Selection, Reallocation, and Knowledge Spillover: Identifying the Sources of Productivity Gains from Multinational Activity*

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Abstract

The impact of multinational activity on host-country productivity has been a vital topic of economic research. A positive impact can be attributed to knowledge spillovers from foreign multinational to domestic firms or a less stressed, alternative explanation—firm selections—whereby competition from multinational firms leads to market reallocations and allows only the most productive domestic firms to survive. We develop a theoretical and structural empirical framework to quantify and decompose the productivity gains from openness to multinational activity and show that even though knowledge spillovers and selections both predict positive gains, the two effects can be disentangled by exploring their distinct predictions on the distribution properties of domestic productivity and revenue. Using a large cross-country panel dataset of manufacturing firms, we find both knowledge spillovers and selections constitute important sources of productivity gains while their relative importance varies sharply across nations. The analysis also suggests significant evidence of between-industry reallocations in capital and labor markets.

JEL Codes: F2, O1, O4

Key Words: Multinational Firms, Productivity, Knowledge Spillover, Selection, and Market Reallocation

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1 Introduction

Nations with greater openness to multinational activity exhibit, on average, higher productivity.[1] This positive correlation, likely conditional on other factors, is often attributed to *knowledge spillovers* whereby foreign multinationals generate positive technology externalities to domestic firms. Such spillovers can arise from a variety of mechanisms such as direct knowledge transfer through partnership, the possibility to learn from the innovation and experiences of foreign firms, and the interaction and movement in labor markets. In pursuit of these potential knowledge spillovers, governments in many developed and developing countries have substantially reduced barriers to foreign direct investment (FDI) and offered special incentives to attract foreign firms.

There is, however, a less stressed, alternative explanation for the positive correlation, centering on *firm selections*. The first is a self-selection of multinational firms. Helpman et al. (2004) introduce firm productivity into the decision to engage in multinational production and show firms with greater productivity to be more likely to overcome the fixed cost of foreign investment and engage in multinational activity overseas. Countries with greater openness to multinational activity thus attract foreign firms that are, by selection, more productive. The second is a selection of domestic firms. Greater openness to multinational activity leads to tougher competition in product and factor markets, reallocating resources from domestic towards multinational firms and from the less productive towards the more productive domestic firms. The least efficient domestic firms, as a result, are forced to exit the markets, inducing an increase in the average productivity.[2]

The above three mechanisms all imply a positive relationship between multinational activity and host-country productivity, making it extremely difficult to distinguish the sources of productivity gains. But these mechanisms represent sharply different economic causalities and policy implications. The self-selection of multinational firms suggests that

[1] See Harrison and Rodríguez-Clare (2011) and Kose et al. (2011) for recent overviews of the literature that examines the relationship between multinational activity, productivity and economic growth. At the macro level, the cross-country correlations between average FDI-to-GDP ratio and average TFP and TFP growth are 0.27 and 0.26, respectively. Evidence in the existing macro literature shows that FDI exerts a positive effect on economic growth when host countries have sufficient human capital stock and relatively developed financial markets (see, Borensztein et al., 1998; Alfaro et al., 2004, 2010).

[2] The role of firm selections in determining the productivity gains from trade liberalization is well established since Melitz (2003). It is, however, still largely neglected when evaluating the productivity gains from openness to multinational activity. We describe related existing contributions and evidence later this section.

higher host-country productivity can reflect the productivity of self-selected multinational firms, instead of the causal effect of multinational activity. In contrast, the selection of domestic firms and knowledge spillovers imply multinational activity *causes* higher aggregate, domestic productivity. Furthermore, how the latter two affect domestic production is countervailing: tougher domestic selection means a contraction of domestic production while knowledge spillovers create positive externalities.

The main objective of this paper is to disentangle the roles of selections and knowledge spillovers in determining the aggregate productivity impact of multinational activity and quantify the relative importance of these distinct sources of productivity gains. In order to do so, we develop a standard model of monopolistic competition and heterogeneous firms to address simultaneously the selections of domestic and multinational firms and the knowledge spillovers from multinational to domestic production. Our model provides a structural empirical framework that enables us to distinguish the different channels by exploring different distribution properties of multinational and domestic production.

The theoretical framework suggests that while both selections and knowledge spillovers predict a positive relationship between openness to multinational activity and aggregate productivity, the effects operate in distinct ways and bear different predictions for the distributions of domestic and multinational production. In particular, multinational firms self-select into multinational production, basing the decision on their ex-ante productivity, host-country characteristics such as market size and production cost, and bilateral country factors that can influence fixed costs of multinational production. Competition then leads to a reallocation of labor and capital from domestic to the more productive multinational competitors and from the less efficient to the more efficient domestic firms. The reallocation of labor erodes the revenue of individual domestic firms while the reallocation of capital results in greater cutoff revenue for new and continuing domestic firms. Both of these effects cause an increase in the cutoff productivity and a tougher selection of domestic firms, forcing the least efficient domestic firms to exit the markets. Finally, knowledge spillovers from foreign multinational activity should induce a rightward shift of the productivity distribution of surviving domestic firms, while the distribution becomes more left truncated due to stronger domestic selection. The revenue distribution, on the other hand, is predicted to have a weaker, or even contrary-direction, shift as market reallocations offset the positive effect of knowledge spillovers.

These predictions are evaluated empirically using a large cross-country firm panel dataset, drawn from Orbis, that contains comprehensive financial, operation, and ownership information for over 1 million public and private manufacturing companies in 2002-2007. The database exhibits two notable strengths: broad cross-country coverage and detailed ownership information. These two features allow us to identify multinational activity across countries and explore the heterogeneous effect of foreign investments.

Our structural estimation consists of two steps. We first estimate the self-selection of multinational firms as a function of multinationals' ex-ante headquarter productivity, a vector of host-country industry dummies, and bilateral factors of multinational headquarters and host countries. The ex-ante headquarter productivity of multinational firms is expected to have an important effect on the decision to participate in multinational activity but, in the meantime, unlikely to be directly correlated with the future productivity of host-country firms, making a suitable exclusion condition for identification. Next, instead of relying on the relationship between multinational activity and host-country average productivity, a primary approach in the existing empirical literature, we evaluate the effect of expected multinational activity on various distribution properties of domestic production, including the cutoff productivity and revenue, and the productivity and revenue distributions of domestic firms. The estimated impact on cutoff productivity and revenue helps determine the selection effect operated through labor and capital market reallocations, while the estimated effect on the productivity distribution quantifies the magnitude of knowledge spillovers.

Our approach offers a number of important advantages. First, it provides a structural framework for separately identifying the opposing effects of multinational activity. Distinguishing knowledge spillovers from selections is difficult without building a model that explicitly incorporates the two aspects. Our predictions are grounded in a standard model of firm heterogeneity, but in the meantime apply to a broader class of theoretical setups. Second, our framework accounts for the endogenous self-selection of multinational firms and the possibility that multinational activity and host-country productivity can be driven by the same unobserved economic characteristics and shocks. Third, the structural framework employed in the paper enables us to perform useful policy counterfactual analysis and quantify both the aggregate and the decomposed productivity gains from openness to multinational activity.

Our empirical analysis suggests that multinational activity leads to not only knowledge spillover but also tougher selection and factor reallocation in domestic markets. Entry of multinational firms is found to raise the cutoff productivity of domestic firms, pushing the least productive domestic firms to exit the markets. New multinational activity also leads to an increase in the minimum revenue of continuing domestic firms, implying an increase in fixed production cost and capital price. Further, the estimates show a significant decrease in the aggregate price, suggesting increased competition and market reallocations. This result is also pronounced in the revenue distribution of domestic firms. Following the entry of multinational firms, the revenue distribution of domestic firms is found to shift leftward, at both the 25th and 50th percentiles. In contrast, the productivity distribution of domestic firms is shown to shift rightward, while the distribution becomes more left truncated due to selection. Surviving domestic firms at the 25th and 50th percentiles witness an increase in productivity, suggesting knowledge spillovers for low- and intermediate-productivity domestic firms.

When quantifying the productivity gains from multinational activity, we find the aggregate productivity to increase by 1.4 percent across countries when the probability of entry by new multinational firms increases by 100 percent. In particular, the productivity of domestic firms increases by 0.9 percent, with knowledge spillover and domestic selection accounting for 69 and 31 percent, respectively. This result suggests that, in addition to knowledge spillover, tougher selection and factor reallocation constitute a significant source of productivity gain. Further, the relative importance of each source exhibits significant country heterogeneity. In particular, we find the gains are driven by knowledge spillovers in developing nations but by selections and market reallocations in developed countries.

Our study is related to three strands of existing literature. First, our paper builds on an extensive literature that assesses the existence of productivity spillovers from multinationals to domestic firms.[3] One of the earliest contributions in this literature is Aitken and Harrison (1999) who find evidence of negative spillovers in a panel of Venezuelan manufacturing enterprises. The authors interpret this result as a market-stealing effect whereby foreign multinational firms steal the market shares of domestic firms. The paper by Aitken and Harrison (1999) soon spawned a large series of empirical studies. Keller

[3]The literature on multinational activity is vast. See Markusen (1995), Caves (1996), and Harrison and Rodriguez-Clare (2010) for excellent overviews of the broader literature.

and Yeaple (2009), for example, show strong evidence of positive spillovers from foreign multinational to domestic firms in the United States. Javorcik (2004) explores spillovers through vertical production linkages and shows multinational activity leads to positive externalities via backward production linkage, from multinational affiliates to local intermediate input suppliers. Fons-Rosen et al. (2011), in contrast, find negative productivity spillovers in the same industry across a sample of rich and emerging nations but positive intra-industry spillovers in developed countries. The authors associate their results to potential knowledge spillovers from FDI being outweighed by competition/business stealing effects in emerging markets. Studies by Arnold and Javorcik (2009) and Guadalupe et al. (2011) account for the endogenous acquisition decisions of foreign multinational firms and find foreign multinationals to acquire best performing domestic firms. They also show that foreign ownership leads to significant productivity spillovers in acquired plants even after addressing the acquisition decisions.

Evidence on the domestic selection effect of multinational activity is limited. Analysis that disentangles the relative importance of knowledge spillovers and selections, by comparison, is even more scarce. A few studies took the step to evaluate the factor market effects of multinational production. Aitken, Harrison, and Lipsey (1996) investigate the impact of foreign owned plants on the wages of domestically owned establishments in Mexico and Venezuela. Their analysis suggests an increase of industry wages due to foreign multinational activity, especially for skilled workers and plants in Venezuela. Similarly, Feenstra and Hanson (1997) find that a higher level of maquiladora activity leads to a higher share of total wages going to skilled (non-production) workers in Mexico, a result they interpret as increased demand for skilled labor from foreign multinational firms. Exploring the effect of multinational activity on domestic financial markets, Harrison and McMillan (2003) find that not only domestic firms are more credit constrained than foreign firms, borrowing by foreign firms also exacerbates the credit constraints of domestic firms.[4] Ramondo (2009) is one of the few studies that attempts to examine both knowledge spillover and domestic turnover related to the presence of foreign plants. Using a panel of domestic and foreign plants in the Chilean manufacturing sector, she

[4]In contrast to Harrison and McMillian (2003), Harrison, Love and McMillian (2004) find FDI inflows to be associated with a reduction in firms' financing constraints using data from Worldscope on 7,079 firms in 28 countries. Harrison and Rodriguez-Clare (2011) argue that these contrasting results point to policy complementarities, such as complementarities between FDI and local financial markets (see Alfaro et al. 2004, 2010).

finds foreign plants' entry to be negatively correlated with the market shares of domestic firms and positively correlated with the productivity of domestic incumbents.

More generally, our work relates to the literature that emphasizes the productivity effect of resource allocation across establishments. A growing strand of literature argues that policies broadly defined significantly influence the allocation of resources across heterogeneous establishments. The working hypothesis in this literature is that not only the level of factor accumulation, but also how these factors are allocated across heterogeneous production units matters in explaining income differences (see, Hsieh and Klenow, 2009; Alfaro et al, 2008). That is, the great divide between rich and poor countries may not just be explained by the lack of capital and skilled labor but also a consequence of the allocation of resources. Echoing these work, our paper shows that the reallocation of capital and labor as a result of increased openness to multinational activity could lead to significant productivity gains.[5]

Our paper contributes to these literatures by disentangling the roles of selection and knowledge spillovers in determining the aggregate impact of multinational activity on host-country productivity. Our micro theoretical foundation captures simultaneously the distinct aspects of multinational activity and develops an empirical strategy to distinguish their relative importance while accounting for the self-selection of multinational firms. It also provides a structural framework to quantify the magnitude of productivity gains associated with each effect and perform counterfactual analysis. Our analysis offers new evidence on the market reallocation effect of FDI and, further, the cross-country heterogeneity in productivity gains from openness to multinational activity.

Our study provides important implications on policy designs aimed to influence FDI flows. Our results suggest that if foreign firms have important knowledge spillover effects to domestic firms, special treatment may be justified. If instead, increases in productivity are due to tougher selection on domestic firms as a result of competition for scarce labor and capital, a more sensible policy would be to focus on improving domestic conditions, including conditions of labor (in particular, skilled-labor) supply and credit access, while in the meantime eliminating regulatory barriers to facilitate gains from competition and

[5] Our paper is also related to studies that evaluate the other welfare effects of multinational activity, including interactions between trade and multinational production, innovation, and reallocation of managerial knowhow; see Ramondo and Rodriguez-Clare (2010), Guadalupe et al. (2011), and Bloom et al. (2010).

reallocation of resources.[6]

The rest of the paper is organized as follows. Section 2 presents a theoretical framework to illustrate the effect of multinational activity on domestic productivity. Section 3 describes the data employed in the empirical analysis. Sections 4 and 5 report the structural estimation results and productivity gain estimates, respectively. Section 6 concludes.

2 Theoretical Framework

In this section, we employ a standard model of monopolistic competition and heterogeneous firms, adapted from the work of Melitz (2003) and Helpman *et al.* (2004), to illustrate the selection and the effects of multinational firms.

2.1 Setup

Suppose the world consists of two countries, H and F, and two sectors, one homogeneous and one differentiated. The homogeneous good serves as the numeraire. There is a continuum of firms in each country. Each firm produces a different variety of the differentiated product and has a distinct productivity level θ.

Given a CES utility function, the demand function for each variety of the differentiated product is given by

$$x(\theta) = \frac{E}{P}\left[\frac{p(\theta)}{P}\right]^{-\varepsilon}, \tag{1}$$

where $x(\theta)$ denotes the quantity of demand, E the aggregate expenditure on the differentiated product, $p(\theta)$ the price of the product variety, $P \equiv \left[\int_{\theta\in\Omega} p(\theta)^{1-\varepsilon} d\theta\right]^{\frac{1}{1-\varepsilon}}$ the aggregate price with Ω denoting the set of available varieties, and $\varepsilon \equiv 1/(1-\alpha) > 1$ the demand elasticity.

Without loss of generality, we assume countries H and F are identical and focus on country H. If firms of country H chooses to produce and sell at home, it must employ one unit of labor for each unit of output and incur a marginal cost w/θ, where w is the common wage rate. Firms must also pay a per-period fixed cost cf_D, where c denotes unit capital price and f_D denotes the units of capital (e.g., machinery) required in the

[6] See a recent theoretical study by Monge (2011) for policy implications on the optimal taxation of multinational firms in the presence of knowledge spillovers.

production. The profit-maximizing strategy is to set $p(\theta) = w/(\alpha\theta)$, which yields the domestic revenue and profit functions, denoted as $r_D(\theta)$ and $\pi_D(\theta)$, respectively, below:

$$r_D(\theta) = E\left(\frac{\alpha P\theta}{w}\right)^{\varepsilon-1} \tag{2}$$

$$\pi_D(\theta) = \frac{r_D(\theta)}{\varepsilon} - cf_D = \frac{E}{\varepsilon}\left(\frac{\alpha P\theta}{w}\right)^{\varepsilon-1} - cf_D. \tag{3}$$

Firms of country F may also invest and produce in country H to serve country H's consumers via multinational production.[7] If that is the case, foreign multinational firms must pay a fixed cost cf_M in each period. Following Helpman *et al.* (2004), the fixed cost of production is assumed to be higher for foreign firms than for domestic firms, i.e., $f_M > f_D$. The revenue and the profit earned by foreign firms in country H, denoted as $r_M(\theta)$ and $\pi_M(\theta)$, respectively, are given by:

$$r_M(\theta) = E\left(\frac{\alpha P\theta}{w}\right)^{\varepsilon-1} \tag{4}$$

$$\pi_M(\theta) = \frac{r_M(\theta)}{\varepsilon} - cf_M = \frac{E}{\varepsilon}\left(\frac{\alpha P\theta}{w}\right)^{\varepsilon-1} - cf_M. \tag{5}$$

Domestic firms produce in the domestic market if $\pi_D(\theta) \geqslant 0$. Setting $\pi_D(\theta) = 0$ yields the cutoff productivity level θ_D for domestic firms to survive:

$$\pi_D(\theta_D) = 0 \Longrightarrow \theta_D = \left(\frac{\varepsilon cf_D}{E}\right)^{\frac{1}{\varepsilon-1}}\left(\frac{w}{\alpha P}\right). \tag{6}$$

Domestic firms with $\theta \geqslant \theta_D$ produce in the home market and domestic firms with $\theta < \theta_D$ exit.

Foreign firms invest and produce in the domestic market if $\pi_M(\theta) \geqslant 0$. The cutoff productivity level for foreign firms is obtained by setting $\pi_M(\theta) = 0$:

$$\pi_M(\theta_M) = 0 \Longrightarrow \theta_M = \left(\frac{\varepsilon cf_M}{E}\right)^{\frac{1}{\varepsilon-1}}\left(\frac{w}{\alpha P}\right). \tag{7}$$

Both the domestic and multinational cutoffs are an increasing function of c and the

[7] To keep the analysis tractable, we abstract from the possibility of exporting and essentially assume prohibitive trade costs. Our main analytical hypotheses shall remain qualitatively similar when the choice between multinational production and exports is taken into account.

respective fixed costs and a decreasing function of E and P.

Given the above two equations, the ratio of the domestic and foreign cutoff productivity levels is given by:

$$\frac{\theta_M}{\theta_D} = \left(\frac{f_M}{f_D}\right)^{\frac{1}{\varepsilon-1}} \tag{8}$$

Since $f_M > f_D$, we have $\theta_M > \theta_D$. This implies that the minimum productivity to survive in each country is higher for foreign multinational firms than for domestic firms.

Now consider the productivity of domestic firms. We assume that when there is foreign multinational production, there can be potential knowledge spillovers—transferring foreign technology knowhow—from foreign multinational to domestic firms.[8] To capture this effect, the productivity of domestic firms is assumed to be a function of two components: a raw productivity θ_a drawn from a distribution function $G(\theta_a)$ and a slope parameter $\tau_\theta(z_M)$ where z_M is a simple indicator variable that denotes the existence of foreign multinational production. Equation (7) suggests that there will be multinational production when θ_M is non-prohibitive and, equivalently, when f_M is finite, i.e., $z_M = I(\theta_M < \infty) = I(f_M < \infty)$. Specifically, we assume

$$\theta \equiv \tau_\theta(z_M)\theta_a = \tau_\theta^{z_M} \cdot \theta_a \tag{9}$$

where $\tau_\theta > 1$ implies positive knowledge spillovers.

Let N_D denote the equilibrium mass of incumbent domestic firms in each country. Given the country symmetry and the ex-ante probability of foreign investment $\gamma_M \equiv [1 - G(\theta_M)] / [1 - G(\theta_D)]$, $N_M = \gamma_M N_D$ represents the equilibrium mass of firms that engage in multinational activity and, equivalently, the number of foreign owned firms in each country. The total mass of varieties available to consumers in each country and the total mass of firms competing in each country are hence $N = N_D + N_M$.

[8] This assumption is in the spirit of Findlay (1978) as knowledge spillovers from multinational to domestic firms take place through the diffusion of ideas and new technologies. In the robustness section, we explore other forms of externalities and interactions via linkages à la Hirschman (1958). It is worth noting that the productivity spillovers can also be in the reverse direction, from domestic to foreign multinational firms. Here, we do not consider the latter possibility given our focus on the host-country effect of FDI.

2.2 Aggregate Outcomes

Let $\widetilde{\theta}_D$ and $\widetilde{\theta}_M$ denote, respectively, the weighted average productivity levels of domestic and foreign firms:

$$\begin{aligned}\widetilde{\theta}_D &\equiv \widetilde{\theta}(\theta_D) = \frac{1}{1-G(\theta_D)}\left[\int_{\theta_D}^{\infty}\theta^{\varepsilon-1}g(\theta)d\theta\right]^{\frac{1}{\varepsilon-1}} \\ \widetilde{\theta}_M &\equiv \widetilde{\theta}(\theta_M) = \frac{1}{1-G(\theta_M)}\left[\int_{\theta_M}^{\infty}\theta^{\varepsilon-1}g(\theta)d\theta\right]^{\frac{1}{\varepsilon-1}}.\end{aligned} \tag{10}$$

The aggregate productivity of all firms in each country, $\widetilde{\theta}$, can be written as:

$$\widetilde{\theta} = \left\{\frac{1}{N}\left[N_D^{\varepsilon-1}\widetilde{\theta}_D^{\varepsilon-1} + N_M^{\varepsilon-1}\widetilde{\theta}_M^{\varepsilon-1}\right]\right\}^{\frac{1}{\varepsilon-1}}. \tag{11}$$

As shown in Melitz (2003), this productivity average plays an important role as it summarizes the effects of the distribution of productivity levels on aggregate outcomes. The aggregate price index P, the expenditure level E, and welfare per worker W in each country can all be written as functions of the productivity average $\widetilde{\theta}$ and the number of varieties available in the market N:

$$\begin{aligned}P &= N^{\frac{1}{1-\varepsilon}}p\left(\widetilde{\theta}\right) = N^{\frac{1}{1-\varepsilon}}\frac{w}{\rho\widetilde{\theta}} \\ E &= Nr_D\left(\widetilde{\theta}\right) \\ W &= \frac{E}{L}N^{\frac{1}{\varepsilon-1}}\rho\widetilde{\theta}.\end{aligned} \tag{12}$$

2.3 Equilibrium Conditions

There is a large pool of prospective entrants into the industry. To enter, firms must make an initial investment, modeled as a fixed entry cost $cf_E > 0$. Firms then draw their initial productivity upon entry. If a firm obtains a low productivity draw, the firm may decide to immediately exit and not produce. If a firm produces, it then faces a constant probability δ of a bad shock in every period that would force it to exit.

Now consider the steady state equilibria in which the aggregate variables remain con-

stant over time. Since each firm's productivity level does not change over time, its optimal per-period profit will also remain constant. An entering firm with productivity θ would immediately exit if its profit level were negative or would produce and earn $\pi(\theta)$ in every period until it is hit with the bad shock and is forced to exit.

The zero cutoff profit condition implies that

$$\begin{aligned} r(\theta_D) &= \varepsilon c f_D \\ r(\theta_M) &= \varepsilon c f_M. \end{aligned} \tag{13}$$

Since the average productivity levels $\widetilde{\theta}_D$ and $\widetilde{\theta}_M$ are completely determined by the cutoff productivity levels θ_D and θ_M, the average profit and revenue levels are also tied to the cutoff levels:

$$\begin{aligned} \overline{r}_D &= r(\widetilde{\theta}_D) = \left[\frac{\widetilde{\theta}_D}{\theta_D}\right]^{\varepsilon-1} r(\theta_D), \qquad \overline{r}_M = r(\widetilde{\theta}_M) = \left[\frac{\widetilde{\theta}_M}{\theta_M}\right]^{\varepsilon-1} r(\theta_M) \\ \overline{\pi}_D &= \pi(\widetilde{\theta}_D) = \left[\frac{\widetilde{\theta}_D}{\theta_D}\right]^{\varepsilon-1} \frac{r(\theta_D)}{\varepsilon} - c f_D, \; \overline{\pi}_M = \pi(\widetilde{\theta}_M) = \left[\frac{\widetilde{\theta}_M}{\theta_M}\right]^{\varepsilon-1} \frac{r(\theta_M)}{\varepsilon} - c f_M. \end{aligned} \tag{14}$$

Given equations (3) and (5), the average profits of domestic and foreign firms in the domestic market, $\overline{\pi}_D$ and $\overline{\pi}_M$, can be written as:

$$\begin{aligned} \overline{\pi}_D &= \lambda_D c f_D \\ \overline{\pi}_M &= \lambda_M c f_M. \end{aligned} \tag{15}$$

where $\lambda_D \equiv \left[\widetilde{\theta}(\theta_D)/\theta_D\right]^{\varepsilon-1} - 1$ and $\lambda_M \equiv \left[\widetilde{\theta}(\theta_M)/\theta_M\right]^{\varepsilon-1} - 1$. The average profit of all firms competing in the domestic market is given by:

$$\overline{\pi} = \overline{\pi}_D + \gamma_M \overline{\pi}_M = \lambda_D c f_D + \gamma_M \lambda_M c f_M, \tag{16}$$

where $\gamma_M \equiv [1 - G(\theta_M)] \,/\, [1 - G(\theta_D)]$.

Assuming that there is no time discounting, each firm's value function is given by:

$$v(\theta) = \sum_{t=0}^{\infty} (1-\delta)^t \pi(\theta) = \frac{\pi(\theta)}{\delta}. \tag{17}$$

The present value of the average profit flows is:

$$\overline{v} = \sum_{t=0}^{\infty}(1-\delta)^t\overline{\pi} = \frac{1}{\delta}\overline{\pi}, \tag{18}$$

and the net value of entry is

$$v_E = \frac{1}{\delta}\left[1 - G(\theta_D)\right]\overline{\pi} - cf_E. \tag{19}$$

The free entry condition implies that the expected value of future profits must, in equilibrium, equal the fixed entry cost.

$$v_E = 0 \Longrightarrow \overline{\pi} = \frac{\delta c f_E}{\gamma_D}, \tag{20}$$

where $\gamma_D \equiv 1 - G(\theta_D)$ is the ex-ante probability of survival after entry. The above equation, together with equations (13) and (14), determine $\overline{\pi}$, θ_D and θ_M.

Now consider the factor market clearing conditions. The labor market clearing condition requires that the total demand for labor in the domestic market equals the total supply of labor L, i.e., $N_D\left(\overline{r}_D + \gamma_M\overline{r}_M\right)/\alpha^{\varepsilon-1} = N_D\overline{r}/\alpha^{\varepsilon-1} = L$ where $N_D\overline{r}_D/\alpha^{\varepsilon-1}$ is the demand for domestic labor by domestic firms and $N_D\gamma_M\overline{r}_M/\alpha^{\varepsilon-1}$ is the demand for domestic labor by foreign firms. This, in turn, determines the equilibrium mass of incumbent domestic firms producing in each country:

$$N_D = \frac{\alpha^{\varepsilon-1}L}{\overline{r}} = \frac{\alpha^{\varepsilon-1}L}{\varepsilon\left(\overline{\pi} + cf_D + \gamma_M cf_M\right)}, \tag{21}$$

which then yields the number of foreign firms N_M and the total number of firms competing in the domestic market N.

In the capital market, we assume that firms finance a constant share of their fixed foreign investment cost in home countries and the rest abroad.[9] The total demand for capital by domestic and foreign multinationals in each country is then given by $N_D\gamma_M f_M$.

[9]In terms of capital accumulation, Graham and Krugman (1991), Kindleberger (1969), and Lipsey (2002), and Harisson and McMillian (2003) show that investors often fail to fully transfer capital upon taking control of a foreign company; instead, they tend to finance an important share of their investment in the local market. If foreign firms borrow heavily from local banks, instead of bringing scarce capital from abroad, they may exacerbate domestic firms' financing constraints by crowding them out of domestic capital markets.

The capital market clearing condition requires that $N_D\left(f_D+\gamma_M f_M+\delta f_E/\gamma_D\right)=K$, where $N_D f_D$, $N_D\gamma_M f_M$, and $N_D\delta f_E/\gamma_D$ represent, respectively, the demand for capital in the domestic market by domestic producers, domestic and foreign multinationals, and domestic entrants and K is the aggregate supply of capital.[10] Given (16) and (21), this leads to

$$c=\frac{\alpha^{\varepsilon-1}L\left(f_D+\gamma_M f_M+\delta f_E/\gamma_D\right)}{K\varepsilon\left[(\lambda_D+1)f_D+(\lambda_M+1)\gamma_M f_M\right]}. \tag{22}$$

2.4 The Impact of Multinational Activity

We now use the present model to examine the impact of multinational production, including: What happens to the productivity distribution of domestic firms? How is the aggregate productivity and welfare affected? The analysis draws from comparisons of steady state equilibria and captures therefore the long run consequences of multinational production.

Selection of Domestic Firms Inspection of the zero cutoff profit conditions reveals that openness to multinational activity induces an increase in the domestic cutoff productivity level θ_D. Assuming the effect of knowledge spillovers is inadequate to offset the negative competition effect, the least productive firms with productivity levels between the ex-post cutoff θ_D and the ex-ante cutoff, denoted as θ_A, can no longer earn positive profits and therefore exit. As in Melitz (2003), this selection effect operates through domestic factor markets where domestic and multinational firms compete for a common source of labor and capital. The increased factor demand by multinational firms bids up the real wage and capital price and forces the least productive firms to exit.[11]

[10] We abstract from considerations regarding international capital flows. The international trade literature suggests that firms engage in FDI not because of differences in the cost of capital but because certain assets are worth more under foreign than local control. If lower cost of capital were the only advantage a foreign firm had over domestic firms, it would still remain unexplained why a foreign investor would endure the troubles of operating a firm in a different political, legal, and cultural environment instead of simply making a portfolio investment.

[11] As noted in Melitz (2003), an alternative channel of the selection effect is though the increase in product market competition after entry of multinational firms. Domestic firms face an increased number of foreign competitors that are, on average, more productive than the domestic firms. However, this channel is not operative in either Melitz's (2003) or our model due to the property of monopolistic competition under the CES preferences: the price elasticity of demand for any variety does not respond to changes in the number or prices of competing varieties. A solution offered in the literature is to introduce variable markups as in Melitz and Ottaviano (2008). However, since factor market competition is a more critical aspect in the case of multinational production (compared to trade), we focus on the

Now we examine the effects of multinational activity on the market share of domestic firms. We focus on domestic firms with productivity higher than the ex-ante cutoff θ_A. Let $r_A(\theta)$ denotes the domestic firm's ex-ante revenue before the entry of foreign multinational firms. Recall that the aggregate revenue of firms earned in each country is exogenously given by $R = N_D\left(\overline{r}_D + \gamma_M \overline{r}_M\right) = \alpha^{\varepsilon-1}L$. Hence, $r_A(\theta)/R$ and $r_D(\theta)/R$ represent, respectively, the domestic firm's market share before and after the entry of foreign firms.

The impact of foreign multinational activity on the domestic firm's market share is twofold. On the one hand, the increase in the average productivity and the increase in the number of firms serving the market contribute to a decrease in the aggregate price P in open economy, which in turn exerts a negative effect on domestic firm revenue. On the other hand, knowledge spillovers from foreign firms exert a positive effect on firm revenue. The two effects lead to the following inequalities:

$$\frac{r_D(\theta)}{\tau_\theta^{z_M(\varepsilon-1)}} < r_A(\theta) < \frac{r_D(\theta) + \gamma_M r_M(\theta)}{\tau_\theta^{z_M(\varepsilon-1)}}, \ \ \forall \theta > \theta_A. \tag{23}$$

The first part of the inequality indicates that, in the absence of knowledge spillovers, all domestic firms incur a loss in domestic sales in the presence of foreign multinational activity. The second part of the inequality indicates that firms that engage in multinational activity incur an unambiguous increase in total revenue because the revenue from the foreign market more than makes up their loss of domestic sales.

Aggregate Productivity Next consider the effect of multinational activity on aggregate productivity. Inspections of equation (21) reveals that openness to multinational production leads to a decrease in the number of domestic firms N_D and an increase in the aggregate productivity of domestic firms. This, as described above, arises from the reallocations in factor markets and tougher selection of domestic firms. However, in addition to the selection effect, openness to multinational production can also induce an increase the aggregate productivity of domestic firms because of knowledge spillovers. Surviving domestic firms benefit from the positive productivity externalities from foreign firms and witness an increase in their productivity levels.

former in our theoretical analysis.

Welfare The decrease in the number of domestic firms following the openness to multinational activity is typically dominated by the number of foreign firms even though it is possible when the foreign investment fixed cost is sufficiently high that foreign firms replace a larger number of domestic firms. When there is an increase in total product variety, this effect, together with increased aggregate productivity, contributes positively to welfare as indicated by equation (12).

2.5 Estimating Equations

In this sub-section, we describe the empirical framework through which we examine the self-selection and the effects of multinational activity. To do so, we first examine the decision of foreign firms to invest in a host country and then explore the properties of the model to identify the effects of multinational activity on domestic selection, factor market reallocations, and knowledge spillovers.

(1) The Self-Selection of Multinational Firms

A foreign firm will invest in a host country if $\pi_M(\theta) > 0$ or equivalently $\theta > \theta_M$. Given equation (7), we consider the following empirical specification

$$\begin{aligned} \Pr\left[z_M(\theta) = 1 | \theta > \theta_D\right] &= \Pr\left[\theta > \theta_M | \theta > \theta_D\right] \\ &= \Phi_{\theta > \theta_D}\left[\ln\theta + \ln\left(E^{\frac{1}{\varepsilon-1}}\alpha P/w\right) - \frac{1}{\varepsilon-1}\ln\left(\varepsilon c f_M\right) > 0\right]. \end{aligned} \tag{24}$$

In this equation, we estimate the probability of a multinational firm entering a host country $z_M(\theta) = 1$, conditional on being active in the home country market, as a function of firm ex-ante productivity θ, host country demand conditions E and P, wage rate w, and fixed investment cost cf_M. All host-country specific factors are controlled for using country-industry fixed effect FE_M. In addition, we control for bilateral factors including the distance between host and headquarters countries and whether the countries share common land border and language, all of which may affect the fixed cost of multinational production (as well as trade costs).

Based on estimates of the above equation, we obtain the predicted probability of entry for each multinational firm, i.e., $\widehat{\Pr}\left[\theta > \theta_M | \theta > \theta_D\right]$, the expected productivity of

multinational firms in each host country, i.e., $\widehat{\widehat{\theta}}_M$, and the expected probability of new multinational activity in each host country, i.e., $\widehat{\gamma}_M$.

(2) The Selection of Domestic Firms

After entry of multinational firms, a domestic firm will survive in the market if $\pi_D(\theta) > 0$ or equivalently $\theta > \theta_D$. Given equation (6), we consider the following empirical specification

$$\Pr\left[z_D(\theta) = 1\right] = \Pr\left[\theta > \theta_D\right], \tag{25}$$

where the dependent variable $z_D(\theta)$ denotes whether the domestic firm survives in the market. Based on the estimates, we obtain the predicted probability of survival for each domestic firm $\widehat{\Pr}\left[\theta < \theta_D\right]$, the expected productivity of surviving domestic firms in each host country $\widehat{\widehat{\theta}}_D$, and the expected survival rate $\widehat{\gamma}_D$.

Alternatively, we consider the cutoff productivity of domestic firms. Given equation (6), we obtain

$$\theta_D = \theta_A \left(\frac{c}{c_A}\right)^{\frac{1}{\varepsilon-1}} \frac{P_A}{P}, \tag{26}$$

where θ_A, c_A and P_A are, respectively, the cutoff productivity, capital price, and aggregate price prior to multinational entry. Taking natural logs of the above equation yields:

$$\ln \theta_D - \ln \theta_A = \frac{1}{\varepsilon - 1} \ln \frac{c}{c_A} + \ln \frac{P_A}{P}. \tag{27}$$

Given the estimate of $\ln c/c_A$ below, we can obtain an estimate of $\ln P_A/P$.

(3) Labor Market Reallocation

To evaluate the labor market reallocation effect of multinational activity, we assess the distribution of domestic firm revenue. As described in Section 2.4, $r_D(\theta)/\tau_\theta^{z_M(\varepsilon-1)} < r_A(\theta)$ for all surviving domestic firms, i.e., $r_D(\theta) = \left(\frac{P}{P_A}\tau_\theta^{z_M}\right)^{\varepsilon-1} r_A(\theta)$. Foreign multinational activity hence would shift the revenue distribution of domestic firms either rightward or leftward depending on whether $P\tau_\theta^{z_M} > P_A$. We hence consider the following empirical specification:

$$r_D(q_A) = \left(\frac{P}{P_A}\tau_\theta^{z_M}\right)^{\varepsilon-1} r_A(q_A), \tag{28}$$

where q_A represents the qth (e.g., 25th, 50th and 75th) percentile of the ex-ante revenue distribution. Given the estimate of $\tau_\theta^{z_M}$ from equation (30) below, we can obtain an estimate of P/P_A by estimating the slope of the above equation.

(4) Capital Market Reallocation

Next, we explore the zero profit condition to estimate the effect of multinational activity on domestic capital price. Given $r_D(\theta_D) = \varepsilon c f_D$ at the cutoff productivity θ_D, we consider

$$\ln r_D(\theta_D) = \ln \frac{c}{c_A} + \ln \varepsilon c_A f_D = \ln \frac{c}{c_A} + \ln r_D(\theta_A), \tag{29}$$

where c/c_A is expected to be greater than 1 and $r_D(\theta_A)$ is the cutoff revenue prior to the entry of multinational firms.

(5) Knowledge Spillover

Finally, consider the knowledge spillover effect of foreign multinationals. Recall $\theta = \tau_\theta^{z_M} \cdot \theta_a$ where θ_a is drawn from the distribution function $G(\theta_a)$. When there is multinational entry in an industry, knowledge spillovers from foreign multinational firms would shift the productivity distribution of surviving domestic firms rightward by τ_θ. Let q_A denote the qth percentile of θ_a; we can estimate the knowledge spillover effect τ_θ by considering the following estimation:

$$\theta(q_A) = \tau_\theta^{z_M} \theta_a(q_A), \tag{30}$$

where q_A represents the qth (e.g., 25th, 50th and 75th) percentile of the ex-ante productivity distribution. To address the self-selection of foreign multinationals, z_M will be instrumented by $\widehat{\gamma}_M$ from equation (24).

Figures 1-3 illustrate all the theoretical predictions, i.e., how multinational entry affects, via market reallocations and knowledge spillovers, the cutoff as well as the distribution of domestic productivity and revenue.

[Figures 1-3 about here]

3 Cross-Country Firm Financial and Ownership Data

We employ a cross-country firm-level panel dataset, drawn from Orbis, that contains comprehensive financial, operation, and ownership information for public and private companies in 60 countries.[12] Orbis is published by Bureau van Dijk, a leading source of company information and business intelligence for individual countries, regions, and the world. ORBIS combines information from around 100 sources and information providers. Over 99 percent of the companies included in Orbis are private.

The dataset reports for each company the following categories of information: (1) detailed 10-year financial information including 26 balance sheet and 25 income sheet items; (2) industries and activities including primary and secondary industry codes in both local and international classifications; (3) corporate structure including board members and management; (4) ownership information including shareholdings and subsidiaries, direct and indirect ownership, ultimate owner, independence indicator, corporate group, and all companies with the same ultimate owner as the subject company; (5) mergers and acquisitions deals and rumors.

Orbis provides several distinct advantages that are central to our analysis. First, a notable strength of Orbis is its ownership information, which covers over 30 million shareholder/subsidiary links and is known for its scope and accuracy. The information is collected from a variety of additional sources including official registers, annual reports, private correspondence, telephone research, company websites, and newswires. The data show full lists of direct and indirect subsidiaries and shareholders, a company's degree of independence, its ultimate owner, and other companies in the same corporate family. We explore the shareholder, ultimate owner, and subsidiary information to identify MNC activities across countries. Second, the financial data in Orbis consist of a rich array of time-series financial information. This enables us to measure and compare firm total factor productivity over time. Third, Orbis provides a broad country coverage, including a wide range of industrial and emerging economies. This enables us to perform analysis of multinational activity for a range of heterogeneous countries and investigate how the impact of multinational activity varies across nations.

[12] Table A.1 provides a list of countries. We imposed a number of requirements in cleaning the data. First, we dropped all records that lack revenue, employment, asset, and industry information. Second, we focused on manufacturing industries only. Third, we excluded countries with fewer than 100 observations.

Our analysis focuses on manufacturing industries and covers over 1 million companies in 60 countries. We use four categories of information for each firm: (i) industry information including the 4-digit NAICS code of the primary industry in which each establishment operates; (ii) ownership information including each firm's domestic and global parents and domestic and foreign subsidiaries; (iii) location information; (iv) financial information including revenue, employment, asset, investment, and export activities. A firm is considered foreign owned if its global ultimate owner is based in a different country. There are about 36,000 foreign owned subsidiaries in the final sample.

We use revenue, employment, asset, and investment information to estimate each firm's total factor productivity, a primary variable of the paper. In particular, we use firms' financial data in the 2002-2007 period to derive estimates of production function and productivity.[13] The estimation methodology employed in the paper is the semiparametric estimator developed by Olley and Pakes (1996).[14] Based on this approach, we estimate the production function for each country and each NAICS 4-digit industry and obtain the productivity of each firm based on the country-industry specific production function estimates. In the empirical analysis, we divide the 6-year period to two sub-periods: 2002-2004 and 2005-2007 and investigate how changes in multinational activity between the two periods affect host-country domestic firms.

To take a first glance at the data, we plot, in Figures 4 and 5, the correlations between multinational activity and average productivity. We find that not only are countries and industries with greater multinational activity, on average, more productive (with a statistically significant correlation of 0.36), the productivity growth is also positively and significantly correlated with the growth in multinational activity (with a correlation of 0.13). Now consider the productivity distributions of domestic firms in the two periods of the analysis. As shown in Figure 6, the productivity distribution of domestic firms remained largely similar in the two periods for countries and industries where there was no multinational entry. Only the top range firms experienced a slight rightward shift in their productivity levels in 2005-2007. For countries and industries with positive multinational

[13] Revenue, asset, and investment are all deflated by their respective deflators.

[14] We also considered a number of approaches to obtain estimates of TFP, including instrumental variables and semiparametric estimations. Van Biesebroeck (2008) provides a comparison of these methods and finds them to produce similar productivity estimates. Similar to Van Biesebroeck (2008), we did not find significant differences in the estimates of TFP obtained from either the IV or the semiparametric estimations. We report the results based on the semiparametric estimator introduced by Olley and Pakes (1996).

entry, the productivity distribution of domestic firms shifted slightly to the right, even for the small- and medium-productivity firms, while the distribution became more left truncated (Figure 7). In the next section, we explore the characteristics of the distributions to identify the different effects of multinational activity.

[Figures 4-7 about here]

4 Empirical Evidence

In this section, we estimate the structural empirical framework described in Section 2.5 and assess the self-selection of multinational firms and the effects of multinational activity on domestic selections, factor market reallocations, and knowledge spillovers.

4.1 The Self-Selection of Multinational Firms

We begin our empirical analysis by examining first the entry of foreign multinational firms. To proceed, we estimate the following equation adopted from equation (24):

$$\begin{aligned} \Pr\left[z_M(\theta)=1|\theta>\theta_D\right] &= \Phi_{\theta>\theta_D}\left[\ln\theta-\ln\theta_M>0\right] \\ &= \Phi_{\theta>\theta_D}\left[\ln\theta+FE_M-\frac{1}{\varepsilon-1}\ln d>0\right], \end{aligned} \tag{31}$$

where $z_M(\theta)$ represents foreign multinationals' binary decision to enter a given host country in 2005-2007, θ is the ex-ante productivity of multinational firms estimated based on headquarter activities in 2002-2004, FE_M is a vector of host country-industry dummies, and d represents bilateral country factors including distance, common border, and common language between headquarters and host countries. The ex-ante headquarter productivity of multinational firms is expected to have an important effect on the decision to participate in multinational activity as shown in Helpman et al. (2004) but, in the meantime, unlikely to be directly correlated with the future productivity of host-country local firms. We thus adopt this variable as an exclusion condition in the second-stage estimations below to identify the effect of multinational activity.

Table 1 reports the estimation results of equation (31).[15] We find that, as expected in

[15] A linear probability model is used to avoid the incidental parameter problem that arises in fixed-effect maximum likelihood estimators.

Section 2, more productive firms exhibit a greater likelihood of entering foreign countries, a result consistent with Helpman et al. (2004). Further, the probability of multinational activity decreases in the distance between headquarter and host countries, in alignment with the existing empirical literature of multinational production. Multinationals are also more likely to enter host countries that have land borders and common languages with headquarter countries. These findings are robust to the inclusion of host country-industry and headquarter country-industry fixed effects, which control for all country-industry specific factors that could affect multinationals' entry decisions, and the use of firm-level clustering.

[Table 1 about here]

Based on the estimates, we then obtain the predicted probability of entry for each multinational firm $\widehat{\Pr}[\theta > \theta_M | \theta > \theta_D]$, the expected productivity of multinational firms in each host country $\widehat{\bar{\theta}}_M$, and the expected probability of new multinational activity in each host country $\widehat{\gamma}_M$, the latter two of which are used in the following analysis.

Now we move on to evaluate the effect of multinational activity on host-country domestic firms taking into account the self-selection of multinational firms.[16] Table 2 shows that multinational activity exerts, on average, a positive and significant effect on the average productivity of domestic firms, after we take into account the endogeneity of multinational entry. This positive relationship alone does not allow us to distinguish the sources of productivity gains. Is the gain attributed to knowledge spillovers, selections, or both? We explore next the various channels through which multinational production may affect host-country productivity.

[Table 2 about here]

4.2 The Selection of Domestic Firms

We start with the selection of domestic firms. We first examine the survival of individual domestic firms by estimating

$$\Pr\left[z_D(\theta) = 1\right] = \Phi\left[\beta_0 + \beta_1 \ln \theta_A + \beta_Z z_M\right], \tag{32}$$

[16] Given the MNC entry measure is obtained from a first-stage estimation, we bootstrap the standard errors in all the following estimations.

where $z_D(\theta)$ represents whether the domestic firm continues production in 2005-2007, θ_A is the lagged productivity of the domestic firm, and z_M is an indicator for new multinational entry. Because only the lagged productivity is observable for exiting firms, based on Section 2.5, $\beta_Z \equiv \ln \tau_\theta - \left(\frac{1}{\varepsilon-1} \ln \frac{c}{c_A} + \ln \frac{P_A}{P}\right)$ represents the cumulative effect of new multinational entry on the survival probability of domestic firms, including the positive knowledge spillover effect and the effects of capital and aggregate prices. In addition, we include vectors of country and industry dummies to control for country and industry factors and country-industry clustering to allow for correlations within each cluster. To account for the endogeneity of z_M, we substitute $\widehat{\gamma}_M$ obtained from equation (31) into the above equation.

Table 3 reports the results. We find that a greater probability of new multinational activity exerts a negative and significant effect on the survival probability of domestic firms. Domestic firms are more likely to exit the market in the presence of new multinational entry. This result, robust to the control of firm characteristics including productivity and size, suggests that $\frac{1}{\varepsilon-1} \ln \frac{c}{c_A} + \ln \frac{P_A}{P} > \ln \tau_\theta$, i.e., the selection effect dominates the effect of knowledge spillovers. Based on the estimates, we obtain the predicted probability of survival for each domestic firm $\widehat{\Pr}[\theta > \theta_D]$, the expected productivity of surviving domestic firms in each host country $\widehat{\widetilde{\theta}}_D$, and the expected survival rate $\widehat{\gamma}_D$.

[Table 3 about here]

Alternatively, we estimate directly the cutoff productivity of domestic firms following equation (27) in Section 2.5:

$$\ln \theta_D - \ln \theta_A = \beta_D z_M. \tag{33}$$

Column (1) of Table 4 suggests that a higher probability of multinational entry leads to a significant increase in the cutoff productivity of domestic firms. In particular, we find $\beta_D \equiv \frac{1}{\varepsilon-1} \ln \frac{c}{c_A} + \ln \frac{P_A}{P} = 0.16$, implying a 100-percent increase in the probability of new multinational firms is associated with 16 percent increase in the cutoff productivity. Domestic firms whose productivity falls between the ex-ante and the new, higher productivity thresholds would be forced to exit the markets.

[Table 4 about here]

4.3 Labor Market Reallocation

To evaluate the labor market reallocation effect of multinational activity, we assess changes in the revenue distribution of domestic firms, based on equation (28), by tracking firms located in different percentiles of the ex-ante revenue distribution:

$$\ln r_D(q_A) - \ln r_A(q_A) = (\varepsilon - 1)(\beta_P + \beta_\theta) z_M, \tag{34}$$

where $\beta_P \equiv \ln(P/P_A)$ is expected to be negative and $\beta_\theta \equiv \ln \tau_\theta$ is expected to be positive. Given the estimate of β_θ from equation (36) below, we can obtain an estimate of β_P and subsequently P/P_A.

The lower panel of Table 5 suggests that a higher likelihood of multinational entry leads to a significant decrease in the level of revenue for firms at both the 25th and 50th percentiles. The magnitude of decline is, however, smaller at the 50th percentile, suggesting that the relatively smaller domestic firms see a bigger contraction in their revenue.[17]

[Table 5 about here]

4.4 Capital Market Reallocation

Next, we estimate the effect of foreign multinational entry on domestic capital markets by examining the following equation adopted from equation (29) in Section 2.5:

$$\ln r_D(\theta_D) - \ln r_D(\theta_A) = \beta_c z_M \tag{35}$$

where $\ln r_D(\theta_D) - \ln r_D(\theta_A)$ is the change in the cutoff revenue of domestic firms and $\beta_c \equiv \ln(c/c_A)$, expected to be positive, captures the effect of foreign multinational activity on capital price. Again, to address the self-selection of foreign multinationals, z_M is instrumented by $\widehat{\gamma}_M$ from equation (31).

As shown in column (2) of Table 4, we find a higher probability of multinational entry to lead to a significant increase in the cutoff revenue of domestic firms. In particular,

[17] While the monopolistic competition model adopted in the paper abstracts from selections through product market competition, the latter is captured in our empirical analysis, specifically by the estimated effect of multinational entry on the revenue distribution of domestic firms.

$\beta_c \equiv \ln(c/c_A) = 0.06$, which implies that a 100-percent increase in the likelihood of new multinational firms is associated with 6 percent increase in the unit capital price. Given $\beta_c \equiv \ln(c/c_A) = 0.06$ and $\beta_D \equiv \frac{1}{\varepsilon-1}\ln\frac{c}{c_A} + \ln\frac{P_A}{P} = 0.16$ and assuming, for example, $\varepsilon = 2$, we obtain $\ln\frac{P_A}{P} = 0.1$ and $\frac{P}{P_A} = 0.9$, that is, 10 percent decrease in the aggregate price.

4.5 Knowledge Spillover

Finally, we assess the extent of knowledge spillovers by examining the productivity distribution of domestic firms following equation (30):

$$\ln\theta(q_A) - \ln\theta_a(q_A) = \beta_0 + \beta_\theta z_M, \tag{36}$$

where $\beta_\theta \equiv \ln\tau_\theta$ captures the magnitude of knowledge spillovers and z_M is instrumented by $\widehat{\gamma}_M$ from equation (31).

The upper panel of Table 5 reports the results. The estimates suggest that a higher probability of new multinational firms leads to an increase in the productivity of domestic firms at both the 25th and 50th percentiles with $\beta_\theta = 0.03$ and 0.04, respectively. This implies $\tau_\theta = 1.03 \sim 1.04$, that is, 3-4 percent upward shift of the productivity in the lower range of the distribution. The productivity in the upper range is not found to be significantly affected. Table 6 provides a summary of the estimated effects.

[Table 6 about here]

5 Quantifying Productivity Gains from Multinational Activity

In this section, we quantify both the aggregate and the decomposed impact of multinational activity on the productivity of host countries.

5.1 Aggregate Productivity Gain

First, we evaluate the aggregate productivity effect, $\Delta\widetilde{\theta}$. To do so, we compute

$$\Delta\widetilde{\theta} \equiv \frac{\widetilde{\theta}}{\widetilde{\theta}_c} - 1 = \left\{ \frac{\frac{1}{N}\left[N_D^{\varepsilon-1}\widetilde{\theta}_D^{\varepsilon-1} + N_M^{\varepsilon-1}\widetilde{\theta}_M^{\varepsilon-1}\right]}{\frac{1}{N_A}N_A^{\varepsilon-1}\widetilde{\theta}_A^{\varepsilon-1}} \right\}^{\frac{1}{\varepsilon-1}} - 1, \tag{37}$$

where $\widetilde{\theta}$ is the expected aggregate productivity given the entry of multinational firms and $\widetilde{\theta}_c \equiv N_A\widetilde{\theta}_A/N_A^{\frac{1}{\varepsilon-1}}$ is the aggregate productivity in 2002-2004. Given $N_M = \gamma_M N_D$ and $N = (1+\gamma_M)N_D$, the above equation can be written as:

$$\Delta\widetilde{\theta} = \left\{ \frac{\frac{N_D^{\varepsilon-2}}{1+\gamma_M}\left[\widetilde{\theta}_D^{\varepsilon-1} + \gamma_M^{\varepsilon-1}\widetilde{\theta}_M^{\varepsilon-1}\right]}{N_A^{\varepsilon-2}\widetilde{\theta}_A^{\varepsilon-1}} \right\}^{\frac{1}{\varepsilon-1}} - 1. \tag{38}$$

where $\widehat{\widetilde{\theta}}_D/\widehat{\widetilde{\theta}}_A$, $\widehat{\widetilde{\theta}}_M/\widehat{\widetilde{\theta}}_A$, $\widehat{\gamma}_D$, and $\widehat{\gamma}_M$ are used to proxy for $\widetilde{\theta}_D/\ \widetilde{\theta}_A$, $\widetilde{\theta}_M/\ \widetilde{\theta}_A$, N_D/N_A, and γ_M, respectively.

Based on the estimates reported in Table 6, we find the average productivity to increase by 1.4 percent across countries when the probability of entry by new multinational firms increases by 100 percent (Table 7). This gain arises from three sources: (1) the greater productivity of entering multinational firms (the self-selection of multinational firms); (2) the higher average ex-ante productivity of surviving domestic firms (the selection of domestic firms); (3) knowledge spillovers. To investigate the importance of each source in total productivity gain, we decompose the aggregate productivity gain next by considering only one channel at a time.

[Table 7 about here]

5.2 Decomposing the Productivity Gain

The Self-Selection of Multinational Firms First, we estimate the direct productivity gain associated with the self-selection of multinational firms, i.e.,

$$\Delta\widetilde{\theta}_M = \frac{\widetilde{\theta}_M}{\widetilde{\theta}_A} - 1. \tag{39}$$

The results suggest $\Delta\widetilde{\theta}_M = 0.049$, that is, entering multinationals are, on average, 4.9 percent more productive than domestic incumbents. Given the weight of multinational firms in the aggregate economy, i.e., 14 percent ($= \gamma_M/(1+\gamma_M)$), this productivity advantage leads to 0.68 percent increase in aggregate productivity.[18]

The Productivity Gain of Domestic Firms Next, we evaluate the productivity gain of domestic firms as a result of knowledge spillover and tougher selection. This is captured by:

$$\Delta\widetilde{\theta}_D = \frac{\widetilde{\theta}_D}{\widetilde{\theta}_A} - 1. \tag{40}$$

The results suggest that aggregate domestic productivity increases by 0.87 percent when the probability of multinational entry rises by 100 percent. Given the weight of domestic firms in the aggregate economy, i.e., 86 percent ($= 1/(1+\gamma_M)$), this is equivalent to 0.75 percent increase in aggregate productivity.

Next we further decompose the productivity gains of domestic firms to two parts: gains from knowledge spillovers and gains from selections.

The Productivity Gain of Domestic Firms: Knowledge Spillovers The productivity gain as a result of knowledge spillovers can be estimated by assuming away the effects of domestic selection and market reallocation, i.e., by setting $\beta_P, \beta_c = 0$:

$$\Delta\widetilde{\theta}_D\Big|_{\beta_P,\beta_c=0} = \left.\frac{\widetilde{\theta}_D}{\widetilde{\theta}_A}\right|_{\beta_P,\beta_c=0} - 1. \tag{41}$$

We find that knowledge spillovers alone lead to about 0.6 percent increase in domestic productivity (or equivalently 69 percent of the domestic productivity gain).

The Productivity Gain of Domestic Firms: Selections The productivity gain as a result of the tougher selection of domestic firms and market reallocations (while assuming

[18] Note that this estimate is derived by using multinationals' ex-ante headquarter productivity as a proxy for their subsidiary productivity to avoid endogeneity concerns. In our data, we find the two are highly correlated, suggesting the former serves as a reasonable proxy for evaluating the productivity advantage of multinational subsidiaries. An alternative interpretation for this source of productivity gain is the productivity upgrading of acquired plants after the acquisition by multinational firms. As shown in Arnold and Javorcik (2009) and Guadalupe et al. (2011), multinational firms tend to acquire the most productive domestic firms, which then, after acquisition, adopt foreign technologies and achieve higher productivity.

zero knowledge spillovers) is given by:

$$\Delta\widetilde{\theta}_D\Big|_{\beta_\theta=0} = \frac{\widetilde{\theta}_D}{\widetilde{\theta}_A}\Big|_{\beta_\theta=0} - 1. \tag{42}$$

The estimates suggest 0.3 percent increase in domestic firm productivity (or equivalently 31 percent of the total domestic productivity gain) when domestic selections and market reallocations are the only operative channel. This result suggests that it is important to take into account the role of selections and market reallocations in determining the productivity gains from multinational activity. Ignoring this source can lead to significant bias in understanding the nature of productivity gains and an over-estimation of the importance of knowledge spillovers.

5.3 Country Heterogeneity of Productivity Gains

In this sub-section, we explore how the estimated productivity gains may vary across countries. We proceed by first dividing the country sample to two groups: developed and developing countries. We re-estimate the empirical model and quantify the aggregate as well as the decomposed productivity gains for the two groups, respectively. The results are summarized in the last two columns of Tables 6 and 7. We show in Table 6 that multinational entry leads to a significant increase in cutoff productivity and cutoff revenue in developed countries, suggesting tougher domestic market selections and reallocations. The increased multinational activity raises the threshold productivity for domestic firms to survive. This is channeled through both capital market, as implied by the increase in cutoff revenue (a proxy of financing cost), and labor market, as indicated by the decrease in revenue for both 25th and 50th percentile domestic firms. The results also show the existence of some knowledge spillover, but limited to low-productivity domestic firms. Domestic firms with medium or high productivity do not see a rightward shift.

The results are drastically different in developing nations. Multinational entry is not found to increase cutoff productivity or cutoff revenue. Only the medium-size domestic firms see a decrease in revenue. In contrast, there is greater evidence of knowledge spillover. The left and the middle range of the domestic productivity distribution shifts significantly rightward.

When computing productivity gains based on these estimates, we find a 100-percent

increase in the probability of new multinational entry leads to 1.22 percent aggregate productivity gain and 0.55 percent increase in domestic productivity in developed nations. Further, multinationals that enter developed countries exhibit 7.29 percent greater productivity than domestic competitors. Of the 0.55 percent domestic productivity gain, knowledge spillover and market reallocation account for 0.20 and 0.35 percentage points, respectively, suggesting that market reallocation plays a more important role in determining the productivity gains from multinational activity.

In comparison to developed nations, the magnitudes of aggregate and domestic productivity gains are greater in developing countries, estimated to be 2.11 and 2.25 percent, respectively. The productivity premium of multinationals, on the other hand, is smaller. In sharp contrast to the developed countries, the vast majority of the domestic productivity gain is due to knowledge spillover. Market reallocation plays little role in the domestic productivity gain from multinational activity.

In Table 8, we present the list of countries with the highest estimated productivity gains, in both aggregate and decomposed terms. The top 10 countries that are estimated to receive the greatest aggregate productivity gains consist of Lithuania, Norway, France, Argentina, Bulgaria, Sweden, Hong Kong, Finland, Spain and Japan. Among these countries, Lithuania is also estimated to register the greatest domestic productivity gain (22.3 percent), most of which arises from knowledge spillover (22.01). This is similarly true for Norway, Argentina, Bulgaria, and Finland, where domestic productivity gains are estimated to be 9.91, 5.97, 6.57 and 3.00 percent, respectively, with the majority due to knowledge spillover. The distribution of productivity gains is different for France and Hong Kong. The productivity premium of multinational firms accounts for an important share in the aggregate productivity gain. The domestic productivity gain is about 0.78 percent in France, with knowledge spillover and market reallocation each accounting for about half.

[Table 8 about here]

5.4 Discussion: FDI Promotion Policy and Productivity Gains

Next we exploit the pattern underlying the estimated heterogeneous productivity gains and its relationship with country FDI policies. As described in the introduction, many countries offer a variety of FDI promotion policies to attract foreign multinational firms

and attain productivity gains from multinational activity. Policies to promote FDI take a variety of forms. In general, incentives fall into two categories: fiscal incentives, such as tax holidays and lower taxes for foreign investors; and financial incentives, such as government grants, credits at subsidized rates, government equity participation and government insurance at preferential rates. Other incentives can include subsidized infrastructure, subsidized services, contract preferences, foreign exchange privileges, and even monopoly rights.

But do we observe a relationship between these policies and the productivity effect of FDI? To answer this question, we employ the World Bank 2005 Census of Investment Promotion Agencies. The Census collects information on whether a country offers favorable incentives to foreign investors. The types of incentives include financial incentives, tax holidays, tax reduction, and regulatory exemption. We consider the existence of incentives in a lagged period (2002-2004) and examine its relationships with the productivity gains estimated for 2005-2007.

Due to data availability, the sample is restricted to a subsample of 41 developed and developing countries. As shown in Table 9, we find the offering of incentives to foreign multinational firms is negatively associated with the productivity advantage of multinationals. The average productivity of multinational firms tends to be lower in countries that provide favorable incentives. Among the different types of incentives, tax holiday is shown to exhibit a weak positive relationship with the domestic productivity gains from FDI, in particular, gains from knowledge spillovers. Gains from market reallocation, however, are found to be negatively and significantly associated with the provision of FDI promotion incentives. A possible explanation is that since the offering of FDI incentives leads to entry of multinationals that are on average less productive, it weakens the competition effect of multinationals and subsequently the gains from market reallocations.

[Table 9 about here]

6 Conclusion

Identifying productivity gains from openness to multinational activity has been a fundamental topic of economic research. A primary challenge in empirical investigations is to distinguish the sources of productivity gains, including gains from knowledge spillovers

and selections. In this paper, we disentangle the roles of knowledge spillovers and selections in determining the aggregate productivity impact of multinational activity and quantify the relative importance of each source.

We develop a standard model of monopolistic competition and heterogeneous firms to address simultaneously the selections of domestic and multinational firms and the knowledge spillovers from multinational to domestic production. Our theoretical framework suggests that while both selections and knowledge spillovers predict a positive relationship between openness to multinational activity and aggregate productivity, the effects can be distinguished by exploring their distinct predictions for the distributions of domestic firms. Knowledge spillovers induce a rightward shift of the productivity distribution; the selection effect, in contrast, causes a weaker, or even leftward, shift of the revenue distribution and an increase in the cutoff productivity and revenue.

These predictions are evaluated structurally using a large cross-country firm panel dataset, drawn from Orbis, that contains comprehensive financial, operation, and ownership information for over 1 million public and private manufacturing companies in 2002-2007. Our empirical evidence suggests that multinational activity leads to not only knowledge spillover but also tougher selection and factor reallocation in domestic markets. Entry of multinational firms raises the cutoff productivity of domestic firms, pushing the least productive domestic firms to exit the markets. New multinational activity also leads to an increase in the minimum revenue of continuing domestic firms, indicating an increase in fixed production cost and capital price. Further, the estimates show a significant decrease in the aggregate price, suggesting increased competition and market reallocations. Following the entry of multinational firms, the revenue distribution of domestic firms is found to shift leftward, at both the 25th and 50th percentiles. In contrast, the productivity distribution of domestic firms is shown to shift rightward, while the distribution becomes more left truncated due to selection.

When quantifying the productivity gains from multinational activity, we find the aggregate productivity to increase by 1.4 percent across countries when the probability of entry by new multinational firms increases by 100 percent. In particular, the productivity of domestic firms increases by 0.9 percent, with knowledge spillover and domestic selection accounting for 69 and 31 percent, respectively. Further, the relative importance of each source exhibits significant country heterogeneity. In particular, we find the gains

to be driven by knowledge spillovers in developing nations but by selections and market reallocations in developed countries.

7 Appendix: Between-Industry Market Reallocations and Knowledge Spillovers

Our main analysis has focused on quantifying the within-industry effects of multinational activity. In this section, we explore how multinational activity can affect the productivity of different industries through factor market reallocations and knowledge spillovers.

Starting with market reallocations, we consider how increased multinational activity in one industry may lead to increased demand for capital and labor and subsequently higher factor prices. This factor market effect could influence the production costs of domestic firms in other industries, especially in industries that employ similar types of capital goods and labor. To capture this potential factor market externality between industries, we construct three separate measures.

First, we construct a measure of industry pair's similarity in occupational labor requirements, $Labor\ similarity_{ij}$. Industries with greater similarity in occupational labor structure are expected to share greater externality in labor markets. We use the Bureau of Labor Statistics' 2006 National Industry-Occupation Employment Matrix (NIOEM) which reports industry-level employment across detailed occupations (e.g., Assemblers and Fabricators, Metal Workers and Plastic Workers, Textile, Apparel, and Furnishings Workers, Business Operations Specialists, Financial Specialists, Computer Support Specialists, and Electrical and Electronics Engineers). We convert occupational employment counts into occupational percentages for each industry and measure each industry pair i and j's correlation in occupational percentages. Second, we attempt to evaluate capital market externality by constructing a measure of industries' similarity in capital-good demand, $Capital\ similarity_{ij}$. This variable uses capital flow data from the Bureau of Economic Analysis (BEA), a supplement to the 1997 benchmark input-output (I-O) accounts, which shows detailed purchases of capital goods (e.g., motors and generators, textile machinery, mining machinery and equipment, wood containers and pallets, computer storage devices, wireless communications equipment) by using industry. We measure

each using-industry pair i and j's similarity in capital-good demand by the correlation of investment flow vectors.

Using the above two measures of industry relatedness as the weights, we then construct variables to capture multinational activity in related industries. The results are reported in Table 10. We find that increased multinational activity in industries that share similar labor demand can lead to an increase in the domestic cutoff productivity. This suggests that an increase in labor demand can lead to labor reallocations between related industries, resulting in tougher domestic market selections. The analysis also shows evidence of capital reallocations between industries. As shown in column (4), increased multinational activity in an industry will lead to an increase in cutoff revenue, a proxy for capital financing cost, in industries that share similar capital-good demand.

[Table 10 about here]

In addition to market reallocations, multinational activity can also lead to knowledge spillovers across industries. To explore this effect, we examine how multinational activity in a given industry can affect the productivity distribution of domestic firms in related industries. Following Javorcik (2004), we construct two variables, $Backward\ linkage_{ij}$ and $Forward\ linkage_{ij}$, to measure the extent of the input-output relationships between each pair of industries. $Backward\ linkage_{ij}$ measures the share of a downstream industry j's inputs that come from an upstream industry i and $Forward\ linkage_{ij}$, equal to $Backward\ linkage_{ji}$, measures the share of a downstream industry i's inputs that come from an upstream industry j. The shares are computed using the 2002 Benchmark Input-Output Accounts published by the Bureau of Economic Analysis. We then interact the above variables with predicted multinational activity in each industry j and compute the weighted sum of multinational activity in downstream and upstream industries, respectively.

Our results suggest significant knowledge spillovers via backward linkages, from downstream foreign multinational firms to upstream domestic firms, at both the 25th and the 50th percentiles. This finding is limited to developed countries (Table 11), however; we find no systematic evidence of between-industry spillovers in developing nations. In the meantime, previous results on within-industry spillovers remain largely similar.

[Table 11 about here]

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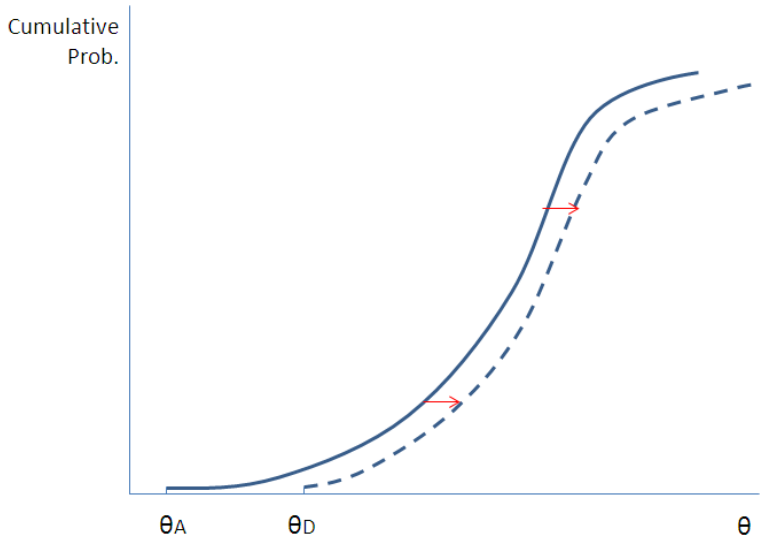

Figure 1: The productivity distribution before and after multinational entry

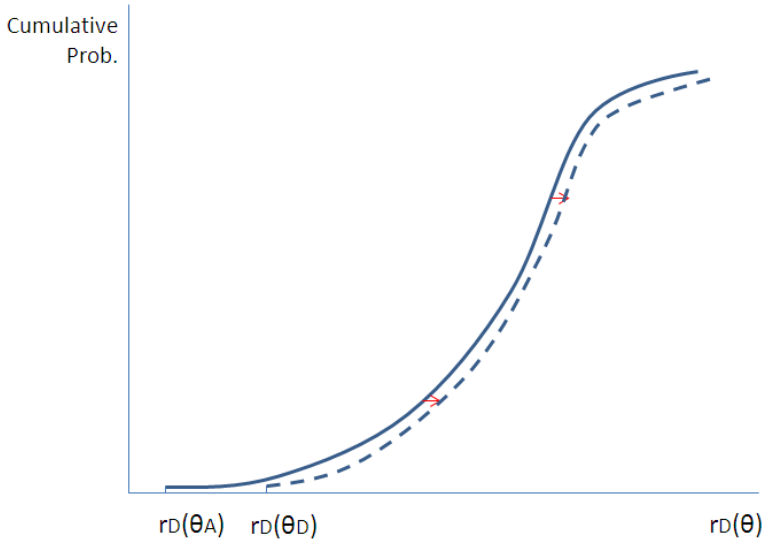

Figure 2: The revenue distribution before and after multinational entry (case I)

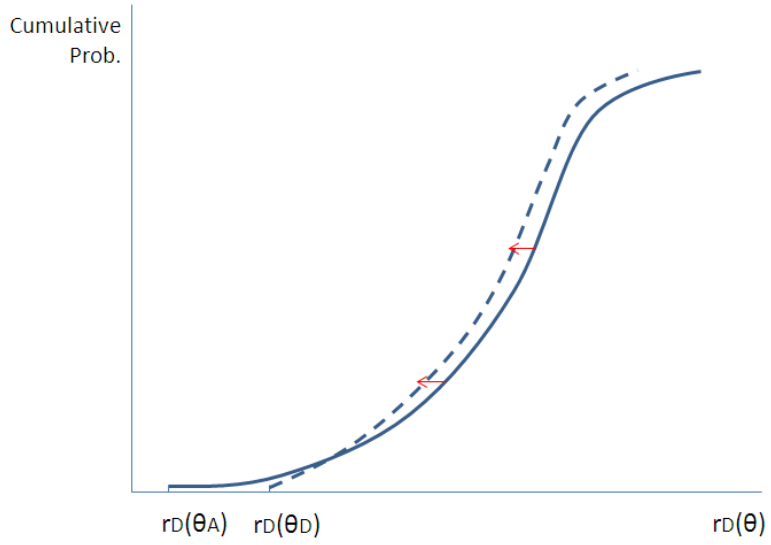

Figure 3: The revenue distribution before and after multinational entry (case II)

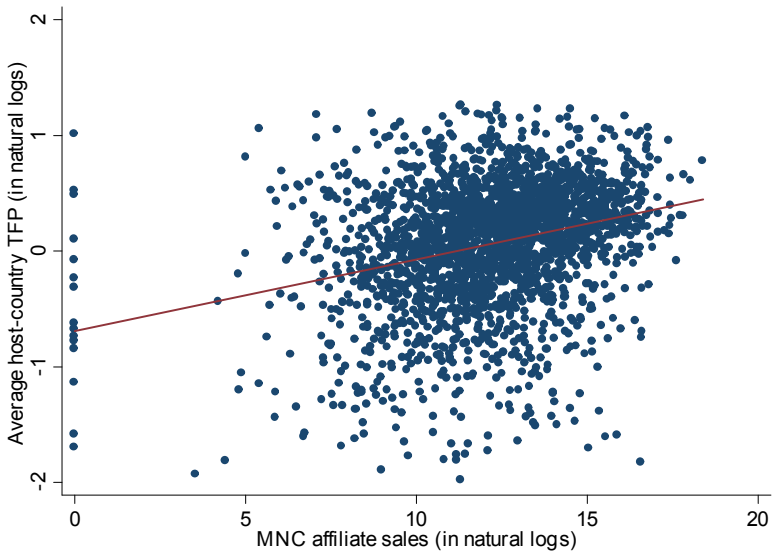

Figure 4: The correlation between multinational activity and average productivity

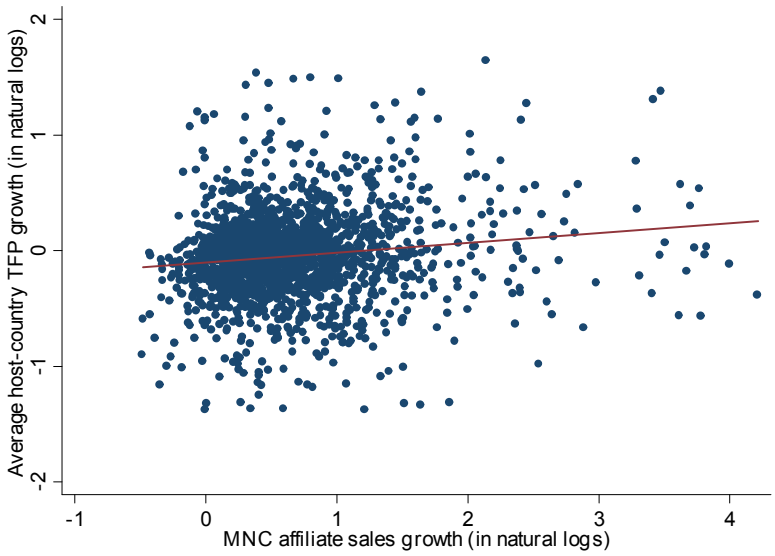

Figure 5: The correlation between increase in multinational activity and average productivity growth

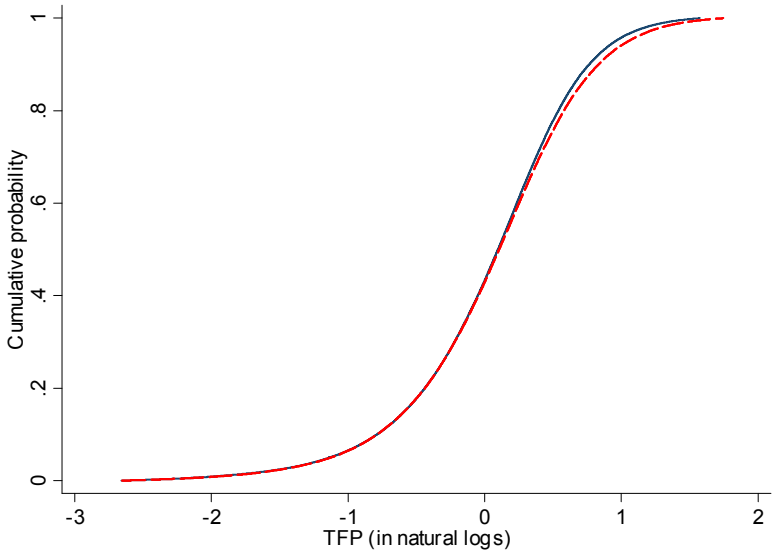

Figure 6: The productivity distributions of domestic firms in countries and industries without multinational entry in 2005-2007 (solid: 2002-2004, dashed: 2005-2007)

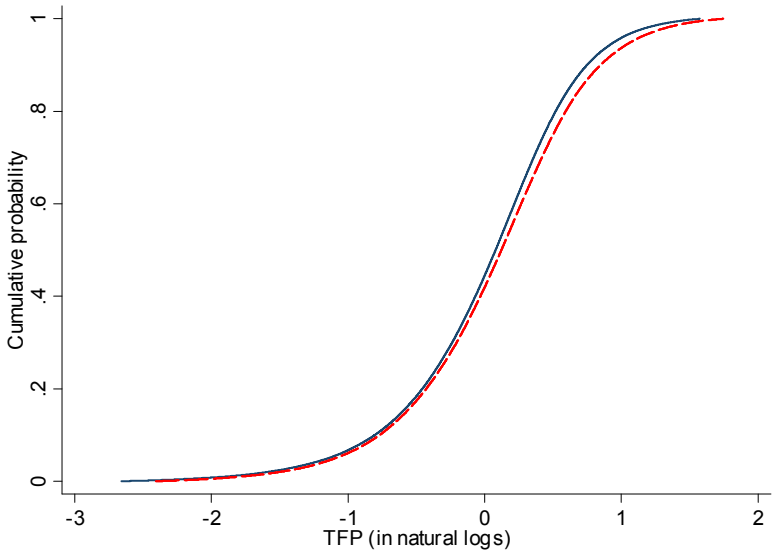

Figure 7: The productivity distributions of domestic firms in countries and industries with multinational entry in 2005-2007 (solid: 2002-2004, dashed: 2005-2007)

Table 1: The Self-Selection of Multinational Firms

Dependent var.: MNC entry	(1)	(2)
HQ TFP	0.004***	0.004***
	(0.001)	(0.001)
Distance	-0.003***	-0.007***
	(0.001)	(0.001)
Contiguity	0.06***	0.06***
	(0.004)	(0.007)
Language	0.03***	0.03***
	(0.003)	(0.004)
Host country-ind FE	Yes	Yes
HQ country-ind FE	No	Yes
Firm cluster	Yes	Yes
Obs	907,776	907,776
R square	0.08	0.08

Notes: (i) Linear probability (LP) estimates are reported; (ii) Standard errors clustered at the firm level are reported in the parentheses; (iii) ***, **, and * represent statistical significance at 1, 5, and 10 percent, respectively.

Table 2: Multinational Activity and Average Productivity

Dependent var.: Change in —	(1) Average TFP	(2) Average TFP
MNC entry (predicted)	0.05*	0.02**
	(0.03)	(0.01)
Host country FE	-	Yes
Industry FE	-	Yes
Obs	60	2,814
R square	0.08	0.37

Notes: (i) Columns (1) and (2) report country- and country-industry level OLS estimates, respectively; (ii) Bootstrapped standard errors are reported in the parentheses; (iii) ***, **, and * represent statistical significance at 1, 5, and 10 percent, respectively.

Table 3: The Selection of Domestic Firms

Dependent var.: Domestic firm survival	(1)	(2)
MNC entry (predicted)	-0.001***	-0.001***
	(0.000)	(0.000)
TFP (lagged)		0.002***
		(0.000)
Employment (lagged)		0.005***
		(0.000)
Host Country FE	Yes	Yes
Industry FE	Yes	Yes
Country-Industry cluster	Yes	Yes
Obs	548,249	548,249
R square	0.15	0.18

Notes: (i) Linear probability estimates are reported; (ii) Standard errors clustered at the firm level are reported in the parentheses; (iii) Bootstrapped standard errors are reported in the parentheses; (iv) ***, **, and * represent statistical significance at 1, 5, and 10 percent, respectively.

Table 4: Selections and Market Reallocations

Dependent var.: Change in —	(1) Cutoff TFP	(2) Cutoff revenue
MNC entry (predicted)	0.16*	0.06***
	(0.09)	(0.03)
Host country FE	Yes	Yes
Industry FE	Yes	Yes
Obs	2,819	3,408
R square	0.38	0.43

Notes: (i) Weighted least squre estimates are reported; (ii) Bootstrapped standard errors are reported in the parentheses; (iii) ***, **, and * represent statistical significance at 1, 5, and 10 percent, respectively.

Table 5: The Productivity and Revenue Distributions of Domestic Firms

	(1) 25th Percentile	(2) 50th Percentile	(3) 75th Percentile
Panel A: TFP of different percentiles			
MNC entry (predicted)	0.03*	0.04***	-0.00
	(0.02)	(0.01)	(0.01)
Host country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Obs	2,313	2,313	2,313
R square	0.14	0.15	0.13
Panel B: Revenue of different percentiles			
MNC entry (predicted)	-0.05***	-0.03*	-0.002
	(0.01)	(0.02)	(0.02)
Host country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Obs	3,773	3,773	3,773
R square	0.19	0.17	0.12

Notes: (i) The percentiles are taken from the distributions in 2002-2004; (ii) Bootstrapped standard errors are reported in the parentheses; (iii) ***, **, and * represent statistical significance at 1, 5, and 10 percent, respectively.

Table 6: Estimated Effects of Multinational Activity

Parameters	Estimates		
	All	Developed	Developing
Cutoff productivity	0.16	0.35	0.00
Cutoff revenue/Financing cost	0.06	0.09	0.00
Aggregate real price	-0.10	-0.26	0.00
Revenue – 25th perc.	-0.05	-0.04	0.00
Revenue – 50th perc.	-0.03	-0.02	-0.04
Revenue – 75th perc.	0.00	0.00	0.00
Knowledge spillovers – 25th perc.	0.03	0.02	0.05
Knowledge spillovers – 50th perc.	0.04	0.00	0.11
Knowledge spillovers – 75th perc.	0.00	0.00	0.00

Notes: (i) The table reports the estimated effect of multinational activity on variables listed in the first column, for all, developed and developing nations, respectively.

Table 7: Estimated Productivity Gains

TFP Gains (in percentage)	Estimates All	Developed	Developing
Aggregate	1.40	1.22	2.11
Multinational Firms	4.90	7.29	1.31
Domestic Firms	0.87	0.55	2.25
– Spillover	0.60	0.20	2.20
– Reallocation	0.27	0.35	0.05

Notes: (i) The table reports estimated productivity gains, including both the aggregate and the decomposed, for all, developed and developing nations, respectively.

Table 8: Countries with the Highest Estimated Productivity Gains

Aggregate		Multinational		Domestic		Spillover		Reallocation	
Lithuania	21.22	Hong Kong	74.73	Lithuania	22.28	Lithuania	22.01	Canada	0.90
Norway	8.06	France	67.38	Norway	9.91	Norway	9.79	Sweden	0.52
France	5.62	Austria	34.74	Bulgaria	6.57	Bulgaria	6.28	Ireland	0.42
Argentina	5.52	Mexico	30.93	Argentina	5.97	Argentina	5.73	Russia	0.40
Bulgaria	5.50	Spain	23.84	Sweden	4.75	Sweden	4.23	Austria	0.38
Sweden	4.99	Ukraine	23.58	Finland	3.00	Finland	2.63	Romania	0.37
Hong Kong	3.67	Sweden	23.44	Czech Rep	2.77	Czech Rep	2.47	Finland	0.37
Finland	2.90	Portugal	23.06	Japan	1.13	Japan	0.82	Belgium	0.36
Spain	1.93	Japan	22.63	Spain	0.95	Spain	0.60	Denmark	0.36
Japan	1.68	S. Korea	20.43	Canada	0.90	France	0.42	France	0.36

Notes: (i) The table reports the top 10 countries with the highest estimated productivity gains, by both the aggregate and the decomposed terms; (ii) The estimated productivity gains are expressed in percentages.

Table 9: Estimated Productivity Gains and FDI Promotion Policies

	Aggregate	Multinational	Domestic	Spillover	Reallocation
Any incentives	0.001	-0.23**	0.01	0.01	-0.001*
	(0.01)	(0.11)	(0.01)	(0.01)	(0.00)
Financial incentives	0.01	0.08	0.01	0.001	-0.001*
	(0.02)	(0.12)	(0.02)	(0.01)	(0.00)
Tax holiday	0.03	-0.35***	0.04*	0.04*	-0.001*
	(0.03)	(0.11)	(0.02)	(0.02)	(0.00)
Tax reduction	-0.003	-0.22*	-0.001	0.01	-0.000
	(0.01)	(0.12)	(0.01)	(0.01)	(0.00)
Regulation exemption	-0.02**	-0.17*	-0.01	-0.001	-0.001*
	(0.01)	(0.10)	(0.01)	(0.004)	(0.00)
Number of incentives	-0.004	-0.06**	-0.001	-0.000	-0.0002*
	(0.01)	(0.03)	(0.01)	(0.004)	(0.00)

Notes: The table reports the relationship between estimated productivity gains, including both the aggregate and the decomposed, and countries' FDI promotion policies in a lagged period. The first 5 policy variables are dummies that indicate the existence of any or a specific type of incentives and the last policy variable measures the number of types of incentives offered by a country.

Table 10: Within- and Between-Industry Reallocations

Dependent var.:	(1)	(2)	(3)	(4)
Change in —	Cutoff TFP		Cutoff Revenue	
MNC entry (predicted)				
in the same industry	0.09***	0.15***	0.07***	0.05***
	(0.04)	(0.04)	(0.03)	(0.02)
in related industries				
– Labor similarity	0.02***		-0.002	
	(0.003)		(0.002)	
– Capital similarity		0.004		0.005***
		(0.003)		(0.001)
Host country FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Obs	2,802	2,802	3,391	3,391
R square	0.37	0.36	0.33	0.33

Notes: (i) Weighted least squre estimates are reported; (ii) Bootstrapped standard errors are reported in the parentheses; (iii) ***, **, and * represent statistical significance at 1, 5, and 10 percent, respectively.

Table 11: Within- and Between-Industry Knowledge Spillovers: Developed Countries

Dependent var.:	(1)	(2)	(3)
Change in TFP	25th Percentile	50th Percentile	75th Percentile
MNC entry (predicted)			
in the same industry	0.02	0.02*	0.01
	(0.02)	(0.01)	(0.01)
in related industries			
– Backward linkage	0.08**	0.05*	0.06
	(0.04)	(0.03)	(0.05)
– Forward Linkage	-0.15	-0.19	0.05
	(0.13)	(0.13)	(0.12)
Host country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Obs	1,057	1,057	1,057
R square	0.18	0.28	0.22

Notes: (i) The percentiles are taken from the productivity distributions in 2002-2004; (ii) Bootstrapped standard errors are reported in the parentheses; (iii) ***, **, and * represent statistical significance at 1, 5, and 10 percent, respectively.

Table A.1: List of Countries

Algeria	Germany	Norway
Argentina	Greece	Poland
Australia	Hong Kong	Portugal
Austria	Hungary	Republic of Korea
Belarus	Iceland	Romania
Belgium	India	Russian Federation
Bermuda	Indonesia	Serbia
Brazil	Ireland	Slovakia
Bulgaria	Israel	Slovenia
Canada	Italy	South Africa
Chile	Japan	Spain
China	Kazakhstan	Sweden
Colombia	Latvia	Switzerland
Croatia	Lithuania	Taiwan
Czech Republic	Macedonia	Tunisia
Denmark	Malaysia	Turkey
Egypt	Mexico	Ukraine
Estonia	Morocco	United Arab Emirates
Finland	Netherlands	United Kingdom
France	New Zealand	United States