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Firm Efficiency and Input Market Integration:

Trade versus FDI

By

Michele Imbruno



The Author

Michele Imbruno is an assistant professor at IMT Institute for Advanced Studies, Lucca (Italy), and a research fellow at The Leverhulme Centre for Research on Globalisation and Economic Policy (GEP), Nottingham (UK).

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Abstract

This paper highlights the crucial role played by international access to intermediate inputs to explain 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). At the same time, 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 the Chinese manufacturing sector over the period 2002-2006, we find some results coherent with our theoretical predictions.

JEL: F12, F14, F23

Keywords: Heterogeneous firms, Trade liberalization, FDI, Intermediate inputs, Productivity

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1. Introduction

Understanding the relationship between global economic integration and economic growth is a longstanding issue in academic and policy debates. A large strand of literature in international economics 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 the 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. The study finds that firms increase their productivity owing to both sides of tariff liberalization. Similar findings have been documented by Goldberg, Khandelwal, Pavcnik, and Topalova (2010) and Khandelwal and Topalova, (2011) for India, where the input tariff impact is found to be even larger than the output tariff one.¹ Using Indonesian data, Amiti and Konings (2007) discriminate the input tariff effect between importers and non-importers, and document that the former benefit relatively more than the latter in terms of productivity 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-importers within the Chinese manufacturing sector actually gain from input trade liberalization as 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

¹ Other 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, 2014) and conclude that the productivity gap between importers and other firms is due to both self-selection mechanism and post-import effects.

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 learning or competition effects from foreign-owned competitors within the same sector (horizontal spillover) or some technical support from their foreign-owned customers within downstream sectors (vertical spillover via backward linkages). While very few papers develop theoretical frameworks to incorporate spillover channels from FDI (see Rodriguez-Claire, 1996, and Markusen and Venables, 1999), a large amount of empirical evidences present mixed results. For instance, by simultaneously examining FDI spillovers through horizontal, backward and forward leakages, Driffield, Munday and Roberts (2002) find robust evidence of positive forward vertical spillover within the UK manufacturing sector, whereas Javorcik (2004) finds stronger evidence of positive backward spillover amongst Lithuanian firms. Using data for the period 1998-2001, Liu, Wang and Wei (2009) document that Chinese firms increase their performance mainly through vertical spillovers from FDI, i.e. via both forward and backward linkages with multinationals (MNEs) located within country.²

The theoretical studies by Rodriguez-Claire (1996) and Markusen and Venables (1999) focus on FDI in the final good sector – assuming no trade and no FDI within the 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 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. From a theoretical perspective, no attention has been paid to FDI in the 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 literature, highlighting new interesting insights that we also explore empirically.

The “new new trade theory”, born in the last decade with 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

² See Görg and Greenaway (2004) for an empirical literature survey, as well as Havranek and Irsova (2011) for a recent meta-analysis of empirical evidences on spillovers from FDI.

aggregate productivity gains within sector – even if firm-level performance remains constant – owing to some business reallocation towards the more productive firms. Recent theoretical studies have extended Melitz (2003)’s model to import behaviour and trade in intermediate inputs to show that the aggregate productivity within final good sector can increase owing to efficiency improvements within firms that are able to access foreign inputs as well as some reallocation effects across firms (Gibson and Graciano, 2011, Kasahara and Lapham, 2013, Imbruno, 2014). 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 by exporting. Accordingly, a reduction in FDI barriers could entail an increase in aggregate productivity through a reallocation mechanism, similar to a reduction in trade barriers. Harrison, Martin and Nataraj (2012) explore empirically the impact of several international reforms – output tariff, input tariff, (output) FDI and licensing – on the 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.

Our 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 the 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). Moreover, we also assume that 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 show that input trade liberalization determines an efficiency enhancement for importers, as they are able to switch the worst domestic inputs with best ones from abroad, and a decrease in efficiency for non-importers due to a fall in domestic input availability. Conversely, input FDI liberalization leads to 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 empirically this issue by using firm-level data from the 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 complements two recent studies on FDI and heterogeneous firms, developed by Alfaro and Chen (2013) and Carluccio and Fally (2012). The first study also extends HMY (2004)'s model to disentangle a firm-level efficiency effect of FDI openness, but it neglects the role of vertical linkages. It shows that (output) FDI can determine an increase in firm-level performance thanks to horizontal knowledge spillovers, in addition to some industry-level productivity effect from reallocation mechanism. The second work builds a heterogeneous-firm model to study the vertical spillovers from FDI via backward linkages, but it ignores any role played by FDI within the intermediate good sector and consequently the related vertical forward spillovers. By assuming that final good firms can use intermediate inputs from local suppliers only, their framework shows that following a decrease in fixed cost of (output) FDI, more foreign final good producers enter the market and more firms within both final good and intermediate good sectors will upgrade their technology. Consequently, high-productivity firms enjoy efficiency gains, and low-productivity firms suffer losses from input varieties. Therefore, unlike these two studies, 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.

At empirical level, our work is very close to Du, Harrison and Jefferson (2014) 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 by controlling also for trade policies. Their main results show that all productivity spillovers from FDI are generally positive, although horizontal spillovers occur for domestic-owned firms only, backward spillovers for foreign-owned firms only, and forward spillovers for all firms. They also document that vertical spillovers are much larger and evident for all firms after China's entry to WTO (i.e. since 2002) and if they arise from subsidized FDI. Differently from their study, we focus on the productivity effect from different channels of international access to foreign inputs (trade and FDI) over the post-WTO liberalization period only (time over which many trade and FDI barriers have been drastically removed), by

discriminating firms able to import from other firms, since they can be affected in a 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 , which is chosen as our *numeraire* ($w=1$). Each country has two differentiated good sectors, which are vertically interrelated to each other: a *final good sector* y , where firms are homogenous in productivity and produce their output under monopolistic competition and increasing returns to scale by using labour and differentiated intermediate inputs (as in Krugman, 1980, and Ethier, 1982); and an *intermediate good sector* m , where firms are heterogeneous in productivity and produce their output under monopolistic competition and increasing returns to scale through using labour only (as in Melitz, 2003). We assume that no FDI is allowed within the final good sector as well as free trade in final goods. Moreover, only a given fraction ψ_y^M of firms within the final good sector are assumed to be able to import intermediate inputs, through for instance a random allocation of import licences. Consequently, firms within the intermediate good sector can decide to serve only a fraction of the foreign market using the export channel – which is associated with an additional fixed cost proportional to the share of foreign market served³ $\psi_y^M f$ and a variable trade cost (i.e. input tariff) $\tau_m > 1$ – or alternatively the whole foreign market by the FDI channel – which is associated with a larger fixed cost $f_I > f$.

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.

2.1.1. Consumer preferences

In each country, a representative consumer has Constant Elasticity of Substitution (CES) preferences for varieties within the differentiated good sector. More specifically, the utility function is:

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

where Q_y is the aggregate consumption in differentiated goods, $q_y(y)$ is the quantity consumed for each differentiated variety y , and $\sigma = \frac{1}{1-\rho} > 1$ denotes the elasticity of substitution between any two products within the set of all final varieties available Y . Therefore, the demand for a particular final variety y is given by:

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

where $R_y = wL$ 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):

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

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

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

where q_y is the firm-level output, x_m is the quantity used for each differentiated input variety, and $\sigma = \frac{1}{1-\rho} > 1$ denotes the elasticity of substitution between any two inputs within the set of all available intermediate differentiated varieties M .⁴ Thus, in each country, the final good firm-level demand for a particular intermediate differentiated variety m is given by:

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

where $p_m(m)$ is the 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):

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

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 $mc_y = \frac{P_m}{\varphi_y}$ 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 productivity φ_y – which is 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):

$$p_y = \frac{P_m}{\rho \varphi_y} \quad (7)$$

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

⁴ 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.

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

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 by trade channel (M_X), through for instance a random allocation of import licenses. Therefore, the price index of intermediate inputs available for non-importers is:

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

whereas for importers is:

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

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 , and the expected average profit $\tilde{\pi}_y$ should be high enough to cover it. Thus, the free entry condition for the final good sector is:

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

By considering that the average expected profit can be alternatively written as $\tilde{\pi}_y = \frac{R_y}{\sigma N}$, 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 varieties available within country ($2N$) can be written as:

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

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

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

2.1.3. 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:

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

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

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

where R_m is the total spending in intermediate goods, which corresponds to the aggregate revenue within the intermediate good sector.⁵

In the intermediate good sector, there is a continuum of firms heterogeneous in productivity φ_m that produce a differentiated variety under monopolistic competition and increasing returns to scale by using labour only. 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. 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 $c_m = f + \frac{q_m}{\varphi_m}$.

⁵ 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: $R_m = \rho R_y$.

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 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

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

yielding the following profit from home market

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

An intermediate good firm within each economy can also serve a given share ψ_y^M of foreign final good firms by the 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 $\tau_m > 1$.⁶ 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:

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

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

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 an additional fixed cost only, which however is assumed to be larger than domestic one $f_t > f$, similarly to HMY (2004). Thus, through the FDI channel, an intermediate good firm will charge abroad the

⁶ Notice that if exporters within final good sector are able to serve the whole foreign market similarly to HMY's model ($\psi_y^M = 1$), they have to face an additional fixed cost equivalent to the domestic fixed cost f unlike HMY's model (where the fixed cost of exporting has been assumed be larger $f_x > f$). Consequently, the self-selection into export market takes place via variable trade cost only in our setup, rather than via both variable and fixed cost of exporting as in HMY's model.

same price as the domestic price, obtaining however a relatively lower profit compared with the home market:

$$p_m^I(\varphi_m) = p_m(\varphi_m) \quad (17)$$

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

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, by setting equation (14) equal 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 the trade channel only if the export profit is positive. Therefore, by setting equation (16) equal to zero (*Export Zero Profit Condition (X-ZPC)*), we can define the export productivity threshold φ_m^X , i.e. the minimum level of productivity required to export. 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 equation (18) equal to 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)*:

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

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

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

which in turn can simply be written as $\tilde{\pi}_m = \left(\frac{\sigma-1}{1+k-\sigma} \right) \Delta_m$, 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 $\psi_m^X = \frac{G(\varphi_m^I) - G(\varphi_m^X)}{1 - G(\varphi_m^D)}$ is the probability of exporting (or

fraction of exporters) and $\psi_m^I = \frac{1 - G(\varphi_m^I)}{1 - G(\varphi_m^D)}$ denotes the probability of investing abroad (or

portion of FDI-makers) within intermediate good sector. From all four conditions above, the

uniqueness of equilibrium $(\varphi_m^D, \varphi_m^X, \varphi_m^I, \tilde{\pi}_m)$ 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 :

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

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

Note 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 larger than the costs of exporting, which in turn are relatively higher than the domestic costs of production.

[Insert **Figure 1** Here]

Figure 1 displays that the least productive intermediate good firms will produce for the home market only (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 the 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 the 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

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

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:

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

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

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:

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

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:

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

where $M_I = \psi_m^I M$ denotes the mass of FDI-makers within the intermediate good sector. At the same time, 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:

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

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 the export cutoff decreases $\frac{\partial \varphi_m^X}{\partial \tau_m} > 0$, both the

survival cutoff and the FDI cutoff increase $\frac{\partial \varphi_m^D}{\partial \tau_m} < 0$, $\frac{\partial \varphi_m^I}{\partial \tau_m} < 0$ within the 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 the fraction of survivors (or input supplier's probability of

survival) and the 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 the trade

channel, by shutting down their foreign affiliates. That implies an increase in aggregate

productivity within the 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 as they are able to replace the worst domestic inputs with better imported foreign

inputs (gains from input switching). However, we show that these gains concern importers

only, since non-importers actually suffer 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 the FDI cutoff $\frac{\partial \varphi_m^I}{\partial f_I} > 0$, and an increase in both the survival cutoff and the export cutoff $\frac{\partial \varphi_m^D}{\partial f_I} < 0$, $\frac{\partial \varphi_m^X}{\partial f_I} < 0$ within the intermediate good sector. Indeed, while the fraction of FDI-makers (or input supplier's probability of investing abroad) rises $\frac{\partial \psi_m^I}{\partial f_I} < 0$, both the fraction of survivors (or input supplier's probability of survival) and the fraction of exporters (or input supplier's probability of exporting) decline $\frac{\partial \psi_m^{in}}{\partial f_I} > 0$, $\frac{\partial \psi_m^X}{\partial f_I} > 0$. Thus, the least productive input suppliers are pushed 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 the 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 $\frac{\partial P_m^H}{\partial f_I} > 0$. In other words, final good firms on average increase their efficiency as 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 show that these gains concern certainly non-importers, and maybe also importers: indeed, while non-importers' price index of intermediates decreases $\frac{\partial P_m^D}{\partial f_I} > 0$, the change in importers' price index of intermediates turns out to be ambiguous $\frac{\partial P_m^M}{\partial f_I} = ?$, 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 as they also suffer some additional efficiency losses from foreign input availability by the trade channel.*

3. Evidence

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

First, all trade tariffs have been bound at values close to applied tariffs, whose the average rate was about 12.2 percent. Then, China made several commitments to further reduce tariffs, extend trading rights and remove non-tariff barriers (NTBs) – such as quotas, licenses, tendering requirements and price controls – by the first three years of the WTO liberalization. In 2005, the applied rate was around 9.7 percent, trading rights were fully liberalized and the majority of NTBs were eliminated. Thus, tariffs remain one of main trade policy instruments in China.⁷

Several restrictions to inward FDI firms have also been removed after China joined the WTO: *a)* FDI firms are not compelled anymore to use exclusively their own foreign exchange funds to make payments or remittances abroad, but they can purchase the foreign currency from commercial banks; *b)* FDI firms are not required anymore to export at least 70 percent of their output and to give priority to domestic suppliers when sourcing their inputs, but they are free to outsource and sell from/to everywhere; *c)* FDI firms do not have to file their business plan with the government authority anymore; *d)* legal environment for inward cross-border Merger&Acquisitions has become more flexible. Moreover, both industrial and fiscal policies have been oriented to attract foreign direct investors, such as the Provisions on Guiding the Orientation of Foreign Investment issued in 2002 – which classified FDI into ‘encouraged’, ‘permitted’, ‘restricted’, and ‘prohibited’ – and many tax incentives and tax

⁷ See WTO’s China Trade Policy Review (2006) for more details.

holidays offered to FDI firms until 2007, when the tax system has been unified for domestic and foreign firms.

All these international openness reforms contributed to the enhancing role of China into both imports and inward foreign direct investments, which can be considered amongst the main drivers of its economic growth and export performance in the last decade.⁸

3.1. Data and main variables

Our analysis is based upon firm-level data of the Chinese manufacturing sector from two main 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 4-digit industry (GB/T4754 or CIC)⁹ – 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 as firm name, code of imported or exported product at 8-digit HS level, 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, and compute our dependent variable, i.e. firm-level total factor productivity (TFP). To account for labour L and capital K in addition to (CES combination of) intermediate inputs X_m to measure empirically firm productivity, we extend equation (4) to the Cobb-Douglas production function:

$$q_y = \varphi_y L^{\gamma_l} K^{\gamma_k} X_m^{\gamma_m} \quad (22)$$

which can be rearranged in the following way:

$$q_y = \Phi_y L_y^{\gamma_l} K^{\gamma_k} E_m^{\gamma_m} \quad (23)$$

⁸ See Chen (2011) for further discussion.

⁹ GB/T4754 is the four-digit Chinese Industrial Classification (CIC). There are two editions about this classification over the analysed period: GB/T4754-1994 and GB/T4754-2002. The former (renamed CIC02) has been used until 2002 and the latter (renamed CIC03) has been used from 2003. In particular, we have used a concordance table constructed by Brandt, Van Biesebroeck, Wang, and Zhang (2012), to have a time-consistent information of the industry for each firm.

where γ_l , γ_k and γ_m denote the factor shares of production, $E_m = P_m X_m$ is firm's total costs in intermediate inputs, which is the typical information available and used empirically to proxy firm consumption in intermediates, and $\Phi_y = \varphi_y P_m^{-\gamma_m}$ is the *measured TFP*, which is composed of an exogenous Hicks-neutral productivity term φ_y and an endogenous component $P_m^{-\gamma_m}$ that incorporates the efficiency effect from trade in intermediate inputs. Then, for each 2-digit CIC sector, we estimate the logarithmic form of equation (23):

$$\ln q_{it} = \gamma_0 + \gamma_l \ln L_{it} + \gamma_k \ln K_{it} + \gamma_m \ln E_{it}^m + u_{it} \quad (24)$$

where q_{it} is measured as the nominal value of industrial output, deflated by *ex-factory price index at 2-digit industry level*, labour L_{it} refers to the number of employees, capital K_{it} is defined as the total fixed assets, deflated by *province-specific fixed asset investment price index*, and intermediate inputs E_{it}^m is measured by total expenditure in intermediate goods, deflated by the *weighted-average of price index of intermediates at 2-digit industry level* constructed by Upward, Wang and Zheng (2010). The terms i and t denote firm and time, respectively. We employ an extended version of Olley and Pakes (1996) estimation procedure proposed by Amiti and Konings (2007), in order to account for the problem of simultaneity between productivity shock and firm's decision to trade – by considering that firms could pay sunk fixed costs to access the international market – in addition to the problem of simultaneity between input choices and productivity shocks and the problem of sample selection, already addressed by Olley and Pakes (1996). We use the estimated coefficients for capital, labour and intermediate inputs to compute measures of TFP for each firm and year:

$$\ln TFP_{it} = \ln q_{it} - \hat{\gamma}_l \ln L_{it} - \hat{\gamma}_k \ln K_{it} - \hat{\gamma}_m \ln E_{it}^m$$

Moreover, we are also able to compute one of our main explanatory variables, i.e. the *industry-level input foreign direct investment* FDI_{jt}^m , constructed as a weighted average of multinationals' domestic sales in total domestic sales in upstream sectors:

$$FDI_{jt}^m = \sum_k w_{kj}^{2002} * \left(\frac{MNE_domsales_{kt}}{ALL_domsales_{kt}} \right) \quad (25)$$

where the term w_{kj}^{2002} refers to input weights calculated from the Chinese input-output table for 2002.¹⁰ More specifically, it is the share of inputs purchased by industry j from industry k in total inputs used by industry j . Therefore, FDI_{jt}^m proxies the extent of intermediate inputs sourced by firms arising from foreign-owned input suppliers located within country: an increase in FDI_{jt}^m entails a higher access to (foreign) inputs through the FDI channel.

Finally, the dataset has been integrated with tariff data downloaded from WITS¹¹ database to compute our second main explanatory variable, i.e. the *industry-level input tariff* τ_{jt}^m , calculated as a weighted average of output tariffs τ_{kt}^y ¹² in upstream sectors:

$$\tau_{jt}^m = \sum_k w_{kj}^{2002} * \tau_{kt}^y \quad (26)$$

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 the 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.

[Insert **Figure 2** Here]

¹⁰ We use a table that link 8-digit HS codes, 4-digit CIC (or GB/T) codes and 3-digit IO codes. 3-digit IO codes refer to classification codes adopted by Chinese Input-Output table for 2002, which have been firstly associated with 4-digit CIC codes (i.e. 4-digit GB/T codes) through a concordance table, constructed by Brandt, Van Biesebroeck, Wang, and Zhang (2012), which in turn have been matched with 8-digit HS codes, thanks to a concordance table provided by Upward, Wang and Zheng (2010). Notice that the first two digits of 4-digit CIC code equal the first two digits of original code from Input-Output table. Moreover, since the sectors 13 (processing of food) and 14 (manufacturing of food) appear as single sector within the Input-Output table, we consider them as single sector, henceforth.

¹¹The World Integrated Trade Solution (WITS) is a software developed by the World Bank, in close collaboration with several International Organizations (UNCTAD, ITC, UNSD and WTO).

¹² Output tariff has been computed as the simple average of 8-digit HS level *ad valorem* Most-Favourite-Nation applied duties.

3.2. Empirical strategy

In order to examine the relationship between firm-level measured productivity 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:

$$\ln TFP_{it} = \beta_1(1 - FM_{it})\tau_{jt}^m + \beta_2(FM_{it})\tau_{jt}^m + \beta_3(1 - FM_{it})FDI_{jt}^m + \beta_4(FM_{it})FDI_{jt}^m + \phi_i + \phi_t + \varepsilon_{it} \quad (27)$$

where $\ln TFP$ is the log of measured TFP 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 and time fixed effects respectively, and ε is the 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 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 by trade channel ($\beta_4 < 0$).

To rule out any effect that the process of input market integration may have on firm productivity through any change in firm's probability of either importing intermediates or surviving in the market, we restrict the sample to a balanced panel of firms that do not change their importer status over time. Thus, our dataset includes 9,608 firms, of which 14.5 percent are directly involved in import activity.¹³ **Table 1** presents the summary statistics of the main variables in the first year of our analysis (2002) as well as their change over the whole period (2002-2006). As we can see, firms in our final sample on average face an input tariff rate

¹³ We decide to remove Tobacco industry, whose inclusion can bias our results, and all direct-importers that do not import at all under ordinary trade regime, since firms can purchase goods abroad under different trade regimes connected to specific regulations. For example, importers under processing trade regime are exempt from tariff duties.

around 7.1 percent in 2002, which decreased by about 1.6 percentage points over the entire period, while the input FDI extent was around 16.7 percent 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 percent over the same period.

[Insert **Table 1** Here]

3.3. Results

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

[Insert **Table 2** Here]

The estimation results of our baseline equation are presented in column 2. These suggest that importers increase relatively less their productivity compared to non-importers from input FDI openness (12.3 percent versus 15.1 percent). 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 smaller for importers compared to non-importers, possibly because they also suffer some relevant losses from foreign input availability as pointed out within our theoretical framework. Moreover, the positive effect of input trade liberalization on TFP is much larger for importers compared to non-importers (i.e. 21.7 percent versus 8.9 percent). Despite these results are in line with other empirical studies (Amiti and Konings, 2007), they seem only partially coherent with our theoretical predictions. While importers' larger TFP gains support our theoretical hypothesis 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 as they are not directly involved in import activity, but they can access inputs produced abroad through trade intermediaries. For this reason, following their study, in column 3, we interact all our variables of interest with a variable capturing the degree 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 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 percent 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. 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.

Second, 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 either enjoy smaller gains or suffer even losses in efficiency, due to a decrease in foreign inputs availability.

Therefore, when 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 falls in 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 TFP gains from input market integration at 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 when we control for other relevant industrial-level variables in column 4 – such as the output tariff and output FDI, which respectively capture the competition/learning 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.

Now, we are still wondering whether these results concern foreign-owned firms only as 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 owners 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.

[Insert **Table 3** Here]

Finally, in **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 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 columns 5 and 6 of Table 2. Changes in input tariffs (and their interactions) are 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. At the same time, Indian input tariffs are not directly related to changes in Chinese firms' productivity.¹⁴ Changes in input FDI (and its interactions) are instrumented by the weighted average of FDI restrictiveness indexes computed by the OECD for China in upstream sectors, by considering that these indexes can influence directly the presence of foreign-owned firms within sectors and are more likely to be exogenous with respect to Chinese firms' performance.¹⁵ 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).¹⁶ Moreover, we also include the Indian output tariffs to measure the trade protection and therefore the level of lobbying across sectors and time: higher output tariff means stronger lobby for international protection within sector and less stringent international restrictions in upstream sectors (i.e. lower trade and FDI barriers to intermediate inputs). The instruments pass standard tests for their validity

¹⁴ Note that this instrument is 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 in the WITS database after India's accession to WTO in 1995.

¹⁵ 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.

¹⁶ See Kalinova, Palerm and Thomsen (2010).

including both weak identification¹⁷ and overidentification tests¹⁸ for the whole sample (column 1) as well as the subsample of Chinese-owned firms (column 2). The endogeneity test always rejects the null hypothesis that our instrumented variables are exogenous.¹⁹

Overall, the results in Table 3 appear to be in line with 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 presence of import intermediation within sector is relatively low. Reverse effects are found for these firms again if wholesalers play a relevant role in 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. It seems that trade intermediaries 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 has studied 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 the intermediate good sector and using data from Chinese manufacturing firms, this paper shows first that 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. At the same time, FDI integration of intermediate input market can determine efficiency improvement for firms unable to import at all – owing to potential input switching effects – while importers' efficiency can either increase or decrease – because of additional efficiency losses linked to a decline in foreign input availability.

¹⁷ Kleibergen-Paap rk Wald F statistic is above the critical values listed in Table 1 of Stock and Yogo (2005) in all specifications (it ranges from 40.64 to 30.96).

¹⁸ The p-value of Hansen J-statistic ranges from 0.107 to 0.244.

¹⁹ The p-value of Endogeneity statistic is 0.000 across all specifications.

These findings suggest that trade and FDI reforms in upstream sectors entail different winners and losers across downstream firms, and an important role seems to be played by their capability to outsource intermediate inputs produced abroad. Therefore, policy-makers should decrease relatively more tariffs on intermediate inputs if the majority of firms are able to import (directly or indirectly by trade intermediaries), and attract relatively more FDI in upstream sectors if it is not easy for downstream firms to access the foreign market of intermediate inputs by the trade channel.

Figures and Tables

Figure 1- Intermediate good sector: Exports versus Horizontal FDI

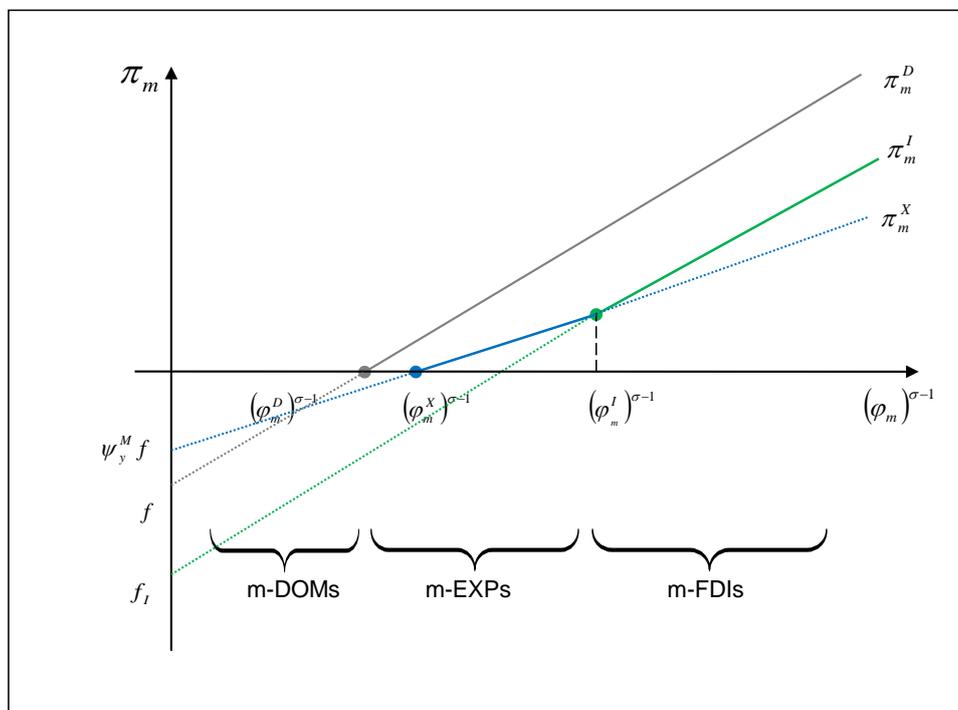


Figure 2 – Industry-level Input tariff and input FDI over time

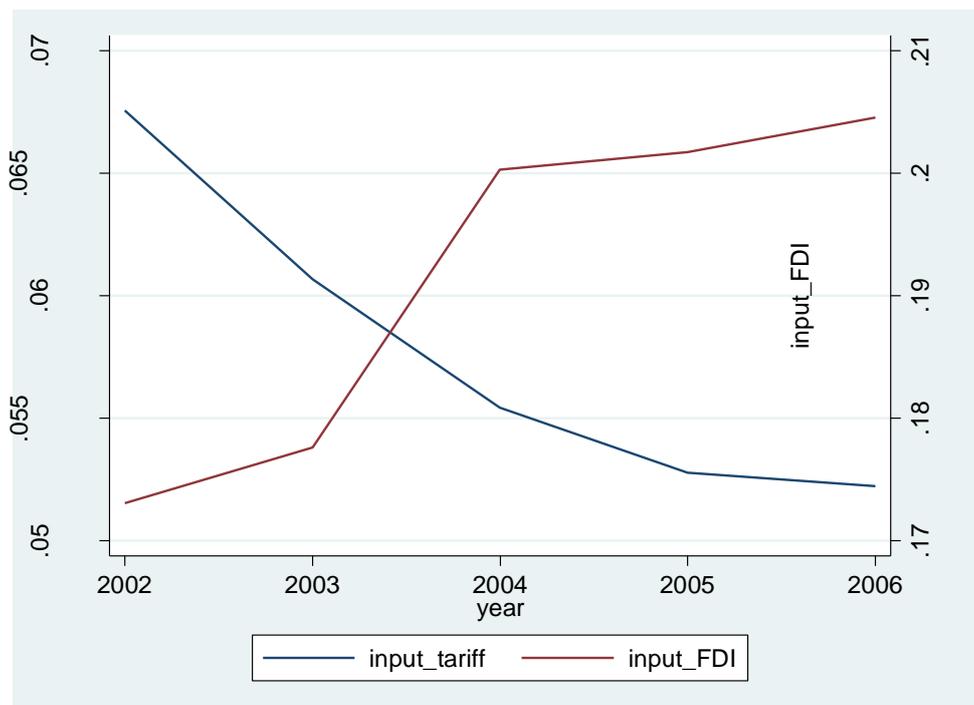


Table 1 – Summary statistics (balanced panel of 9,608 firms)

Variables	level in 2002		change over 2002-2006	
	Mean	Std. Dev.	Mean	Std. Dev.
<i>FM</i>	0.1451	0.3522	0.0000	0.0000
<i>lnTFP</i>	0.6448	0.2983	0.1183	0.3463
τ^m	0.0713	0.0265	-0.0165	0.0125
<i>FDI^m</i>	0.1671	0.1184	0.0240	0.0375

Table 2 - Input tariff, input FDI and Firm efficiency

	(1)	(2)	(3)	(4)	(5)	(6)
Dependent variable: <i>ln TFP</i> (O&P)	All firms	All firms	All firms	All firms	All firms	Chinese-owned firms
Input tariff	-1.045*** (0.254)					
Input FDI	1.465*** (0.0660)					
<i>Non-direct-importers</i>						
Input tariff		-0.889*** (0.267)	4.158*** (0.896)	5.497*** (0.921)	5.488*** (0.921)	6.290*** (0.985)
Input tariff*Input WS ₂₀₀₂			-31.77*** (5.426)	-36.06*** (5.433)	-36.01*** (5.434)	-41.16*** (5.672)
Input FDI		1.515*** (0.0775)	2.593*** (0.353)	2.526*** (0.353)	2.517*** (0.353)	3.199*** (0.399)
Input FDI*Input WS ₂₀₀₂			-6.632*** (1.980)	-6.551*** (1.975)	-6.506*** (1.975)	-9.499*** (2.179)
<i>Direct-importers</i>						
Input tariff		-2.175*** (0.398)	-5.086*** (1.831)	-4.299** (1.827)	-4.385** (1.828)	-3.865 (3.857)
Input tariff*Input WS ₂₀₀₂			17.97 (11.37)	17.94 (11.29)	18.49 (11.29)	18.92 (27.76)
Input FDI		1.226*** (0.110)	1.635*** (0.508)	1.696*** (0.503)	1.700*** (0.504)	1.758* (1.036)
Input FDI*Input WS ₂₀₀₂			-2.167 (2.946)	-2.673 (2.908)	-2.697 (2.915)	-1.365 (6.044)
Output tariff				-0.437*** (0.0697)	-0.436*** (0.0697)	-0.489*** (0.0755)
Output FDI				0.0869*** (0.0274)	0.0863*** (0.0274)	0.102*** (0.0331)
Exporter dummy					0.0118 (0.00758)	0.0315*** (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)	(2)
	All firms	Chinese-owned firms
<i>Non-direct-importers</i>		
Δ Input tariff	15.92*** (3.050)	16.33*** (3.379)
Δ Input tariff*Input WS ₂₀₀₂	-60.14*** (14.01)	-63.85*** (15.36)
Δ Input FDI	15.10*** (2.590)	13.40*** (2.808)
Δ Input FDI*Input WS ₂₀₀₂	-51.58*** (13.13)	-44.15*** (14.23)
<i>Direct-importers</i>		
Δ Input tariff	-14.79*** (4.644)	-15.11 (12.12)
Δ Input tariff*Input WS ₂₀₀₂	109.1*** (30.81)	122.1 (92.89)
Δ Input FDI	6.593*** (1.683)	5.458 (3.607)
Δ Input FDI*Input WS ₂₀₀₂	-9.414 (10.53)	-4.313 (25.84)
Δ Controls	√	√
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

References

- Alfaro, L., and M. X. Chen (2013): "Market Reallocation and Knowledge Spillover: The Gains from Multinational Production," Harvard Business School BGIE Unit Working Paper No. 12-111.
- Arkolakis, C., (2010): "Market Penetration Costs and the New Consumers Margin in International Trade," *Journal of Political Economy*, 118(6), 1151 - 1199.
- Amiti, M., and J. Konings (2007): "Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia," *American Economic Review*, 97(5), 1611-1638.
- Bas, M., and V. Strauss-Kahn. (2014): "Does Importing more Inputs Raise Exports? Firm Level Evidence from France," *Review of World Economics*, 150(2), 241-275.
- Brandt, L., J. Van Biesebroeck, L. Wang, and Y. Zhang, (2012), 'WTO Accession and Performance of Chinese Manufacturing Firms,' CEPR Discussion Papers 9166, C.E.P.R. Discussion Papers.
- Carluccio, J. & Fally, T. (2012). 'Foreign entry and spillovers with technological incompatibilities in the supply chain', *Journal of International Economics*, Vol. 90, pp. 123-135.
- Chen. C. (2011): "The Development of China's FDI Laws and Policies after WTO Accession", in Jane Golley and Ligang Song (eds.), *Rising China: Global Challenges and Opportunities*, ANU E Press, pp.85-98
- Defever, F., M. Imbruno, R. Kneller (2012): "Trade liberalization, Firm Productivity and the role of Trade Intermediaries: Evidence from China". Mimeo.
- Driffield, N., M. Munday, and A. Roberts (2002): "Foreign direct investment, transactions linkages and the performance of the domestic sector," *International Journal of the Economics of Business*, 9(3), 335–351.
- Du L., A. Harrison and G. Jefferson (2014): "FDI Spillovers and Industrial Policy: The Role of Tariffs and Tax Holidays," *World Development*, 64(C), 336-383.
- Ethier, W. J. (1982): "National and International Returns to Scale in the Modern Theory of International Trade," *American Economic Review*, 72(3), 389-405.
- Gibson, M. J., and T. A. Graciano (2011): "The Decision to Import," *American Journal of Agricultural Economics*, 93, 444-449.
- Goldberg, P. K., A. K. Khandelwal, N. Pavcnik, and P. Topalova (2010): "Imported Intermediate Inputs and Domestic Product Growth: Evidence from India". *The Quarterly Journal of Economics* 125 (4): 1727-1767.
- Görg, H., and D. Greenaway (2004): "Much ado about nothing? Do domestic firms really benefit from foreign direct investment?," *World Bank Research Observer*, 19, 171–197.
- Grossman, G. M., and E. Helpman (1991): "Innovation and Growth in the Global Economy".
- Halpern, L., M. Koren, and A. Szeidl (2011). "Imported Inputs and Productivity". CeFiG Working Papers 8, Center for Firms in the Global Economy
- Harrison A. E., L. A. Martin and S. Nataraj (2013): "Learning versus Stealing: How Important Are Market-Share Reallocations to India's Productivity Growth?," *The World Bank Economic Review*, 27(2), 202-228.
- Havranek, T. and Irsova, Z. (2011) 'Estimating vertical spillovers from FDI: Why results vary and what the true effect is', *Journal of International Economics*, Vol. 85, pp. 234-244.
- Helpman, E., M. J. Melitz, and S. R. Yeaple (2004): "Export Versus FDI with Heterogeneous Firms," *American Economic Review*, 94(1), 300-316.

- Imbruno, M. (2014): "Trade Liberalization, Intermediate Inputs and Firm Competitiveness: Direct versus Indirect Modes of Import," Discussion Papers 2014-02, University of Nottingham, GEP.
- 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), 605–627.
- Kalinova, B., A. Palerm and S. Thomsen (2010): "OECD's FDI Restrictiveness Index: 2010 Update", OECD Working Papers on International Investment, 2010/03, OECD Publishing.
- Khandelwal, A. K., and P. Topalova. (2011): "Trade Liberalization and Firm Productivity: The Case of India". *The Review of Economics and Statistics* 93 (3): 995-1009.
- Kasahara, H., and J. Rodrigue. (2008): "Does the use of imported intermediates increase productivity? Plant-level evidence". *Journal of Development Economics* 87 (1): 106-118
- Kasahara, H. and B. Lapham (2013): "Productivity and the decision to import and export: Theory and evidence," *Journal of International Economics*, 89(2), 297-316.
- Krugman, P. R. (1980): "Scale Economies, Product Differentiation, and the Pattern of Trade," *American Economic Review*, 70(5), 950-59.
- Liu, X., C. Wang, and Y. Wei (2009): "Do local manufacturing firms benefit from transactional linkages with multinational enterprises in China?", *Journal of International Business Studies*, 40(7), 1113-1130.
- Markusen, J. R. (1989): "Trade in Producer Services and in Other Specialized Intermediate Inputs," *American Economic Review*, 79(1), 85-95.
- Markusen, J. R., and Venables, A. J. (1999): "Foreign direct investment as a catalyst for industrial development," *European Economic Review*, 43(2), 335–356.
- Melitz, M. J. (2003): "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 71(6), 1695-1725.
- Olley, G. S., and A. Pakes (1996): "The Dynamics of Productivity in the Telecommunications Equipment Industry," *Econometrica*, 64(6), 1263-97.
- Rodriguez-Clare, A. (1996): "Multinationals, linkages and economic development," *American Economic Review*, 86(4), 852–873.
- Schor, A. (2004): "Heterogeneous Productivity Response to Tariff Reduction: Evidence from Brazilian Manufacturing Firms." *Journal of Development Economics*, 75(2), 373-96.
- Upward, R., Z. Wang, and J. Zheng (2010), "Weighing China's Export Basket: An Account of the Chinese Export Boom, 2000-2007," Discussion Papers 10/14, University of Nottingham, GEP.
- WTO (2006) China Trade Policy Review, WT/TPR/S/161.