519

Notes: Standard errors (in parentheses) have been corrected for clustering at the firm level.
Significance at: *** 1%, ** 5%, * 10%.

Table 3 – Endogeneity: Instrumental Variables Approach

Dependent variable: $\Delta ln\ TFP$ (O&P)	(1) All firms	(2) Chinese-owned firms
Non-direct-importers		
ΔInput tariff	15.92***	16.33***
	(3.050)	(3.379)
ΔInput tariff*Input WS_{2002}	-60.14***	-63.85***
	(14.01)	(15.36)
ΔInput FDI	15.10***	13.40***
	(2.590)	(2.808)
ΔInput FDI*Input WS_{2002}	-51.58***	-44.15***
	(13.13)	(14.23)
Direct-importers		
ΔInput tariff	-14.79***	-15.11
	(4.644)	(12.12)
ΔInput tariff*Input WS_{2002}	109.1***	122.1
	(30.81)	(92.89)
ΔInput FDI	6.593***	5.458
	(1.683)	(3.607)
ΔInput FDI*Input WS_{2002}	-9.414	-4.313
	(10.53)	(25.84)
ΔControls	√	√
Time dummies	√	√
Observations	37345	28869
R-squared	-0.195	-0.134
F-statistic for weak identification	40.64	30.96
Overidentification Hansen J statistic	2.604	1.357
p-value	0.107	0.244
Endogeneity statistic	556.592	414.717
p-value	0.000	0.000

Notes: Standard errors (in parentheses) have been corrected for clustering at the firm level.
Significance at: *** 1%, ** 5%, * 10%.
Instruments: Indian input tariffs (and its interactions), Input FDI restrictiveness indexes (and its interactions) and Indian output tariffs
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