Market Reallocation and Knowledge Spillover: The Gains from Multinational Production*

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Abstract

Quantifying the gains from multinational production has been a vital topic of economic research. Positive productivity gains are often attributed to knowledge spillover from multinational to domestic firms. An alternative, less emphasized explanation is market reallocation, whereby competition from multinationals leads to factor reallocation and the survival of only the most productive domestic firms. We develop a model that incorporates both aspects and quantify their relative importance in the gains from multinational production by exploring their distinct predictions for domestic distributions of productivity and revenue. We show that knowledge spillover shifts both distributions rightward while market reallocation raises the left truncation of the distributions and shifts revenue leftward. Using a rich firm-level panel dataset that spans 60 countries, we find that both market reallocation and knowledge spillover are significant sources of productivity gain. Ignoring the role of market reallocation can lead to significant bias in understanding the nature of gains from multinational production.

JEL Codes: F2, O1, O4

Key Words: Gains from Multinational Production, Market Reallocation, and Knowledge Spillover

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1 Introduction

Nations with greater openness to multinational production (MP) exhibit, on average, higher productivity and faster economic growth. This stylized fact—illustrated in Figure 1 which depicts a positive and significant relationship between multinational affiliate sales and host-country total factor productivity (TFP), in both absolute levels and growth rates—has been established in numerous macro-level studies (see, for example, Borensztein et al., 1998; Alfaro et al., 2004).[1] The positive relationship is often attributed to *knowledge spillover*, whereby foreign multinationals generate positive productivity externalities to domestic firms. Such externalities can arise from direct knowledge transfer through partnership, opportunities to observe and learn the technologies of foreign firms, sharing intermediate input suppliers, and interaction and movement in labor market.

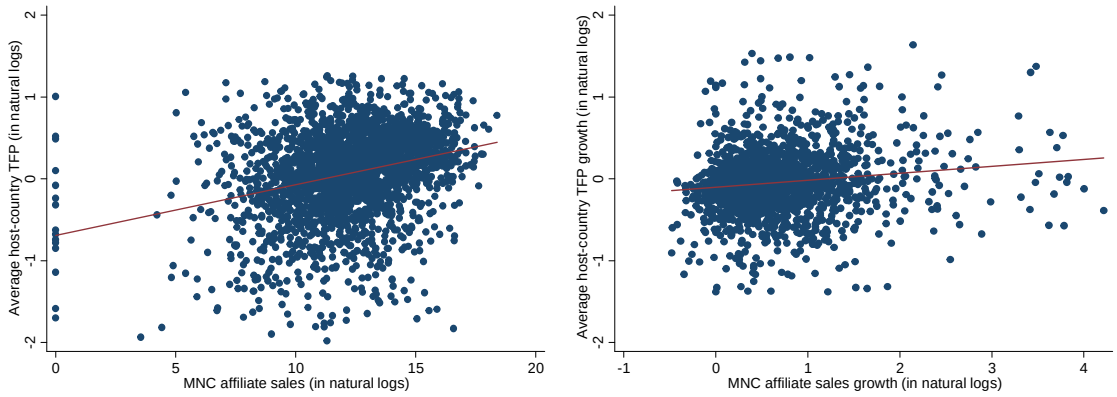

Figure 1: The relationship between multinational production and host-country TFP

There is, however, a less emphasized, alternative explanation, centering on *market reallocation*. Greater openness to multinational production leads to tougher competition in host-country product and factor markets, which results in a reallocation of resources

[1] See Harrison and Rodríguez-Clare (2011) and Kose et al. (2011) for recent overviews of the literature on the relationship between multinational production, productivity, and economic growth. Evidence suggests that multinational production exerts a positive effect on economic growth conditional on local conditions, such as sufficient human capital stock and relatively developed financial markets. Figure 1 is plotted with country-industry multinational affiliate sales and TFP data computed using Orbis, a cross-country firm-level database used in the paper (see Section 3 for a detailed description of the data). 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 (sources: World Bank World Development Indicators and Penn World Tables; data: 1980-2005).

from domestic to multinational and from less productive to more productive firms. This resource reallocation forces the least efficient domestic firms to exit the market, increasing the host country's average productivity.[2]

Although both knowledge spillover and market reallocation imply that multinational production positively affects domestic productivity, they represent two distinct margins at which this occurs. Knowledge spillover operates through an intensive margin whereby MP increases the within-firm productivity of continuing firms; market reallocation, in contrast, works at an extensive margin whereby MP leads to the exits of the least productive domestic firms. Their implications for domestic economies are also sharply different and even contrary. Positive externalities engendered by knowledge spillover cause an expansion of domestic industries and stimulate local technological development whereas market reallocation results in a contraction of domestic industries and may hinder the growth of domestic entrepreneurship.

Distinguishing between market reallocation and knowledge spillover is thus essential in improving our understanding of the mechanisms by which an economy responds to multinational production and crucial for evaluating the effect of foreign investment and setting corresponding economic policies. If knowledge spillover is the primary source of productivity gains, special treatment for foreign firms, often provided by host countries in the form of tax breaks and financial incentives, may be justified and sufficient. But if productivity increases arise also from market reallocation, it would be important to improve domestic market conditions, including labor mobility and credit access, to facilitate gains from competition and reallocation of resources. While an extensive body of research has been devoted to assessing the knowledge spillover effect of multinational firms, little analysis has investigated the role of market reallocation in the aggregate impact of multinational production and how market reallocation and knowledge spillover distinctively influence the potential gains from multinational competition.[3]

[2] The positive relationship between multinational production and host-country productivity might also reflect the possibility that multinationals are attracted to host countries with higher productivity. Our empirical strategy, as discussed below, will address this potential endogeneity to identify the causal effects of multinational production.

[3] Although the role of market reallocation is underemphasized in evaluating gains from multinational production, its role is well established in assessing the productivity gains from trade liberalization (see Melitz, 2003). An important empirical study in this area, Pavcnik (2002), finds that of the 19.3 percent manufacturing productivity growth from trade liberalization in Chile during 1979-1986, 12.7 percent is attributable to reallocation of resources from less to more efficient producers and 6.6 percent to increased productivity within plants. See Melitz and Redding (2013) for a recent overview.

This paper disentangles the roles of market reallocation and knowledge spillover in determining the aggregate gains from multinational production and quantifies their relative importance. This cannot be accomplished by simply examining the relationship between multinational production and host-country average productivity, as both channels predict a positive relationship. We therefore develop an empirical framework based on a model of monopolistic competition and heterogeneous firms adapted from Melitz (2003) and Helpman et al. (2004) and augmented to incorporate the two aspects of multinational production. This framework, grounded in a standard model of firm heterogeneity but applying to a broader class of theoretical setups, addresses simultaneously the market reallocation and the knowledge spillover effects of multinational competition and accounts for the endogenous entry decision of multinational firms. It enables us to distinguish the different channels and establish their relative importance by exploring their different predictions for domestic distributions of productivity and revenue.

In particular, greater competition from multinational production is predicted to raise factor prices and reallocate labor and capital from domestic to multinational and from less productive to more productive firms. The reallocation in labor market erodes the revenue of individual domestic firms shifting the revenue distribution leftward, while the reallocation of capital results in greater cutoff revenue for domestic firms. Both effects cause an increase in the cutoff productivity and force the least efficient domestic firms to exit the market. Knowledge spillover from foreign multinational production, in contrast, induces a rightward shift of the productivity distribution of surviving domestic firms. The revenue distribution might shift either rightward or leftward depending on the extent to which market reallocation offsets the positive effect of knowledge spillover.

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 more than one million public and private manufacturing companies for the 2002-2007 period. The database exhibits several notable strengths central to our analysis. First, Orbis reports detailed ownership information that covers over 30 million shareholder-subsidiary links collected from a variety of sources including official registers, annual reports, research, and newswires. We explore the shareholder, ultimate owner, and subsidiary information to identify MNC activities across countries. Second, the dataset provides rich firm-level time-series financial and operation data, enabling us to compare

firm TFP and other economic attributes over time. Third, Orbis offers a broad country coverage that includes an extensive set of industrial and emerging economies.

Our estimation proceeds in two steps. First, we account for the endogenous entry decision of multinational firms using the instrument and specification motivated by the theoretical framework. The entry decision of multinationals is considered as a function of not only time-variant host-country industry factors and bilateral country characteristics but also multinational headquarters' ex-ante productivity (measured relative to the average productivity of headquarters-country counterparts). The latter is expected to have an important effect on the multinationals' foreign entry decision, but is unlikely to be directly correlated with the future productivity of host-country firms, thus offering a suitable exclusion restriction for identifying the causal effects of multinational production.

Second, we quantitatively assess the relative importance of market reallocation and knowledge spillover by estimating the effect of expected multinational entry on various distribution properties of domestic production, including the cutoffs and quantiles of the domestic firms' productivity and revenue distributions. The estimated impact on changes in cutoff productivity and revenue determines the reallocation effect, while the estimated effect on the shift of the overall productivity distribution quantifies the magnitude of knowledge spillover.

Our empirical analysis suggests that knowledge spillover and market reallocation are two significant but distinctly different sources of gains from multinational production. Entry of multinational firms raises the cutoff productivity and the cutoff revenue of domestic firms, pushing the least productive to exit the market. The revenue distribution of domestic firms shifts leftward, at both the 25th and 50th percentiles. These results imply an increase in factor prices and a decrease in aggregate price as a result of increased competition and reallocation in factor markets. In contrast, the productivity distribution of domestic firms shifts rightward at the 25th and 50th percentiles, suggesting knowledge spillover for low- and intermediate-productivity domestic firms. In quantifying the productivity gains from multinational production, we find that, when the probability of entry by new multinational firms increases by 100 percent, aggregate domestic productivity increases by 0.9 percent across countries, with knowledge spillover and market reallocation accounting for 64 and 36 percent of that increase, respectively. These results highlight that a significant share of productivity gains are channeled through market reallocation.

Ignoring the role of market reallocation could therefore lead to a biased understanding of the origin and magnitude of gains from multinational production.

We perform a series of robustness analysis, including assessing the employment distribution and wage effects of multinational entry to further explore labor market reallocation, re-estimating our parameters with different data samples such as industries with relatively homogeneous products (to address potential markup issues in productivity measure) and countries with better data coverage, introducing additional controls such as the role of trade, and exploring between-industry factor reallocation and knowledge spillover with measures of industry-pairs' relatedness in factor demand and technology. We find consistent evidence of knowledge spillover and market reallocation. In particular, the importance of market reallocation rises to 64 percent of domestic productivity gains when we restrict the analysis to a subsample of countries with arguably better data coverage in order to minimize any potential bias from sampling differences across countries. We also show significant evidence of labor and capital reallocations between related industries, which further reinforce the estimated productivity gains from market reallocation.

Our study is closely related to several strands of the literature. First, as mentioned above, we build on an extensive empirical literature that assesses the existence of productivity spillover from multinationals to domestic firms. One of the earliest contributions to this literature is a study by Aitken and Harrison (1999) that finds evidence of negative spillover in a panel of Venezuelan manufacturing enterprises for the period 1975-1989. The authors attribute this result to a market-stealing effect whereby foreign multinational firms steal market share from domestic firms. That paper soon spawned a large series of empirical studies. Keller and Yeaple (2009), for example, find strong evidence of positive spillover from foreign multinational to domestic firms in the same industry in the United States. Similar results are found in Aghion et al. (2012) for a panel of medium-sized and large Chinese enterprises for the period 1998-2007. Javorcik (2004), exploring spillovers through vertical production linkages in Lithuania between 1996 and 2000, shows that multinational production generates positive externalities via backward production linkage from multinational affiliates to local intermediate input suppliers. Studies by Arnold and Javorcik (2009) and Guadalupe et al. (2012), which account for the endogenous acquisition decisions of foreign multinational firms, find that foreign ownership leads to significant productivity spillover in acquired plants, even after addressing the acquisition

decisions.

In contrast to the ample literature on productivity spillover, evidence for the market reallocation effect of multinational production is scarce. A number of studies offer related insights by evaluating the effects of multinational production on domestic wage rates and financial constraints. Aitken, Harrison, and Lipsey (1996) investigate the impact of foreign-owned plants on the wages of domestically owned establishments in Mexico and Venezuela and report an increase of industry wages due to foreign multinational production. Similarly, Feenstra and Hanson (1997) find a higher level of maquiladora activity to lead to a higher share of total wages going to skilled (nonproduction) workers in Mexico, interpreting their result as increased demand for skilled labor from foreign multinational firms. Exploring the effect of multinational production on domestic financial markets, Harrison and McMillan (2003) find that domestic firms are more credit-constrained than foreign firms and that borrowing by foreign firms exacerbates domestic firms' credit constraints.[4] Ramondo (2009), using a panel of Chilean manufacturing plants, finds entry by foreign plants to be correlated negatively with the market shares of domestic firms and positively with the productivity of domestic incumbents.

Our paper contributes to the above literature by evaluating the distinct roles of market reallocation and knowledge spillover in determining the gains from multinational production. First, our micro theoretical foundation, based on a standard model of firm heterogeneity, addresses simultaneously the two aspects of multinational production. More important, it informs a novel empirical strategy for quantitatively assessing their relative importance that applies beyond the model's specific attributes. Second, our empirical analysis accounts for the endogenous location decision of multinational firms and the potential reverse causality between host-country productivity and multinational production using specifications motivated by the theory. Third, our approach, by allowing both market reallocation and knowledge spillover to play a role instead of focusing on one channel at a time, enables us to perform counterfactual analysis and quantify the aggregate and decomposed gains from greater openness to multinational production. Our analysis should thus be seen as a complement to previous work, as it connects previous studies

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

of knowledge spillover and market reallocation to form a general analysis examining the various gains from multinational production.

More broadly, our work connects to the literature that emphasizes the productivity effect of resource allocation across establishments. A growing strand of literature argues that the allocation of resources across heterogeneous plants, influenced by policies broadly defined, plays a role in explaining income differences (see Hsieh and Klenow, 2009; Alfaro et al., 2009). Echoing these studies, our paper suggests that reallocation of capital and labor as a result of increased multinational production could lead to important productivity gains. Our findings thus have implications of interest to both policy and academic debates on FDI, as understanding the sources of potential gains from multinational production is critical to designing economic policies (Harrison and Rodríguez-Clare, 2011).

The rest of the paper is organized as follows. Section 2 presents the theoretical framework. Section 3 describes the data used in the empirical analysis. Sections 4 and 5 report the estimation results and productivity gain estimates, respectively. Section 6 discusses additional robustness analyses and results. Section 7 concludes.

2 Theoretical Framework

In this section, we employ a standard model of monopolistic competition and heterogeneous firms augmented to incorporate various aspects of multinational production. The framework, adapted from the work of Melitz (2003) and Helpman et al. (2004), guides the empirical analysis and allows us to quantify the gains from multinational production.

2.1 Environment

Suppose the world consists of two sectors, one homogeneous and one differentiated. The homogeneous good serves as the numeraire. In the differentiated sector, each firm produces a different variety and draws a productivity level θ. Given a CES utility function, the demand function for each variety 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, Ω the set of available varieties, and $\varepsilon \equiv 1/(1-\alpha) > 1$ the demand elasticity.

There are $n+1$ countries and, as in Melitz (2003), countries are assumed to be symmetric.[5] Without loss of generality, we focus the analysis on one representative country. Domestic firms in this country must incur a marginal cost w/θ and a per-period fixed cost cf_D, where w is the common wage rate, c the unit capital price, and f_D the units of capital (such as machinery) required for 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:

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

Foreign firms may also serve this country via either multinational production or exporting. If firms choose to serve through multinational production, they must pay a per-period fixed cost cf_M. The revenue and profit earned by foreign firms, denoted as $r_M(\theta)$ and $\pi_M(\theta)$, respectively, are given by:

$$r_M(\theta) = E\left(\frac{\alpha P\theta}{w}\right)^{\varepsilon-1}; \quad \pi_M(\theta) = \frac{r_M(\theta)}{\varepsilon} - cf_M. \tag{3}$$

If foreign firms choose to export, they incur a per-unit iceberg trade cost d (> 1) and a fixed cost cf_X. The revenue and profit earned by exports, denoted as $r_X(\theta)$ and $\pi_X(\theta)$, respectively, are given by

$$r_X(\theta) = E\left(\frac{\alpha P\theta}{wd}\right)^{\varepsilon-1}; \quad \pi_X(\theta) = \frac{r_X(\theta)}{\varepsilon} - cf_X. \tag{4}$$

Domestic firms will produce in the domestic market if $\pi_D(\theta) > 0$ or equivalently if the

[5] As noted in Melitz (2003), this assumption ensures factor-price equalization so the analysis can examine market reallocation effects that are independent of wage differences. However, the assumption can be relaxed without altering our predictions and empirical strategy outlined later in the section, as they apply beyond the specific attributes.

productivity exceeds the cutoff productivity given by:

$$\theta_D = \left(\frac{\varepsilon c f_D}{E}\right)^{\frac{1}{\varepsilon-1}} \left(\frac{w}{\alpha P}\right). \tag{5}$$

Those with $\theta < \theta_D$ will exit the market.

Foreign firms will choose to invest and produce in the domestic market if $\pi_M(\theta) > \pi_X(\theta)$ or equivalently if the productivity exceeds the cutoff level given by:

$$\theta_M = \left[\frac{\varepsilon c(f_M - f_X)}{E(1-d^{1-\varepsilon})}\right]^{\frac{1}{\varepsilon-1}} \left(\frac{w}{\alpha P}\right). \tag{6}$$

In contrast, foreign firms whose productivity falls between θ_M and the cutoff productivity for exporting given by:

$$\theta_X = \left(\frac{\varepsilon c f_X}{E}\right)^{\frac{1}{\varepsilon-1}} \left(\frac{wd}{\alpha P}\right) \tag{7}$$

will choose to export. Following Helpman et al. (2004), we assume $f_D < d^{\varepsilon-1} f_X < f_M$, which yields $\theta_D < \theta_X < \theta_M$, that is, the cutoff productivity is highest for multinational firms, intermediate for exporters, and lowest for domestic producers.

When there is foreign multinational production, we allow for the possibility of knowledge spillover from foreign multinational to domestic firms.[6] To capture this effect, the productivity of domestic firms is assumed to be a function of two components: an ex-ante 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 representing foreign multinational production. Specifically, we assume $\theta \equiv \tau_\theta(z_M)\theta_a = \tau_\theta^{z_M} \cdot \theta_a$, where $\tau_\theta \geq 1$.[7]

Let N_D denote the equilibrium mass of incumbent domestic firms in each country. The equilibrium masses of firms from each country that engage in multinational production and exports are given by $N_M = \gamma_M N_D$ and $N_X = \gamma_X N_D$, respectively, where $\gamma_M \equiv [1 - G(\theta_M)] \,/\, [1 - G(\theta_D)]$ and $\gamma_X \equiv [G(\theta_M) - G(\theta_X)] \,/\, [1 - G(\theta_D)]$. The total mass of varieties available to consumers in each country and, equivalently, the total mass of firms competing in each country is hence $N = N_D + nN_M + nN_X$.

[6] It is worth noting that knowledge spillover can also occur in the reverse direction, from domestic firms to foreign multinationals. We do not consider that possibility here, given our focus on the host-country effect of multinational production. In addition to within-industry spillover, we also consider, in Section 6, the case of knowledge spillover between industries channeled through vertical production linkages.

[7] In the empirical analysis, we allow the degree of knowledge spillover to be heterogeneous across firms.

2.2 Aggregate Outcomes

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

$$\begin{aligned}
\widetilde{\theta}_D &\equiv \widetilde{\theta}(\theta_D) = \frac{1}{1-G(\theta_D)}\left[\int_{\theta_D}^{\infty}\theta^{\varepsilon-1}g(\theta)d\theta\right]^{\frac{1}{\varepsilon-1}}; \\
\widetilde{\theta}_M &\equiv \widetilde{\theta}(\theta_M) = \frac{1}{1-G(\theta_M)}\left[\int_{\theta_M}^{\infty}\theta^{\varepsilon-1}g(\theta)d\theta\right]^{\frac{1}{\varepsilon-1}}; \qquad (8) \\
\widetilde{\theta}_X &\equiv \widetilde{\theta}(\theta_X) = \frac{1}{G(\theta_M)-G(\theta_X)}\left[\int_{\theta_X}^{\theta_M}\theta^{\varepsilon-1}g(\theta)d\theta\right]^{\frac{1}{\varepsilon-1}}.
\end{aligned}$$

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

$$\widetilde{\theta} = \left\{\frac{1}{N}\left[N_D\widetilde{\theta}_D^{\varepsilon-1} + nN_X\left(\widetilde{\theta}_X/d\right)^{\varepsilon-1} + nN_M\widetilde{\theta}_M^{\varepsilon-1}\right]\right\}^{\frac{1}{\varepsilon-1}}. \qquad (9)$$

As shown in Melitz (2003), this productivity average 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:

$$P = N^{\frac{1}{1-\varepsilon}}p\left(\widetilde{\theta}\right) = N^{\frac{1}{1-\varepsilon}}\frac{w}{\rho\widetilde{\theta}}; \quad E = Nr_D\left(\widetilde{\theta}\right); \quad W = \frac{E}{L}N^{\frac{1}{\varepsilon-1}}\rho\widetilde{\theta}. \qquad (10)$$

2.3 Market Clearing 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. A firm that obtains a low productivity draw may decide to exit immediately and not produce. If a firm produces, it faces, in every period, a constant probability δ of a bad shock that would force it to exit. An entering firm with productivity θ would 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 forced to exit.

The zero cutoff profit condition implies that

$$r(\theta_D) = \varepsilon c f_D. \tag{11}$$

Since the average productivity level is determined by the cutoff productivity level, the average profit and revenue level are also tied to the cutoff levels:

$$\begin{aligned} \overline{r}_D &= r(\widetilde{\theta}_D) = \left[\frac{\widetilde{\theta}_D}{\theta_D}\right]^{\varepsilon-1} r(\theta_D); \qquad (12) \\ \overline{\pi}_D &= \pi(\widetilde{\theta}_D) = \left[\frac{\widetilde{\theta}_D}{\theta_D}\right]^{\varepsilon-1} \frac{r(\theta_D)}{\varepsilon} - c f_D. \end{aligned}$$

Given equations (2) and (3), the average profit of all domestic firms is given by:

$$\overline{\pi} = \overline{\pi}_D + n\gamma_M \overline{\pi}_M + n\gamma_X \overline{\pi}_X = \lambda_D c f_D + n\gamma_M \lambda_M c f_M + n\gamma_X \lambda_X c f_X, \tag{13}$$

where $\overline{\pi}_M$ and $\overline{\pi}_X$ are similarly defined as $\overline{\pi}_D$ in equation (12) and $\lambda_k \equiv \left[\widetilde{\theta}(\theta_k)/\theta_k\right]^{\varepsilon-1} - 1$ for $k = D, M, X$.

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

$$v(\theta) = \sum_{t=0}^{\infty} (1-\delta)^t \pi(\theta) = \frac{\pi(\theta)}{\delta}. \tag{14}$$

The present value of the average profit flows and the net value of entry are given, respectively, by

$$\begin{aligned} \overline{v} &= \sum_{t=0}^{\infty} (1-\delta)^t \overline{\pi} = \frac{1}{\delta}\overline{\pi}; \qquad (15) \\ v_E &= \frac{1}{\delta}\left[1 - G(\theta_D)\right]\overline{\pi} - c f_E. \qquad (16) \end{aligned}$$

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

$$v_E = 0 \Longrightarrow \overline{\pi} = \frac{\delta c f_E}{\gamma_D}, \tag{17}$$

where $\gamma_D \equiv 1 - G(\theta_D)$ is the ex-ante probability of survival after entry. The above equation, together with equations (11) and (12), determine $\overline{\pi}$, θ_D, θ_M, and θ_X.

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, that is, $N_D\left(\overline{r}_D + n\gamma_X\overline{r}_X + n\gamma_M\overline{r}_M\right)/\alpha^{\varepsilon-1} = N_D\overline{r}/\alpha^{\varepsilon-1} = L$ where $N_D\left(\overline{r}_D + n\gamma_X\overline{r}_X\right)/\alpha^{\varepsilon-1}$ is the domestic (exporting and non-exporting) firms' demand for domestic labor and $N_D n\gamma_M\overline{r}_M/\alpha^{\varepsilon-1}$ is foreign multinational firms' demand for domestic labor. This, in turn, determines the equilibrium mass of incumbent domestic firms producing in each country:

$$N_D = \frac{\alpha^{\varepsilon-1}L}{\overline{r}} = \frac{\alpha^{\varepsilon-1}L}{\varepsilon\left(\overline{\pi} + cf_D + n\gamma_X cf_X + n\gamma_M cf_M\right)}, \tag{18}$$

which then yields N_M, N_X, 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.[8] The total demand for capital by domestic and foreign multinationals in each country is then given by $N_D n\gamma_M f_M$. The capital-market clearing condition requires that $N_D\left(f_D + n\gamma_X f_X + n\gamma_M f_M + \delta f_E/\gamma_D\right) = K$, where $N_D\left(f_D + n\gamma_X f_X\right)$, $N_D\gamma_M f_M$, and $N_D\delta f_E/\gamma_D$ represent the demand for capital in the domestic market by domestic (exporting and non-exporting) producers, by domestic and foreign multinationals, and by domestic entrants, respectively, and where K is the aggregate supply of capital.[9] The above equation, in conjunction with equations (17) and (18), determines unit capital cost c.

[8] In terms of capital accumulation, Graham and Krugman (1991), Lipsey (2002), and Harrison 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 rather than bringing capital from abroad, they may exacerbate domestic firms' financing constraints by crowding them out of domestic capital markets.

[9] We abstract from considerations regarding international capital flows in the theoretical framework. The international trade literature suggests that firms engage in MP not because of differences in the cost of capital but because certain assets are worth more under foreign than under local control. If a lower cost of capital were the only advantage a foreign firm had over domestic firms, it would 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. See Antras and Yeaple (2013) for related discussion.

2.4 The Impact of Greater Openness to Multinational Production

We now use the present framework to examine the impact of greater openness to multinational production, due to, for example, a decrease in the fixed cost of multinational production. We ask: What happens to the productivity and revenue distributions of domestic firms? And how are aggregate productivity and welfare affected?

The Productivity Distribution Greater openness to multinational production affects the productivity distribution of domestic firms in two ways. First, knowledge spillover from additional multinational entry enhances the productivity level of domestic firms, inducing a rightward shift of the productivity distribution. Second, inspection of the zero cutoff profit conditions reveals that increased openness to multinational production will lead to an increase in the domestic cutoff productivity level θ_D. Assuming that the effect of knowledge spillover is inadequate to offset the negative competition effect, the least productive domestic 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 will exit. We label the second effect as the market reallocation effect. As in Melitz (2003), the market reallocation effect operates through a reallocation in domestic factor markets. The increased factor demand by foreign multinational firms bids up the real wage and capital price, allocating greater resources to foreign multinationals and forcing the least productive domestic firms to exit.[10]

The Revenue Distribution Now consider the revenue of domestic firms. Let $r_A(\theta)$ denote the domestic firm's ex-ante revenue. As above, the effect of greater foreign multinational production is twofold. On the one hand, knowledge spillover from foreign multinationals exerts a positive effect on firm productivity and revenue. On the other hand,

[10] As noted in Melitz (2003), an alternative channel of the market reallocation effect is through the increase in product market competition. 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, that is, 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 trade literature is to introduce variable markups, as in Melitz and Ottaviano (2008). However, since factor market competition is the primary aspect that distinguishes multinational production from foreign imports, we focus on factor market reallocations in our theoretical analysis. Our empirical strategy, on the other hand, accounts for both product and factor market reallocation by exploring the effect of multinational entry on the revenue distribution of domestic firms. In Section 6.2, we present further discussion on the implications and robustness of our results.

market reallocation induces an increase in average productivity and consequently a decrease in the aggregate price P, which in turn exerts a negative effect on domestic firm revenue. The two effects hence lead to the following inequality:

$$r_D(\theta) < \tau_\theta^{z_M(\varepsilon-1)} r_A(\theta), \ \ \forall \theta > \theta_A, \tag{19}$$

which implies that, in the absence of knowledge spillover, that is, with $\tau_\theta = 1$, or when the degree of knowledge spillover is relatively small, domestic firms will incur a loss in domestic sales and the revenue distribution of surviving firms will shift leftward. When the degree of knowledge spillover is sufficiently large to offset the market reallocation effect, the revenue distribution of surviving domestic firms could shift rightward. But the magnitude of the revenue shift will be smaller than the shift of $\theta^{\varepsilon-1}$. Moreover, inspection of equation (11) suggests that the cutoff revenue level increases with greater foreign multinational production, due to the rising capital cost.

Aggregate Productivity Next we examine the effect of greater foreign multinational production on aggregate productivity. Equation (18) suggests that increased 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 $\widetilde{\theta}_D$. This, as described above, arises from the reallocations in factor markets and the tougher selection of domestic firms. In addition to the market reallocation effect, greater openness to multinational production can also increase the aggregate productivity of domestic firms through knowledge spillover. Surviving domestic firms benefit from the positive productivity externalities from foreign firms and witness an increase in their productivity levels. The increase in domestic productivity then leads to an increase in the country's aggregate productivity.

Welfare The welfare effect of greater multinational production is determined by two components: aggregate productivity and total product variety. When the decrease in total product variety is sufficiently small, the increase in aggregate productivity will lead to an increase in welfare as indicated by equation (10).[11]

[11] See Melitz and Redding (2013) for more discussion.

2.5 Empirical Strategy

In this sub-section, we describe our empirical strategy for disentangling the effects of multinational production on market reallocation and knowledge spillover. First, we examine multinational firms' endogenous decision to enter a host country based on conditions described in Section 2.1. Then, accounting for the endogeneity of multinational entry, we explore the properties of the productivity and revenue distributions, as discussed in Section 2.4, to identify the effects of greater multinational production on market reallocation and knowledge spillover.

Stage 1: The Entry of Multinational Firms As described in Section 2.1, a foreign firm will enter a host country if $\theta > \theta_M$. Given equation (6), we consider the following empirical specification

$$\begin{aligned} \Pr\left[z_M(\theta) = 1 | \theta > \theta_D\right] &= \Phi_{\theta>\theta_D}[\theta > \theta_M] \\ &= \Phi_{\theta>\theta_D}[\ln\theta + \ln((E/\varepsilon c)^{\frac{1}{\varepsilon-1}}\,\alpha P/w) - \frac{1}{\varepsilon-1}\ln\left((f_M - f_X)(1-d^{1-\varepsilon})\right) > 0]. \end{aligned} \tag{20}$$

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 headquarters productivity θ and the multinational cutoff productivity θ_M.

As shown in Section 2.1, the ex-ante headquarters productivity of multinational firms θ (measured relative to the average productivity of peers in the headquarters country) is expected to affect multinationals' decisions to enter a host country, but unlikely to be directly correlated with the future productivity of host-country firms, thereby serving as a suitable exclusion restriction in the second stage to identify the causal effects of multinational production.

As suggested in equation (6), the cutoff multinational productivity θ_M is a function of host-country demand conditions E and P, wage rate w, unit capital cost c, fixed costs f_M and f_X, and trade costs d. Shocks to any of these factors, such as a reduction in the fixed cost of multinational production f_M, could lead to changes in the cutoff productivity and consequently to new entry of foreign multinationals. We use host- as well as headquarters-country-industry-period fixed effect FE_M to control for all country-industry time-variant and invariant factors, including E, P, w, c, f_M and f_X.[12] We also control for the distance

[12] In our empirical analysis, since we focus on multinational entry in a single period, the period dimen-

between host and headquarters countries and whether the countries share a land border and language, all of which may also affect the fixed costs of multinational production and exports, f_M and f_X, as well as trade costs d.

Based on estimates of the above equation, we obtain the predicted probability of entry for each multinational firm, that is, $\widehat{\Pr}\left[\theta > \theta_M | \theta > \theta_D\right]$, and the expected probability of new multinational production in each host country $\widehat{\gamma}_M$.

Stage 2: The Effects of Multinational Entry In the second stage, we assess the market reallocation and knowledge spillover effects of multinational entry accounting for the endogenous entry.

(1) Market Reallocation After the entry of new multinational firms, a domestic firm will survive if $\pi_D(\theta) > 0$ or equivalently $\theta > \theta_D$. This leads to the following empirical specification

$$\Pr\left[z_D(\theta) = 1\right] = \Pr\left[\theta > \theta_D(z_M)\right], \tag{21}$$

where the dependent variable $z_D(\theta)$ denotes whether the domestic firm survives in the market and $\theta_D(z_M)$ is the domestic cutoff productivity given the new multinational entry. In the above and all the following estimating equations, we account for the endogeneity of z_M by substituting it with the expected probability of new multinational production $\widehat{\gamma}_M$ obtained from the first stage.

Alternatively, we examine different properties of the productivity and revenue distributions of domestic firms. First, consider the domestic cutoff productivity given by equation (5). Comparing the ex-post and ex-ante domestic cutoff productivities, we obtain

$$\theta_D = \theta_A \left(\frac{c}{c_A}\right)^{\frac{1}{\varepsilon - 1}} \frac{P_A}{P}, \tag{22}$$

where θ_A, c_A and P_A are, respectively, the cutoff productivity, capital price, and aggregate price prior to new multinational entry.[13] Taking natural logs of the above equation yields:

$$\ln \theta_D - \ln \theta_A = \frac{1}{\varepsilon - 1} \ln \frac{c}{c_A} + \ln \frac{P_A}{P}, \tag{23}$$

sion of the fixed effects is suppressed.

[13] For notational simplicity, we henceforth normalize the aggregate price by the wage rate and refer to P as the real aggregate price.

where $\ln\theta_D - \ln\theta_A$ measures the change in domestic cutoff productivity after multinational entry and $\ln(c/c_A)$ and $\ln(P_A/P)$ capture, respectively, the effects of new multinational entry on capital price and aggregate real price.

Note that, by essentially taking the first difference of the cutoff productivity equation (as well as the equations of the other distribution variables below), we control for all time-invariant country-industry factors that might affect the productivity (and revenue) distributions of domestic firms. In addition, we include separate fixed effects in the first-differenced equations to control for all time-variant country and industry characteristics that might affect changes of the distributions.

Similarly, we assess the change in the cutoff revenue $r_D(\theta_D) = \varepsilon c f_D$ after new multinational entry given by:

$$\ln r_D(\theta_D) - \ln r_D(\theta_A) = \ln \frac{c}{c_A}, \tag{24}$$

where $r_D(\theta_A)$ is the ex-ante cutoff revenue. Estimating equations (23) and (24) provides us with estimates of c/c_A and P/P_A, the effect of new multinational entry on capital and aggregate prices, respectively.

We can also evaluate the overall revenue distribution. As shown in Section 2.4, $r_D(\theta) = \left(P\tau_\theta^{z_M}/P_A\right)^{\varepsilon-1} r_A(\theta)$. Greater multinational production could shift the domestic firms' revenue distribution either rightward or leftward, depending on whether or not $P\tau_\theta^{z_M} > P_A$. We therefore consider the following specification:

$$\ln r_D(q_A) - \ln r_A(q_A) = (\varepsilon - 1)\left[\ln\left(\frac{P}{P_A}\right) + \ln\tau_\theta\right], \tag{25}$$

where $\ln r_D(q_A) - \ln r_A(q_A)$ is the revenue change of the qth (for example, the 25th, 50th and 75th) percentile firm of the ex-ante revenue distribution.[14] Given the estimate of τ_θ from equation (26) below, we can again obtain an estimate of P/P_A. Evaluating revenue at different percentiles also enables us to examine empirically how the market reallocation effect might vary with the size of domestic firms.

(2) Knowledge Spillover Next, consider the knowledge spillover effect of foreign multinationals. Knowledge spillovers from foreign multinational firms would shift the produc-

[14] Because the new productivity and revenue cutoffs would change the percentile rank of each domestic firm, quantile regressions are not appropriate here. Instead, we look at within-firm changes by tracking firms at a given percentile of the ex-ante distributions.

tivity 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:

$$\ln \theta(q_A) - \ln \theta_a(q_A) = \ln \tau_\theta, \tag{26}$$

where $\ln \theta(q_A) - \ln \theta_a(q_A)$ is the productivity change of the qth (for example, the 25th, 50th and 75th) percentile firm of the ex-ante productivity distribution. As above, by exploring shifts of the distribution, we control for all time-invariant country-industry factors that might affect the productivity distribution.

Figures 2-4 summarize the theoretical predictions, that is, how new multinational entry affects, via market reallocation and knowledge spillover, the cutoffs as well as the overall distributions of domestic productivity and revenue.

3 Cross-Country Firm Financial and Ownership Data

We use 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.[15] Orbis is published by Bureau van Dijk, a leading source of company information and business intelligence. Orbis combines information from around 100 sources and information providers. Over 99 percent of the companies included in Orbis are private. For each company, the dataset reports: a) detailed 10-year financial information including 26 balance sheet and 25 income sheet items, b) industries and activities including primary and secondary industry codes in both local and international classifications, c) corporate structure including board members and management, and d) ownership information, including shareholders and subsidiaries, direct and indirect ownership, ultimate owner, independence indicator, corporate group, and all companies with the same ultimate owner as the subject company.

Orbis provides several unique 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

[15] 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.

collected from a variety of sources, including official registers, annual reports, research, 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 (majority- and wholly owned) MNC activities across countries. Second, the financial data in Orbis consist of a rich array of time-series information enabling us to measure and compare a firm's total factor productivity over time. Third, Orbis provides a broad country coverage, including a wide range of both industrial and emerging economies.

Our analysis focuses on manufacturing industries and covers over 1.2 million companies in 60 countries. We use four categories of information for each firm: (a) industry information including the 4-digit NAICS code of the primary industry in which each establishment operates, (b) ownership information including each firm's domestic and global parents and domestic and foreign subsidiaries, (c) location information, and (d) financial information including revenue, employment, assets, investment, and material cost. A firm is considered foreign-owned if it is majority- or wholly owned by a foreign multinational firm. There are about 36,000 foreign-owned subsidiaries in the final sample.[16]

We use revenue, employment, asset, and material cost 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.[17] The estimation methodology is the semiparametric estimator developed by Levinsohn and Petrin (2003).[18] Based on this approach, we estimate the production function for each NAICS 4-digit industry and obtain the productivity of each firm based

[16] The subsidiary data used in our paper do not distinguish between greenfield foreign investment and mergers and acquisitions. However, our primary theoretical predictions and empirical approach are not dependent on the mode of multinational entry.

[17] Revenue, asset, and material cost are deflated in the data. We obtained industry-level revenue, asset, and material cost deflators from the EU KLEMS and OECD STAN databases. For countries without industry-level deflators, we used national income and capital deflators. See Section 6.2 for discussions on the implications of unobserved price information and the robustness analysis.

[18] We also considered a number of approaches to obtain estimates of TFP, including instrumental variables and semiparametric estimations. Van Biesebroeck (2008) and Syverson (2011) provide a comparison of these methods and show them to produce similar productivity estimates. Like these studies, 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 Levinsohn and Petrin (2003). In Section 6.2, we further discuss measures of productivity and related issues.

on industry-specific production function estimates.[19] In the empirical analysis, we divide the 6-year period into two sub-periods—2002-2004 and 2005-2007—and investigate how multinational entry affects host-country domestic firms.[20]

4 Econometric Evidence

In this section, guided by the framework described in Section 2.5, we assess the entry of multinational firms and its effects on domestic market reallocation and knowledge spillover.

4.1 The Entry Decision of Multinational Firms

We begin our empirical analysis by examining the entry of foreign multinational firms. To proceed, we estimate the following equation adopted from equation (20):

$$\begin{aligned} \Pr\left[z_M(\theta)=1|\theta>\theta_D\right] &= \Phi_{\theta>\theta_D}\left[\ln\theta-\ln\theta_M>0\right] \\ &= \Phi_{\theta>\theta_D}\left[\ln\theta+FE_M-\frac{1}{\varepsilon-1}\ln d>0\right], \end{aligned} \tag{27}$$

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 on the basis of headquarter activities in 2002-2004, FE_M is a vector of host- and headquarters-country-industry dummies, and d represents bilateral country factors including distance, common border, and common language between headquarters and host countries.[21] As discussed earlier, the ex-ante headquarters productivity of multinational firms serves as an exclusion restriction in the second-stage estimations to identify the causal effect of multinational production.

Table 1 reports the estimation results of equation (27).[22] We find that, as expected in Section 2, more productive firms exhibit a greater likelihood of entering foreign countries, a result consistent with Helpman et al. (2004), Yeaple (2009), and Chen and Moore (2010).

[19] Table A.2 reports the summary statistics of the data.

[20] Compared to entry, we observe relatively few exits of multinational firms in the data. In the empirical analysis, we therefore focus on the effect of new entry.

[21] See Yeaple (2009) and Chen and Moore (2010) for related empirical analysis.

[22] We use a linear probability model to avoid the incidental parameter problem that arises in fixed-effect maximum likelihood estimators.

Further, the probability of multinational entry decreases with the distance between headquarters and host countries, in alignment with the empirical literature. Multinationals are also more likely to enter host countries that share land borders and common languages with headquarter countries. These findings are robust to the inclusion of host- and headquarters-country-industry fixed effects, which control for all (time-variant and time-invariant) country-industry factors that could affect multinationals' entry decisions, including the possibility that multinationals are attracted to host countries with higher productivity. In addition, firm-level clustering is used to allow for correlations of errors within each firm.

Based on the estimates, we then obtain the predicted probability of entry for each multinational firm $\widehat{\Pr}\left[\theta > \theta_M | \theta > \theta_D\right]$ and the expected probability of new multinational production in each host country $\widehat{\gamma}_M$, the latter to be used in the following analysis.

Now we move on to evaluate the effect of multinational production on host-country domestic firms, taking into account the endogenous entry of multinational firms.[23] Before examining the empirical framework described in Section 2.5, we first estimate the net effect of new multinational entry on the average productivity of domestic firms. Table 2 shows that multinational production exerts, on average, a positive and significant effect on the average productivity of domestic firms, taking into account the endogeneity of multinational entry.

There are, however, two important considerations behind these estimates. First, comparing the OLS and the instrumented results, we find that failure to account for the endogenous entry of multinational firms can lead to an over-estimation of the effect of multinational production. According to column (2), a 100-percent increase in the probability of new multinational entry is associated with a 2-percent increase in domestic productivity, as opposed to a 14-percent increase according to the OLS results. Second, as our theoretical framework shows, increases in domestic productivity can arise from both knowledge spillover and market reallocation. Looking at the relationship between multinational production and average domestic productivity alone does not allow us to distinguish between the two sources of productivity gains. We therefore next use the empirical framework in Section 2.5 to help identify the relative importance of market reallocation and knowledge spillover.

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

4.2 Market Reallocation

We first examine the survival of individual domestic firms by estimating

$$\Pr\left[z_D(\theta)=1\right]=\Phi\left[\beta_0+\beta_1\ln\theta_A+\beta_Z z_M\right], \tag{28}$$

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 on capital and aggregate prices. In addition, we include vectors of country and industry dummies to control for all (time-variant and time-invariant) country and industry factors and country-industry clustering to allow for correlations of errors within each cluster. To account for the endogeneity of z_M, we substitute $\widehat{\gamma}_M$, obtained from equation (27), into the above equation.

Table 3 reports the results. We find that a greater probability of new multinational production 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 $\frac{1}{\varepsilon-1}\ln\frac{c}{c_A}+\ln\frac{P_A}{P}>\ln\tau_\theta$, that is, the market reallocation effect dominates the knowledge spillover effect.

Alternatively, we estimate directly changes in the cutoff productivity of domestic firms following equation (23) in Section 2.5:

$$\ln\theta_D-\ln\theta_A=\beta_D z_M. \tag{29}$$

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 that a 100-percent increase in the probability of new multinational firms is associated with a 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 market.[24]

[24] To address potential noise in the level of cutoff productivity, we also used alternative measures of

4.2.1 Labor Market Reallocation

To evaluate the labor market reallocation effect of multinational production, we assess changes in the revenue distribution of domestic firms, based on equation (25), by tracking firms in different percentiles of the ex-ante revenue distribution:

$$\ln r_D(q_A) - \ln r_A(q_A) = (\varepsilon - 1)(\beta_P + \beta_\theta) z_M, \tag{30}$$

where $\beta_P \equiv \ln(P/P_A)$ and $\beta_\theta \equiv \ln \tau_\theta$. Given the estimate of β_θ from equation (32) 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 revenue for firms at both the 25th and 50th percentiles.[25] The magnitude of the decline is, however, smaller at the 50th percentile, suggesting that the relatively smaller domestic firms see a bigger contraction in their revenue.[26]

4.2.2 Capital Market Reallocation

Next, we estimate the effect of foreign multinational entry on domestic capital markets by examining the following equation adopted from equation (25) in Section 2.5:

$$\ln r_D(\theta_D) - \ln r_D(\theta_A) = \beta_c z_M \tag{31}$$

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 production on capital price. Again, to address the endogenous entry of foreign multinationals, z_M is replaced with $\widehat{\gamma}_M$ from equation (27).

As shown in column (2) of Table 4, we find that a higher probability of multina-

cutoffs such as the bottom 10th percentile and the mean of the bottom 10 percentiles. In Section 6, we further explore different moments of the theoretical framework that are not dependent on productivity estimates and focus on countries with broad coverage. The results are qualitatively similar.

[25] Instead of using individual percentiles, we also considered percentile ranges—such as percentiles 20 to 30, percentiles 45 to 55 percentiles and so on—for both revenue and productivity distributions and found the results to be robust.

[26] While the monopolistic competition model adopted in the paper abstracts from reallocation through product market competition (due to the CES specification), the latter is captured in our empirical analysis, specifically by the estimated effect of multinational entry on the revenue distribution of domestic firms. In Section 6.2, we further discuss the implications of variable markups and the robustness of our results.

tional entry significantly increases the cutoff revenue of domestic firms. In particular, $\beta_c \equiv \ln(c/c_A) = 0.06$, which implies that a 100-percent increase in the likelihood of new multinational firms is associated with a 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, a 10-percent decrease in the aggregate price.[27]

4.3 Knowledge Spillover

Finally, we assess the extent of knowledge spillover by examining the productivity distribution of domestic firms following equation (26):

$$\ln\theta(q_A) - \ln\theta_a(q_A) = \beta_\theta z_M, \tag{32}$$

where $\beta_\theta \equiv \ln\tau_\theta$ captures the magnitude of knowledge spillover.

The upper panel of Table 5 reports the results. The estimates suggest that a higher probability of new multinational firms increases 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 in the productivity in the lower range of the distribution. The productivity in the upper range is not found to be significantly affected.[28] Table 6 provides a summary of the estimated effects.

5 Quantifying the Gains from Multinational Production

In this section, we perform counterfactual analysis and quantify the aggregate as well as the decomposed productivity gains from greater openness to multinational production.

[27] Here we adopt the median value of the demand elasticities reported for SITC 3-digit industries in Broda and Weinstein (2006).

[28] The evidence for the effect of multinational production across heterogeneous firms is mixed. Aitken and Harrison (1999) find negative effects on Venezuelan firms with fewer than 50 workers. Girma and Wakelin (2001) find positive effects on small- and medium-sized domestic firms and conclude that large and highly-skilled domestic firms may not benefit from foreign presence, as the latter firms, being nearest to foreign multinationals in terms of technology and market share, may already operate at the technological frontier.

The aggregate productivity gains of domestic firms are given by:

$$\Delta\widetilde{\theta}_D = \frac{\widetilde{\theta}_D}{\widetilde{\theta}_A} - 1, \tag{33}$$

$$\text{where } \widetilde{\theta}_D = \frac{1}{1-G(\theta_D)} \left[\int_{\theta_D}^{\infty} (\tau_\theta \theta_a)^{\varepsilon-1} g(\theta_a) d\theta_a \right]^{\frac{1}{\varepsilon-1}}$$

represents the expected aggregate domestic productivity given new multinational entry and $\widetilde{\theta}_A$ is the actual aggregate productivity prior to the entry. Using the estimates of β_z and τ_θ from Section 4, we obtain the predicted probability of survival for each domestic firm based on equation (28), the expected survival rate $\widehat{\gamma}_D \equiv 1 - G(\theta_D)$, and the expected productivity of surviving domestic firms in each host country $\widehat{\widetilde{\theta}}_D$.

The results summarized in the lower panel of Table 6, suggest that aggregate domestic productivity increases by 0.87 percent when the probability of new multinational entry rises by 100 percent.[29] Next we decompose the productivity gains of domestic firms into two parts: gains from knowledge spillover and gains from market reallocation.

Productivity Gains from Knowledge Spillover The productivity gains as a result of knowledge spillover can be estimated by assuming away the effects of market reallocation, that is, by setting $\beta_P, \beta_c = 0$:

$$\Delta\widetilde{\theta}_D\Big|_{\beta_P,\beta_c=0} = \frac{\widetilde{\theta}_D}{\widetilde{\theta}_A}\Bigg|_{\beta_P,\beta_c=0} - 1. \tag{34}$$

We find that knowledge spillover alone leads to about a 0.56-percent increase in domestic productivity (or, equivalently 64 percent of the domestic productivity gain).

Productivity Gains from Market Reallocation The productivity gain as a result of market reallocation (while assuming zero knowledge spillover) is given by:

$$\Delta\widetilde{\theta}_D\Big|_{\beta_\theta=0} = \frac{\widetilde{\theta}_D}{\widetilde{\theta}_A}\Bigg|_{\beta_\theta=0} - 1. \tag{35}$$

[29] Note that given our empirical specification, the productivity gains are computed based on a 100-percent increase in the probability of new multinational *entry* in a given period (the productivity gains from a 100-percent increase in the total scale of multinational production are expected to be significantly greater).

The estimates imply a 0.31-percent increase in domestic firm productivity (or equivalently 36 percent of the total domestic productivity gain) when market reallocation is the only operative channel. This result suggests that it is important to take into account the role of market reallocation in determining the productivity gains from multinational production. Ignoring this source can underestimate the productivity increases by 50 percent, leading to significant bias in understanding the nature and magnitude of gains from multinational production.

6 Discussion and Robustness Analysis

6.1 Labor Market Reallocation

In this subsection, we offer additional evidence of labor market reallocation by looking directly at labor employment measures. First, we examine the employment distribution of domestic firms. Section 2 predicts a reallocation of labor from domestic to multinational firms and from less efficient to more efficient domestic firms. This motivates us to assess shifts of the employment distribution at different percentiles. As expected, we find new multinational entry leads to a decrease in employment at the 25th percentile but to no significant changes at the 50th and 75th percentiles (Table 7). This result suggests that the relatively smaller domestic firms are crowded out in the labor market by the new multinational firms, lending support to the prediction of labor market reallocation.[30]

Second, we consider the average wage rate of domestic firms. Section 2 predicts an increase in wage rate as a result of increased labor demand by foreign multinational firms. To examine this hypothesis, we compute the average unit labor cost for domestic firms in each country and industry. As shown in Table 8, we find that a 100-percent increase in the probability of new multinational entry leads to a 2-percent increase in average wage rate.

[30]Note that the estimates here capture only labor reallocation from (small) surviving domestic firms to multinationals. In the meantime, labor has also been reallocated from domestic firms that exited the market due to multinational entry shown in section 4.2.

6.2 Measure of Productivity

As in most empirical work that exploits productivity estimates, we do not observe firm-level physical output quantities and prices. This information is especially difficult to obtain for the large cross-section of countries considered in this paper. We therefore estimate firm productivity based on the output value (instead of physical output) produced by each firm, given its inputs.[31]

It is important to note that the broader point we highlight—that market reallocation constitutes an important source of gains from multinational production—does not depend on the availability of physical output data or on productivity estimation methodologies. Considering knowledge spillover as the only mechanism by which countries realize productivity gains from multinational production would lead to a biased understanding of both the nature and the magnitude of the gains, even if physical output or true productivity were observed.

Next, we discuss further the empirical implications when productivity is systematically correlated with firm prices and markups. Melitz and Ottaviano (2008) show that in a variable-markup setup increased competition should induce a downward shift in the distribution of markups across firms (even in the absence of labor reallocation). They find that, although only relatively more productive firms survive (with higher markups than the less productive firms that exit), the surviving firms' distributions of markups and prices should shift downward. This prediction suggests that the estimates of knowledge spillover in our paper, derived on the basis of the shift of the productivity distribution, would be biased downward if the distribution of productivity partly reflects the distribution of markups.

Given the difficulty of obtaining the data required for measuring output-based productivity, one of the solutions suggested in the literature is to focus on homogeneous goods. Therefore, as an additional robustness check, we re-estimate equation (32) for industries with relatively homogeneous products. In such industries, the concern that revenue-based productivity is systematically correlated with prices or markups is mitigated. The shift

[31] Note that even if price or physical output information were observed, the relationship between prices and markups would still be unclear. Higher prices can reflect higher quality, instead of higher markups. De Loecker (2011) introduces a methodology that uses detailed product-level information to recover the markups and the output-based productivity of firms. However, this approach requires specific assumptions regarding the mechanisms through which demand shocks affect prices and productivity.

of the productivity distribution is more likely to reflect changes in productivity. To proxy for the degree of product differentiation, we use information on country-industry specific import demand elasticities estimated by Broda, Greenfield and Weinstein (2006) who show that industries with more homogeneous products have higher import demand elasticities. We re-estimate equation (32) for country-industry pairs whose elasticity is above the 75th percentile in each country. We find the results to remain qualitatively similar. The productivity distribution of domestic firms shifts rightward by about 3 percent at both the 25th and the 50th percentiles while there is no significant change at the 75th percentile. Moreover, we find that the productivity distribution becomes more left truncated, indicated by an increase in the cutoff productivity in equation (29), suggesting market reallocation in the domestic market.[32]

6.3 The Role of Trade

Our empirical analysis so far controls for all time-invariant country-industry factors by taking first differences of the key outcome equations (for example, cutoff productivity and revenue) between the two sub-periods and all time-variant country factors as well as time-variant industry characteristics through the use of fixed effects. Still, a possible concern that could arise is that observed changes in domestic productivity and revenue distributions might be driven by other factors such as export and import growth. For example, greater import competition could similarly lead to increases in cutoff productivity and a leftward shift of the revenue distribution. Increases in export activity, on the other hand, could shift both productivity and revenue distributions rightward when there is significant learning by exporting.

We adopted two strategies to address this concern. First, we accounted for the endogeneity of multinational entry in the first stage by instrumenting with multinationals' ex-ante headquarters productivity. Our analysis shows that foreign multinational entry exerts significant market reallocation and knowledge spillover effects even when we take into account the potential endogeneity issue. Second, we explicitly controlled for export

[32]In industries with heterogeneous products, another factor that could lead to the shift of the productivity distribution is that domestic firms might engage in productivity self-upgrading in response to foreign multinational competition. In a recent study, Bao and Chen (2013) examine the issue by constructing a database of foreign investment news and investigating the responses of domestic firms to the threat of new multinational entry.

and import growth in host-country industries. We obtained cross-country industry-level export and import data from the UN COMTRADE and computed the export and import growth rates between 2002-2004 and 2005-2007. We found that controlling for the role of trade slightly lowers the estimated effect of multinational entry on cutoff productivity and on the productivity distribution. For example, a 100-percent increase in the probability of new multinational entry is now shown to increase cutoff productivity by 15 percent (instead of 16 percent) and to increase the 25th and the 50th percentiles of the productivity distribution by 2 and 3 percent (instead of 3 and 4 percent), respectively.

Alternatively, one may consider that differences across horizontal, vertical, and export-platform FDI might affect the gains from multinational production through the role of trade. In this paper and, in particular, in our theoretical analysis, we focus on reallocation effects stemming from increased factor (labor and capital) demand by foreign multinational firms. As these effects apply to all types of FDI, our main qualitative point—that market reallocation constitutes an important source of gains from multinational production—remains valid.[33]

6.4 Data Coverage

The dataset used in our empirical analysis spans 60 countries. While this enables us to evaluate the productivity gains from multinational production based on a broad set of countries, the estimates can be affected by the data coverage across countries. In this subsection, we perform a robustness check by focusing on countries which arguably provide relatively better data coverage.

We consider several subsets of countries, including the industrial countries and countries with the largest number of domestic firms. Our earlier results remain qualitatively robust. For example, as shown in Table 9, when restricting the analysis to primarily industrial countries, we find stronger evidence of market reallocation. A 100-percent in-

[33]Product market competition, the extent of relationships to domestic upstream and downstream industries, and the degree of knowledge spillover might, however, depend on the final market of foreign multinationals (see, among others, Markusen and Venables, 1999; Markusen, 2002, for related theoretical work). As in the case of most cross-country firm-level datasets, Orbis does not report intra-firm trade data to differentiate between the different types of FDI. One alternative is to use input-output tables and industry codes to identify potential production linkages between MNC headquarters and subsidiaries (as in Alfaro and Charlton, 2009). However, this would not be able to distinguish export-platform FDI from the rest. Assessing the gains from different types of FDI thus remains an important topic of research that could be advanced by availability of cross-country intra-firm trade data.

crease in the probability of multinational entry is associated with a 35-percent increase in cutoff productivity and a 9-percent increase in cutoff revenue. The analysis also shows the existence of knowledge spillover, but limited to low-productivity domestic firms. Domestic firms with medium or high productivity do not see a rightward shift.

When computing productivity gains based on these estimates, we find that a 100-percent increase in the probability of new multinational entry leads to a 0.55-percent increase in aggregate domestic productivity, of which knowledge spillover and market reallocation account for 0.20 and 0.35 percentage points, respectively. Not only does market reallocation remain as a significant source of productivity gains, but its relative importance rises to 64 percent.

6.5 Between-Industry Factor Reallocation and Knowledge Spillover

Our main analysis has focused on quantifying within-industry gains from multinational production. In this sub-section, we explore how multinational production can lead to gains through between-industry factor reallocations and knowledge spillovers.

We first consider how increased multinational production in one industry may cause increased demand for labor and capital and subsequently factor reallocations in related industries. This between-industry factor reallocation effect could influence the production costs of domestic firms in other industries, especially in industries that employ similar types of labor and capital goods.

To capture this potential factor market externality between industries, we construct two measures. First, we construct a measure of an 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 (for example, Assemblers and Fabricators, Textile, Apparel, and Furnishings Workers, Business Operations Specialists, Financial Specialists, Computer Support Specialists, and Electrical and Electronics Engineers). As in Ellison et al. (2010), 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-good market externality by constructing a measure of industries' similarity

in demand for capital goods, $Capital - good\ similarity_{ij}$. 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 (for example, motors and generators, textile machinery, mining machinery and equipment, wood containers and pallets, computer storage devices, and 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.

Constructing the industry-relatedness measures using U.S. industry account data is motivated by two considerations. First, the measures reflect standardized production technologies and are relatively stable over time. Second, the measures require detailed factor demand information and the U.S. industry account data are more disaggregated than those of most other countries.

We interact the two measures of industry-relatedness with predicted multinational production in each industry j and compute the weighted sum of multinational production in industries with similar labor and capital-good demand. The results are reported in Table 10. We find that increased multinational production in industries with 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. The analysis also shows evidence of capital reallocations between industries. As shown in column (4), increased multinational production in an industry will lead to an increase in cutoff revenue, a function of capital costs, in industries with similar capital-good demand. These findings suggest that the market reallocation effect of multinational production can also occur between industries, further stressing the importance of this channel in determining the productivity gains from multinational production.

Next, we explore the possibility of knowledge spillover across industries, through vertical production linkages. Considering spillovers via horizontal or vertical channels does not invalidate the main point that it is important to take into account the role of market reallocation when analyzing the gains from multinational production. However, as mentioned in the introduction, there is important evidence for knowledge spillover from foreign firms to domestic firms through vertical production linkages. Therefore, to complement our analysis, we explore this effect and examine how multinational production 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 $Forward\ linkage_{ij}$ 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 interact the above variables with predicted multinational production in each industry j and compute the weighted sum of multinational production 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 the 25th percentile (Table 11). Overall, our findings are consistent with Javorcik (2004) who shows the existence of positive spillovers through backward linkages and negative spillovers through forward linkages.

Now we re-compute the productivity gains taking into account the between-industry factor reallocations and knowledge spillovers. As shown in Table 12, we find that the aggregate domestic productivity increases by 1.02 percent, compared to 0.87 percent previously, when the effects of factor reallocations and knowledge spillovers between industries are taken into consideration. A greater share of the additional productivity gain arises from between-industry factor reallocation, which now, together with within-industry factor reallocation, leads to 0.4-percent increase in domestic productivity. This further highlights the importance of accounting for market reallocation in assessing the gains from multinational production even when considering alternative spillover channels.

7 Conclusion

Identifying gains from greater openness to multinational production 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 spillover and from market reallocation. However, this task cannot be accomplished by simply examining the relationship between multinational production and host-country average productivity, as both channels predict a positive relationship. We thus develop a standard model of monopolistic competition and heterogeneous firms to address simultaneously the endoge-

nous entry of multinational firms and the knowledge spillover and market reallocation effects of multinational production.

Our theoretical framework suggests that, while both market reallocation and knowledge spillover predict a positive relationship between openness to multinational production and aggregate domestic productivity, the effects can be distinguished by exploring their distinct predictions on the productivity and revenue distributions of domestic firms. Knowledge spillover induces a rightward shift of the productivity and revenue distributions; market reallocation, in contrast, causes a leftward shift of the revenue distribution and an increase in the cutoff productivity and revenue.

These predictions are evaluated using a rich cross-country firm panel dataset that contains comprehensive financial, operation, and ownership information for over 1.2 million public and private manufacturing companies in 2002-2007. Our empirical evidence suggests that multinational production leads to not only to knowledge spillover but also to factor reallocation in domestic markets. Entry of multinational firms raises the cutoff productivity of domestic firms, pushing the least productive to exit the markets. New multinational production 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 reallocation. Following the entry of multinational firms, the revenue distribution of domestic firms shifts leftward, at both the 25th and the 50th percentiles. In contrast, the productivity distribution of domestic firms shifts rightward, while the distribution becomes more left truncated.

When quantifying the gains from multinational production, we find that, when the probability of entry by new multinational firms increases by 100 percent, the aggregate domestic productivity increases by 0.9 percent, with knowledge spillover and market reallocation accounting for 64 and 36 percent of that increase, respectively. Further, the relative importance of market reallocation rises when we focus on industrial countries and explore between-industry factor reallocation and knowledge spillover. These results suggest that it is important to take the role of market reallocation into account when assessing the gains from multinational production. Ignoring this source can lead to a biased understanding of the nature and the magnitude of the productivity gains, with consequent biases in the design of FDI and industrial policies.

Two potential extensions of our analysis are worthy of particular attention. First, knowledge spillover and market reallocation might take a longer term to fully realize in domestic economies. Our estimates thus capture the lower bound of the total gains from multinational production due to the time length of the available data. It would be useful to investigate the long-run impact of multinational competition when longer time-series data are available. Second, future work would explore the heterogeneous gains from multinational production across countries. For example, how might domestic labor-market rigidities and firm credit constraints affect the extent of factor market reallocation and the subsequent productivity effects of multinational production? How might the different levels of domestic human capital and technology stock across host countries influence the degree of gains from knowledge spillover? Such analysis on the role of economic and institutional characteristics in determining countries' gains from multinational production will provide additional research and policy insights.

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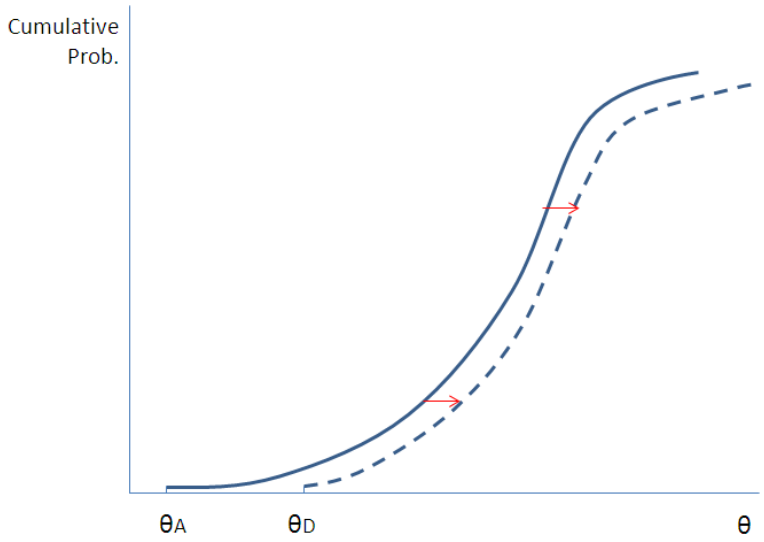

Figure 2: The productivity distribution before and after multinational entry

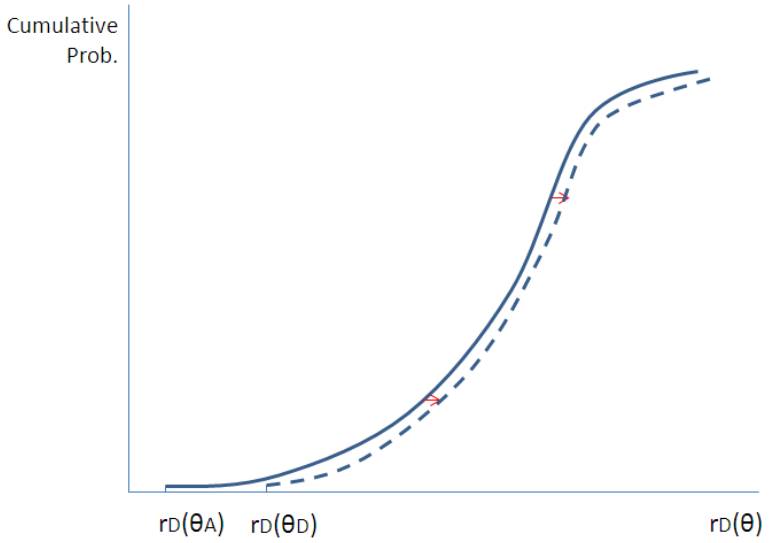

Figure 3: The revenue distribution before and after multinational entry (case I)

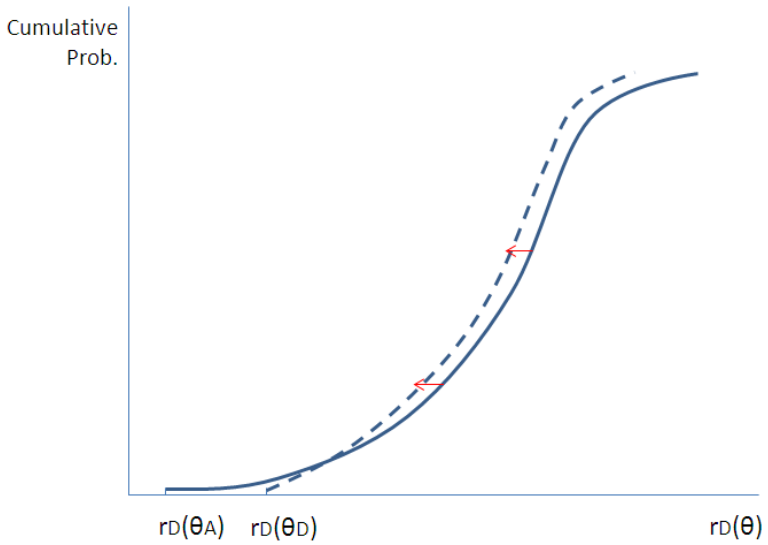

Figure 4: The revenue distribution before and after multinational entry (case II)

Table 1: The Entry Decision of Multinational Firms

Dependent variable:	(1) MNC entry	(2) MNC entry
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 Production and Average Productivity

Dependent: variable:	(1) Change in ave. TFP	(2) Change in ave. TFP
MNC entry	0.14*	
	(0.08)	
MNC entry (predicted)		0.02**
		(0.01)
Host-country FE	Yes	Yes
Industry FE	Yes	Yes
Obs	2,819	2,819
R square	0.39	0.43

Notes: (i) Columns (1) and (2) report OLS and instrumented 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: Survival of Domestic Firms

Dependent variable:	(1) Survival	(2) Survival
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) bootstrapped standard errors are reported in the parentheses; (iii) ***, **, and * represent statistical significance at 1, 5, and 10 percent, respectively.

Table 4: Cutoff TFP and Revenue

Dependent variable:	(1) Change in cutoff TFP	(2) Change in 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 square 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: Productivity and Revenue Distributions of Domestic Firms

	(1) 25th Percentile	(2) 50th Percentile	(3) 75th Percentile
Panel A: Change in TFP			
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: Change in revenue			
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) 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: Parameters and Estimated Productivity Gains

Parameters	Estimates
Cutoff productivity	0.16
Cutoff revenue/Financing cost	0.06
Aggregate real price	-0.10
Revenue – 25th perc.	-0.05
Revenue – 50th perc.	-0.03
Revenue – 75th perc.	0.00
Knowledge spillovers – 25th perc.	0.03
Knowledge spillovers – 50th perc.	0.04
Knowledge spillovers – 75th perc.	0.00
TFP gains (in percentage)	**Estimates**
Aggregate domestic TFP	0.87
Market reallocation	0.31
Knowledge spillover	0.56

Notes: The table summarizes the parameter estimates and the predicted productivity gains when the probability of new multinational entry increases by 100 percent.

Table 7: Robustness: Employment Distribution of Domestic Firms

Dependent variable:	(1)	(2)	(3)
Change in employment	25th Percentile	50th Percentile	75th Percentile
MNC entry (predicted)	-0.01*	-0.001	0.001
	(0.00)	(0.01)	(0.01)
Host-country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Obs	2,869	2,869	2,869
R square	0.11	0.13	0.10

Notes: (i) 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 8: Robustness: Average Wage Rate of Domestic Firms

Dependent variable:	(1) Change in ave wage
MNC entry (predicted)	0.02***
	(0.006)
Host-country FE	Yes
Industry FE	Yes
Obs	2,405
R square	0.58

Notes: (i) Weighted least square 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 9: Robustness: Parameters and Estimated Productivity Gains (Data Coverage)

Parameters	Estimates
Cutoff productivity	0.35
Cutoff revenue/Financing cost	0.09
Aggregate real price	-0.26
Revenue – 25th perc.	-0.04
Revenue – 50th perc.	-0.02
Revenue – 75th perc.	0.00
Knowledge spillovers – 25th perc.	0.02
Knowledge spillovers – 50th perc.	0.00
Knowledge spillovers – 75th perc.	0.00
TFP gains (in percentage)	**Estimates**
Aggregate domestic TFP	0.55
Market reallocation	0.35
Knowledge spillover	0.20

Notes: (i) See Table A.1 for the list of countries in the full sample; (ii) the table summarizes the parameter estimates and the predicted productivity gains when the probability of new multinational entry increases by 100 percent.

Table 10: Robustness: Within- and Between-Industry Reallocations

Dependent:	(1)	(2)	(3)	(4)
variable:	Change in cutoff TFP		Change in 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-good 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 square 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: Robustness: Within- and Between-Industry Knowledge Spillovers

Dependent var.:	(1)	(2)	(3)
Change in TFP	25th Percentile	50th Percentile	75th Percentile
MNC entry (predicted)			
in the same industry	0.04*	0.04***	-0.002
	(0.02)	(0.02)	(0.01)
in related industries			
– Backward linkage	0.06**	0.02	0.07
	(0.03)	(0.05)	(0.05)
– Forward linkage	-0.23**	-0.25	-0.02
	(0.11)	(0.16)	(0.13)
Host-country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Obs	2,291	2,291	2,291
R square	0.12	0.14	0.12

Notes: (i) 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 12: Robustness: Estimated Productivity Gains with Within- and Between-Industry Reallocations and Spillovers

TFP gains (in percentage)	Estimates
Aggregate domestic TFP	1.02
Market reallocation	0.40
Knowledge spillover	0.62

Notes: The table summarizes the parameter estimates and the predicted productivity gains when the probability of new multinational entry increases by 100 percent.

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

Table A.2: Summary Statistics

Variable	Mean	Std. Dev.
Change in cutoff productivity	-0.83	2.07
Change in cutoff revenue	-0.61	2.08
Survival	0.96	0.18
Change in productivity – 25th perc.	0.0002	0.61
Change in productivity – 50th perc.	-0.07	0.50
Change in productivity – 75th perc.	-0.13	0.48
Change in revenue – 25th perc.	0.34	0.91
Change in revenue – 50th perc.	0.28	0.75
Change in revenue – 75th perc.	0.24	0.77