

1 Introduction

Assessing the impact of multinational activity on the productivity of host countries has been a major research topic in the past decades. Nations with greater openness to multinational production have been shown to exhibit, on average, higher aggregate productivity and faster economic growth. This stylized fact, examined in numerous macro-level studies,¹ is often attributed to *within-firm* productivity improvement, resulting from, for example, positive productivity spillover from foreign multinationals or the productivity self-upgrading of domestic firms.² There is, however, a less emphasized, alternative explanation centering on *between-firm* selection and market reallocation. Greater openness to multinational production leads to tougher competition in host-country product and factor markets, resulting in a reallocation of resources 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 and increases the market share of the most productive firms, raising the host country's average productivity.

Although both channels imply aggregate productivity gains from foreign multinational production, they represent two distinct margins at which this occurs. Within-firm productivity improvement operates through an "intensive margin" whereby foreign multinational production raises the productivity of individual continuing domestic firms; between-firm selection and market reallocation, in contrast, work at an "extensive margin" whereby foreign multinational competition induces the exits of the least productive domestic firms and increases the weights of the most productive firms in aggregate output. Their implications for domestic economies are also sharply different and even contrary: Within-firm productivity improvement implies domestic firm growth whereas selection and market reallocation result in a contraction of domestic industries. Distinguishing between the two channels is thus essential for improving our understanding of the mechanisms by which an economy responds to foreign multinational competition and evaluating the effect of foreign direct investment and setting corresponding economic policies. While an extensive body of research has assessed the productivity spillover effect of multinational firms, little analysis has investigated the role of selection and reallocation in the aggregate impact of multinational production and how the

¹See, for example, Borensztein et al. (1998) and Alfaro et al. (2004).

²See 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. 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).

two channels—distinctively as well as jointly—influence the potential gains from multinational competition.³

This paper disentangles the roles of within-firm productivity improvement and between-firm selection and market reallocation in determining the aggregate productivity gains from multinational production and investigates their relative importances. 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 a general analytical framework based on a model of multinational production and heterogeneous firms to investigate how foreign multinational competition might affect host-country economies through within-firm productivity improvement and between-firm selection and market reallocation, respectively. This framework, grounded in a standard model of firm heterogeneity but applying to a broader class of theoretical setups, explores the variations in how the two channels influence the distributions of domestic firms in dimensions including productivity, revenue, employment, and survival, thereby enabling us to empirically distinguish between the two different channels.

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 between-firm reallocation in labor market erodes the revenue of individual domestic firms and shifts the revenue distribution leftward, while the between-firm reallocation of capital results in higher 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. In contrast, within-firm productivity improvement implies 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 the between-firm effect offsets the within-firm effect.

These predictions are evaluated empirically using a cross-country firm panel dataset, drawn from Orbis, that contains comprehensive financial, operation, and ownership information for public and private manufacturing companies in over 30 developed and developing countries for the 2002-2007 period. To account for the endogenous entry decision of multinational firms, we adopt the instrument and the specification motivated by the analytical framework, examining

³Although the role of selection and 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.

the entry decision of multinationals as a function of not only all time-variant country-pair industry factors but also multinationals' ex-ante productivity and their host-country specific fixed-cost shifter reflecting, for example, changes in multinationals' real financial constraints to operate in host countries. Specifically, we use changes in multinational headquarters' cash flow measured in the host-country PPP value as a proxy; multinationals that experience a positive financial shock due to, for example, high investment returns in headquarters or an appreciation of headquarter-country currency are expected to have a reduced financial constraint in foreign investments—especially in host countries where the real value of the shock is large—and thus more likely to make new entry. But such idiosyncratic financial shocks, unlike other firm characteristics such as productivity or the level of cash flow, are unlikely to be directly correlated with the future productivity growth of host-country domestic firms, thereby offering an exclusion restriction for identifying the causal effects of multinational production.

We find that within-firm productivity improvement and between-firm selection and reallocation are two significant but distinctly different sources of gains from multinational production. Entry of multinational firms shifts the revenue distribution of domestic firms leftward while raising the cutoff productivity and the cutoff revenue. These results imply an increase in factor prices and a decrease in the aggregate price as a result of increased competition and reallocation in factor markets. We find consistent evidence when examining the employment distribution and the wage of domestic firms. After new multinational entry, smaller domestic firms are particularly crowded out in the labor market and the average wage rises. In contrast, the productivity distribution of domestic firms shifts rightward, suggesting within-firm productivity improvement among surviving domestic firms. In quantifying the productivity gains from multinational production, we find based on our preferred estimations that when the probability of a new multinational entry increases by 10 percentage points, aggregate weighted domestic productivity increases by 1.6 percent across countries. Between-firm selection and reallocation alone account for 1.4-percent productivity gains, while within-firm productivity improvement by itself accounts for 0.2 percent. These results highlight that a substantial share of productivity gains are channeled through between-firm selection and reallocation. Ignoring this channel could therefore drastically bias our understanding of the origin and the magnitude of the productivity gains from multinational production.

We perform a series of additional exercises, including using alternative moments of the distributions, re-estimating our parameters with different data samples such as industries with relatively homogeneous products (to address potential markup issues in productivity

measures) and countries with better data coverage, including additional controls such as trade growth, performing a falsification test by manually truncating the data at the left tail, and exploring between-industry factor reallocation and spillover with measures of industry-pairs' relatedness in factor demand and technology. In all the exercises, we find consistent evidence of between-firm selection and 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 multinational to domestic firms. One of the earliest contributions to this literature is Aitken and Harrison (1999) who find evidence of negative spillover in a panel of Venezuelan manufacturing enterprises for the period 1975-1989. The authors attribute the 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 significant evidence of within-industry positive spillover from foreign multinational to domestic firms 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 spillover 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. Carluccio and Fally (2013) examine how productivity spillover via backward linkages depend on technological incompatibilities between foreign and domestic technologies and show that a decrease in the cost of inputs compatible with the foreign technology has heterogeneous effects on domestic firms. 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. Another—much less emphasized—factor that could also lead to productivity improvement within domestic firms is domestic firms' productivity self-upgrading in response to foreign multinational competition. Bao and Chen (2014) examine the issue by constructing a database of foreign investment news and investigating the responses of domestic firms to the threats of new multinational entry. Their analysis shows that domestic firms respond significantly to the threats by increasing productivity, innovation, and labor training and adjusting product composition.⁴

⁴Bao and Chen (2014) suggests that within-firm productivity improvement could also occur through within-firm selection and reallocation whereby domestic firms respond to foreign multinational competition by adjusting their product composition and reallocating resources to focus on competitive products. In this paper, we do not attempt to disentangle the possible causes of within-firm productivity improvement—a subject beyond

In contrast to the ample literature on within-firm productivity improvement, evidence on the between-firm selection and 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 borrowing by foreign firms exacerbates domestic firms' credit constraints.⁵ Ramondo (2009), using a panel of Chilean manufacturing plants, finds entry by foreign plants to be associated negatively with the market shares of domestic firms and positively with the productivity of domestic incumbents. Kosova (2012), analyzing exit and growth sales of domestic firms in the Czech Republic, finds evidence consistent with crowding out and technology spillover.

Our paper contributes to the above literature by evaluating the distinct roles of within-firm productivity improvement and between-firm reallocation in determining the gains from multinational production. First, our micro theoretical framework incorporates both aspects of multinational production into a standard firm-heterogeneity model and informs a novel empirical strategy for assessing their relative importances that applies beyond the model's specific attributes. Second, our empirical analysis accounts for the endogenous entry 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 within-firm and between-firm effects to play a role instead of focusing on one channel at a time, enables us to perform counterfactual analysis and quantify the aggregate and the decomposed gains from greater openness to multinational production. Our analysis thus offers a unified framework for understanding and evaluating the different gains from multinational production.

More broadly, assessing the roles of spillover, selection, and reallocation from tougher

the scope of this research, but we note that the importance of selection and market reallocation could likely be even greater if within-firm selection and reallocation is also taken into account.

⁵In contrast to Harrison and McMillan (2003), Harrison, Love, and McMillan (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) note that these contrasting results point to policy complementarities like those between FDI and local financial markets (see Alfaro et al., 2004, 2010).

competition has been an important subject of inquiry in many fields of economics. In addition to trade (e.g. Pavcnik, 2002; Melitz, 2003), Combes et al. (2012), for example, study the role of agglomeration forces (externalities) versus selection in explaining the productivity advantage of large cities,⁶ Bloom et al. (2012) analyze the effects of technology spillover versus market rivalry in R&D, and Acemoglu et al. (2013) examine how reallocation affects the implications of subsidies for growth and welfare in a model of firm innovation with endogenous entry and exit. Our work also connects to the growing literature that emphasizes the productivity effect of resource allocation across establishments (see Hsieh and Klenow, 2009; Alfaro et al., 2009). Echoing these studies, our paper suggests that the reallocation of capital and labor as a result of increased multinational production could lead to important productivity gains.

Our findings 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). If within-firm productivity improvement is the primary source of productivity gains, special treatment to foreign firms, often provided by host countries in the form of tax breaks and financial incentives, might be justifiable. But if productivity gains arise primarily from between-firm selection and reallocation, it would be important to improve domestic market conditions, including labor mobility and credit access, to facilitate the gains from competition and resource reallocation.

The rest of the paper is organized as follows. Section 2 presents the analytical framework. Section 3 describes the data used in the empirical analysis. Sections 4 and 5 report the estimation results and robustness analyses, respectively. Section 6 quantifies and decomposes the productivity gains from increased multinational production. Section 7 concludes.

2 Analytical Framework

In this section, we employ a standard model of heterogeneous firms and multinational production to examine the various mechanisms through which foreign multinational competition could affect host-country domestic firms. The model, adapted from the work of Melitz (2003) and Helpman, Melitz and Yeaple (2004), helps to guide our empirical analysis and offers pre-

⁶Both Combes et al (2012) and our paper are motivated by stylized models in the firm heterogeneity literature. Incorporating Melitz and Ottaviano (2008) with urban economics models, Combes et al. (2012) develop a new quantile regression approach to compare the distribution of establishment productivity for each sector across French areas of different density. Our paper, built on Helpman, Melitz and Yeaple (2004) and Melitz (2003), examines the various gains from multinational production by exploring its effects on the productivity and revenue distributions of domestic firms. Our approach estimates directly the moments derived from the model to infer and decompose the effects of multinational production on various outcome variables including aggregate price, capital price, productivity spillover, and aggregate productivity.

dictions applying beyond the model’s specific attributes that enable us to distinguish between the different sources of gains from multinational production.⁷

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

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

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.⁸ 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 is the unit capital price, and f_D is 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:

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

Foreign firms may also serve a country via either multinational production or exports. We assume that firms must pay a per-period fixed cost cf_M/φ for multinational production and cf_X/φ for exporting, where φ is a firm-specific fixed-cost shifter governed by a cumulative distribution function $H(\varphi)$. The fixed-cost shifter captures cross-firm variation in, for example, financial constraints and foreign business networks, factors that could potentially lead to heterogeneous levels of fixed costs for serving foreign markets.⁹ Heterogeneity in the foreign-

⁷In the robustness section, we discuss various considerations and empirical extensions to the model.

⁸As 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 of the model.

⁹The fixed cost of serving domestic markets could also vary across firms. While we abstract from this possibility in the model for simplicity, allowing for firm-specific domestic fixed cost will not change the analytical predictions of the model.

market fixed cost also allows the model to accommodate the possibility that two firms with identical productivity θ may differ in their choices of export and multinational production locations.

The revenue and profit earned by foreign multinational firms, denoted as $r_M(\theta)$ and $\pi_M(\theta)$, respectively, are given by:

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

The revenue and profit earned by foreign exporters, denoted as $r_X(\theta)$ and $\pi_X(\theta)$, respectively, are given by

$$r_X(\theta) = E \left(\frac{\alpha P \theta}{w d} \right)^{\varepsilon-1}; \quad \pi_X(\theta) = \frac{r_X(\theta)}{\varepsilon} - c f_X / \varphi, \quad (4)$$

where $d (> 1)$ is per-unit iceberg trade cost.

Domestic firms will produce in the domestic market if $\pi_D(\theta) > 0$ or equivalently if the productivity exceeds the cutoff productivity given by:

$$\underline{\theta}_D = \left(\frac{\varepsilon c f_D}{E} \right)^{\frac{1}{\varepsilon-1}} \left(\frac{w}{\alpha P} \right). \quad (5)$$

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, for any given value of φ , the cutoff level given by:

$$\underline{\theta}_M = \left[\frac{\varepsilon c (f_M - f_X)}{E \varphi (1 - d^{1-\varepsilon})} \right]^{\frac{1}{\varepsilon-1}} \left(\frac{w}{\alpha P} \right). \quad (6)$$

In contrast, foreign firms whose productivity falls between $\underline{\theta}_M$ and the cutoff productivity for exporting given by:

$$\underline{\theta}_X = \left(\frac{\varepsilon c f_X}{E \varphi} \right)^{\frac{1}{\varepsilon-1}} \left(\frac{w d}{\alpha P} \right) \quad (7)$$

will choose to export. Following Helpman, Melitz and Yeaple (2004), we assume $f_D < d^{\varepsilon-1} f_X < f_M$, which yields $\underline{\theta}_D < \underline{\theta}_X < \underline{\theta}_M$, that is, the cutoff productivity is highest for multinational firms, intermediate for exporters, and lowest for domestic producers.

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 $\gamma_M \equiv [1 - G(\underline{\theta}_M)] / [1 - G(\underline{\theta}_D)]$ and $\gamma_X \equiv [G(\underline{\theta}_M) - G(\underline{\theta}_X)] / [1 - G(\underline{\theta}_D)]$. The total mass of varieties available to consumers in each country and, equivalently, the total mass of firms competing in each

country is hence $N = N_D + nN_M + nN_X$.

2.2 Aggregate Outcomes

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

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

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

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

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 $\tilde{\theta}$ and the number of varieties available in the market N :

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

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

$$r(\underline{\theta}_D) = \varepsilon c f_D. \quad (11)$$

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

$$\begin{aligned} \bar{r}_D &= r(\tilde{\theta}_D) = \left[\frac{\tilde{\theta}_D}{\underline{\theta}_D} \right]^{\varepsilon-1} r_D(\underline{\theta}_D) = \left[\frac{\tilde{\theta}_D}{\underline{\theta}_D} \right]^{\varepsilon-1} r_D; \\ \bar{\pi}_D &= \pi(\tilde{\theta}_D) = \left[\frac{\tilde{\theta}_D}{\underline{\theta}_D} \right]^{\varepsilon-1} \frac{r_D}{\varepsilon} - c f_D. \end{aligned} \quad (12)$$

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

$$\bar{\pi} = \bar{\pi}_D + n\gamma_M \bar{\pi}_M + n\gamma_X \bar{\pi}_X = c(\lambda_D f_D + n\gamma_M \lambda_M f_M / \varphi + n\gamma_X \lambda_X f_X / \varphi), \quad (13)$$

where $\bar{\pi}_M$ and $\bar{\pi}_X$ are similarly defined as $\bar{\pi}_D$ in equation (12) and $\lambda_l \equiv \left[\frac{\tilde{\theta}(\underline{\theta}_l)}{\underline{\theta}_l} \right]^{\varepsilon-1} - 1$ for $l = D, M, X$.

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

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

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

$$\bar{v} = \sum_{t=0}^{\infty} (1 - \delta)^t \bar{\pi} = \frac{1}{\delta} \bar{\pi}; \quad (15)$$

$$v_E = \frac{1}{\delta} [1 - G(\underline{\theta}_D)] \bar{\pi} - c f_E. \quad (16)$$

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

$$v_E = 0 \implies \bar{\pi} = \frac{\delta c f_E}{\gamma_D}, \quad (17)$$

where $\gamma_D \equiv 1 - G(\underline{\theta}_D)$ is the ex-ante probability of survival after entry. The above equation, together with equations (11) and (12), determine $\bar{\pi}$, $\underline{\theta}_D$, $\underline{\theta}_M$, and $\underline{\theta}_X$.

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

$$N_D = \frac{\alpha^{\varepsilon-1} L}{\bar{r}}, \quad (18)$$

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 obtain a constant share of the capital needed in the fixed foreign investment cost at home and the rest in host countries.¹⁰ 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 $N_D (f_D + n\gamma_X f_X + n\gamma_M f_M + \delta f_E / \gamma_D) = K$, where $N_D (f_D + n\gamma_X f_X)$, $N_D n\gamma_M f_M$, 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.¹¹ The above equation, in conjunction with equations (17) and (18), determines unit capital price c .

2.4 The Impact of Multinational Production

We now use the present framework to examine the impact of greater 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?

¹⁰In terms of capital accumulation, Graham and Krugman (1991), Lipsey (2002), and Harrison and McMillan (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. Bilir, Chor and Manova (2014) show that host countries with more developed financial markets attract more multinational entry. If multinationals borrow heavily from host-country local banks rather than bringing capital from abroad, they may exacerbate domestic firms' financing constraints by crowding them out of domestic capital markets.

¹¹We 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.

The Productivity Distribution Greater multinational production affects the productivity distribution of domestic firms in two ways. First, new multinational entry could cause a productivity improvement within individual domestic firms through, for example, positive productivity spillover, leading to a rightward shift of the productivity distribution. Second, inspection of the zero cutoff profit conditions reveals that increased multinational production will result in an increase in the domestic cutoff productivity level $\underline{\theta}_D$. Assuming that the effect of within-firm productivity improvement is insufficient to offset the negative competition effect, the least productive domestic firms with productivity levels between the ex-ante and the ex-post cutoffs can no longer earn positive profits and will exit. We refer to the second effect as a selection effect. As in Melitz (2003), this effect operates through a reallocation in domestic factor markets. The increased factor demand by foreign multinational firms bids up the real wage and the capital price, allocating greater resources to foreign multinationals and forcing the least productive domestic firms to exit.¹²

The Revenue Distribution Now consider the revenue of domestic firms, $r_D(\theta)$. As above, the effect of greater foreign multinational production is twofold. On the one hand, within-firm productivity improvement exerts a positive effect on firm revenue. On the other hand, the tougher firm selection 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 imply that, in the absence of within-firm productivity improvement or when the degree is relatively small, domestic firms, especially the least productive domestic firms, will incur a loss in domestic sales and the revenue distribution of surviving firms will shift leftward especially at the left tail. We refer to this effect as the (product) market reallocation effect. 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. There are two sources of aggregate productivity gains.

¹²As 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 reallocations by exploring the effect of multinational entry on the revenue distribution of domestic firms. In Section 5.1, we present further discussion on the implications and robustness of our results.

First, equation (8) 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 $\tilde{\theta}_D$. This arises from the reallocations in factor markets and the tougher selection of domestic firms. Second, greater multinational production can, as described above, cause within-firm productivity improvement which also increases the aggregate productivity of domestic firms.¹³

2.5 Empirical Strategy

In this sub-section, we describe our empirical strategy for disentangling within-firm productivity improvement and between-firm selection and reallocation. First, we examine multinational firms' endogenous decision to enter a host country, based on conditions described in Section 2.1, to address the possibility that multinationals might be attracted to host countries with high productivity growth. 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 examine the effects of greater multinational production within and across firms.

It is worth noting that despite the assumptions used to derive functional forms, our empirical approach explores predictions of the model that hold in more general settings. Specifically, within-firm productivity improvement from increased multinational production should imply a rightward shift of the distribution of domestic firm's productivity even though the degree of improvement could be conditional on the productivities of domestic and foreign multinational firms. Between-firm selection and reallocation due to greater multinational production should result in exits of the least productive domestic firms even in models with variable markups as shown in Melitz and Ottaviano (2008) (see more discussion in Section 5.1). Our empirical analysis exploits these generalizable predictions to quantify the gains from multinational production. We proceed by first examining the entry decision of multinational firms.

Stage 1: The Entry of Multinational Firms As described in Section 2.1, a foreign firm will invest in a host country if $\theta > \underline{\theta}_M \equiv \left[\frac{\varepsilon c(f_M - f_X)}{E\varphi(1-d^{1-\varepsilon})} \right]^{\frac{1}{\varepsilon-1}} \left(\frac{w}{\alpha P} \right)$. This leads us to consider the

¹³The 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). See Melitz and Redding (2013) for more discussion.

following empirical specification

$$\begin{aligned} & \Pr [entry_{kij} = 1] \\ = & \Phi \left[\ln \theta_{ki} + \left(\frac{1}{\varepsilon - 1} \right) \ln \varphi_{kij} - \ln \left\{ \left[\frac{\varepsilon c_j (f_{Mj} - f_{Xj})}{E_j (1 - d_{ij}^{1-\varepsilon})} \right]^{\frac{1}{\varepsilon-1}} \left(\frac{w_j}{\alpha P_j} \right) \right\} > 0 \right], \quad (19) \end{aligned}$$

where $entry_{kij}$ is an indicator variable that represents whether a multinational firm k headquartered in country i will enter a host country j in a given period.

The above equation suggests that, as predicted in Helpman, Melitz and Yeaple (2004), firms with a large productivity draw θ_{ki} are more likely to enter new host countries. Moreover, the firm specific fixed-cost shifter φ_{kij} in a given country reflecting, for example, multinationals' financial constraints in the host country, is also expected to affect multinationals' entry decisions. In the empirical analysis, we consider changes in multinational headquarters' cash flow measured in the host-country PPP value as a proxy for changes in multinationals' expected real financial constraints in a given host country. Multinationals that experience an idiosyncratic positive cash flow shock at headquarters, due to, for example, high investment returns or an appreciation of headquarter-country currency, see a decrease of financial constraints in foreign investments, especially in host countries where the real value of the shock is large, and are thus more likely to enter new host countries (see, for example, Froot and Stein, 1991). But these idiosyncratic cash flow shocks of multinational firms, in contrast to other multinational characteristics such as productivity and size, are unlikely to be directly correlated with the future productivity growth of individual host-country domestic firms, thereby serving as a suitable exclusion restriction in the second stage to identify the causal effects of multinational production.

We also use country-pair-industry-time fixed effect to control for all time-variant host-country, headquarter-country, and country-pair industry specific factors including not only E_j , c_j , P_j , w_j , f_{Mj} , f_{Xj} , and d_{ij} but also all other potential determinants of multinational entry such as host-country institutional characteristics, sectoral FDI and trade policies, and domestic industry characteristics. Furthermore, as mentioned earlier, since multinational firms are likely to be attracted to host countries with faster productivity growth, the use of the country-pair-industry-time fixed effect accounts for this possibility by controlling for host-country current and future productivity growth.

Based on estimates of the above equation, we obtain the predicted probability of entry for each multinational firm in each host country, that is, $\widehat{\Pr} [entry_{kij} = 1]$, and the expected

number of multinational entries in each host country, that is, $\widehat{z}_{Mj} \equiv \sum_{k,i} \widehat{\Pr}[\text{entry}_{kij} = 1]$.

Stage 2: The Effects of Multinational Entry In the second stage, we assess the within- and between-firm effects of multinational entry—accounting for the endogenous entry—by examining the impact of multinational entry on the distributions of domestic firms in dimensions including productivity, revenue, and survival.

(1) Within-firm productivity improvement First, consider the potential within-firm productivity effect of foreign multinationals, which would shift the productivity distribution of surviving domestic firms rightward. To examine that, we divide domestic firms into four bins based on the initial level of productivity and estimate the following equation:

$$\ln \theta'_{kj}(q) - \ln \theta_{kj}(q) = \beta_{\theta} \cdot z_{Mj} \quad (20)$$

where $\ln \theta'_{kj}(q) - \ln \theta_{kj}(q)$ is the log productivity change of domestic firms k in the q th bin of country j and z_{Mj} is an indicator of multinational entry. Note that, in the above as well as the following equations, we control for all time-invariant country-industry factors by essentially taking the first difference and exploring the changes in each outcome variable. In addition, we include separate fixed effects in the first-differenced equations to control for all time-variant country and industry characteristics. In the above and all the following estimating equations, we account for the endogeneity of z_{Mj} by substituting it with the expected number of multinational entry \widehat{z}_{Mj} obtained from the first stage.

(2) Between-firm Selection and Reallocation Next, we examine the between-firm selection and reallocation effects. After the entry of new multinational firms, a domestic firm will survive if $\theta > \underline{\theta}'_D$ where $\underline{\theta}'_D$ denotes the ex-post domestic cutoff productivity. This leads to the following empirical specification

$$\Pr[\text{survival}_{kj} = 1] = \Pr[\ln \theta_{kj} - \ln \underline{\theta}'_{Dj}(z_{Mj}, \underline{\theta}_{Dj}) > 0], \quad (21)$$

where the dependent variable survival_{kj} indicates whether a domestic firm k survives in the domestic market j , θ_{kj} is the ex-ante productivity of firm k , and $\underline{\theta}'_{Dj}$, the ex-post domestic cutoff productivity in country j , is a function of multinational entry z_{Mj} and the ex-ante domestic cutoff productivity $\underline{\theta}_{Dj}$, both of which are expected to have a negative impact on domestic firms' survival probability.

We also consider an alternative specification to examine the above firm selection hypothesis

by estimating:

$$\ln \theta_{kj} = \beta_s \text{survival}_{kj} \cdot z_{Mj} \quad (22)$$

where θ_{kj} is the ex-ante productivity of firm k in market j and survival_{kj} is an indicator of whether firm k survives in the domestic market j after multinational entry. If multinational entry leads to tougher selection on domestic firms, β_s is expected to be positive.

Further, we examine different properties of the productivity and revenue distributions of domestic firms. First, consider the domestic cutoff productivity $\underline{\theta}_D = \left(\frac{\varepsilon c f_D}{E}\right)^{\frac{1}{\varepsilon-1}} \left(\frac{w}{\alpha P}\right)$. Comparing the ex-post and ex-ante domestic cutoff productivities, we obtain

$$\ln \underline{\theta}'_{Dj} - \ln \underline{\theta}_{Dj} = \left(\frac{1}{\varepsilon - 1} \ln \frac{c'_j}{c_j} + \ln \frac{P_j}{P'_j} \right) z_{Mj}, \quad (23)$$

where $\ln \underline{\theta}'_{Dj} - \ln \underline{\theta}_{Dj}$ is the log change in domestic cutoff productivity after multinational entry and c'/c and P/P' capture, respectively, the effects of new multinational entry on capital price and aggregate real price.¹⁴ The model suggests that $c'_j > c_j$ and $P'_j < P_j$ which, in turn, imply that $\ln \underline{\theta}'_{Dj} > \ln \underline{\theta}_{Dj}$.

Similarly, we assess the change in the cutoff revenue $\underline{r}_D = \varepsilon c f_D$ after new multinational entry given by:

$$\ln \underline{r}'_{Dj} - \ln \underline{r}_{Dj} = \left(\ln \frac{c'_j}{c_j} \right) z_{Mj}, \quad (24)$$

where $\ln \underline{r}'_{Dj} - \ln \underline{r}_{Dj}$ is the log change of domestic cutoff revenue and is predicted to be positive given $c'_j > c_j$.

We can also evaluate the overall revenue distribution. As shown in Section 2.4, $r_D(\theta) = E \left(\frac{\alpha P \theta}{w}\right)^{\varepsilon-1}$. We therefore consider the following specification:

$$\ln \left(\frac{r'_{Dkj}(q)}{E} \right) - \ln \left(\frac{r_{Dkj}(q)}{E} \right) = (\varepsilon - 1) \left[\ln \left(\frac{P'_j}{P_j} \right) + \ln \left(\frac{\theta'_j(q)}{\theta_j(q)} \right) \right] z_{Mj}, \quad (25)$$

where we again divide domestic firms into four bins based on the initial level of productivity and $\ln \left(r'_{Dkj}(q)/E \right) - \ln \left(r_{Dkj}(q)/E \right)$ is the change of revenue share for domestic firms in the q th bin. Given that $P_j > P'_j$ and—in the presence of within-firm productivity improvement— $\theta'_j > \theta_j$, the prediction on $\ln r'_{Dkj}(q) - \ln r_{Dkj}(q)$ is ambiguous. If the within-firm productivity improvement is sufficiently large to compensate for the decrease in the aggregate price, new multinational entry is predicted to raise domestic firm revenue share; otherwise,

¹⁴For notational simplicity, we henceforth normalize the aggregate price by the wage rate and refer to P as the real aggregate price.

$\ln(r'_{Dkj}(q)/E) < \ln(r_{Dkj}(q)/E)$. Evaluating the above equation separately for different ranges of domestic firms enables us to examine empirically how the market reallocation effect might vary with the initial productivity of domestic firms.

Figures 2-4 summarize the theoretical predictions, that is, how new multinational entry might affect, via within-firm productivity improvement and between-firm selection and reallocation, 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 manufacturing firm-level panel dataset, drawn from Orbis, that contains comprehensive financial, operation, and ownership information for public and private companies in over 30 developed and developing 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. Primary sources include Tax Authorities, Ministry of Statistics, Provincial Bureau of Legal Entities, Securities and Investments Commissions, National Banks, Municipal Chambers of Commerce, and State Register of Accounts. 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 advantages that are central to our analysis. First, a notable strength of Orbis is its ownership information, which covers over 30 million shareholder/subsidiary links and is known for its scope and accuracy. The information is collected from a variety of sources. 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

¹⁵We 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. Last, we restricted the final sample to countries with a relatively good coverage of firm financials that are required to estimate productivity. The main countries in the final sample include Argentina, Australia, Austria, Bosnia and Herzegovina, Belgium, Bulgaria, China, Colombia, Croatia, Czech Republic, Germany, Estonia, Finland, France, Greece, Hungary, Indonesia, Italy, Japan, South Korea, Spain, Lithuania, Malaysia, Poland, Portugal, Romania, Russia, Sweden, Slovenia, Slovakia, Taiwan, and Ukraine.

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.

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) non-consolidated 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

While we believe that Orbis is a very informative and useful data source for answering the question raised in our paper, we are aware of its limitations. Like most other datasets that rely on public registries and proprietary sources, Orbis does not cover the population of businesses across countries. An ideal alternative would be national census data that include the entire population of firms. However, such census data are hard to obtain (usually subject to location and nationality restrictions and requirements) and inexistent in many developing countries. The reason for the lack of data is simple: high costs and institutional restrictions prevent frequent collections of economic census for all the businesses existing in a country.

To assess the extent of coverage, in particular, with respect to small businesses, we compare the data against several benchmarks including, for example, the Structural and Demographic Business Statistics (SDBS) from the OECD. We find Orbis provides satisfactory coverage in many of the countries considered. For France, for example, the SDBS dataset reports that 84 and 91 percent of the enterprises have fewer than 10 and 20 employees, respectively, in 2007. Orbis reports 80 and 86 percent. The coverage for some countries seems highly satisfactory. For Sweden, SDBS reports close to 93 percent of the enterprises have fewer than 20 employees, while Orbis shows 95 percent. For some other countries, Orbis tends to have a lower percentage of small firms. For Spain and Portugal, for example, the percentage of enterprises with fewer than 20 employees is 91 and 89 percent, respectively, in SDBS and 88 and 77 percent, respectively, in Orbis. The SDBS data does not include data for developing countries, but the numbers in Orbis seem comparable for some of the countries. For Argentina,

¹⁶The 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.

for example, the share of enterprises with fewer than 20 employees was close to 90 percent (with INDEC showing 82 percent for Buenos Aires). For Latvia, it was close to 78 percent in Orbis while Eurostat reports 85 percent.

In Section 5.2, we further address potential issues with the data and data sampling in a number of ways, including, in particular, redoing our analysis for subsamples of countries with better data coverage and performing falsification exercises.

Productivity: Estimation Methodology 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

A key challenge in the measurement and identification of productivity relates to the endogeneity of the firm’s optimal choice of inputs. Different estimation measures exhibit different advantages and limitations. As shown by Akerberg, Caves, and Frazer (2006), the use of instruments based on lagged input decisions as the source of identification in structural estimation methods such as Olley and Pakes (1996) and Levinsohn and Petrin (2003) may be associated with collinearity problems.¹⁸

We considered a variety of productivity estimation methodologies, including Olley and Pakes (1991), Levinsohn and Petrin (2003), Akerberg, Caves, and Frazer (2006), and Ghandi et al. (2012).¹⁹ Ghandi et al. (2012) use a transformation of the firm’s first order condition for flexible inputs that does not require finding instrument for the flexible inputs or subtracting them from output. The transformation enables a nonparametric regression of the flexible input revenue share against all observed inputs to non-parametrically identify the flexible input’s production elasticity and the ex-post shocks. We report our primary results based on productivity estimates obtained using Ghandi et al.’s (2012) technique, but confirm that the findings are qualitatively similar when other estimation methods are used.

We estimate the production function for each NAICS 4-digit industry and obtain the productivity of each firm based on industry-specific production function estimates. In Figure 1, we show that multinational affiliate sales and host-country industry TFP exhibit a

¹⁷Revenue, asset, and material cost are deflated in the data. We obtained industry-level revenue, asset, and material cost deflators from the EU KLEMS, the OECD STAN database, and some other national data sources. For countries without industry-level deflators, we used national income and capital deflators. See Section 5.1 for discussions on the implications of unobserved price information and the robustness analysis.

¹⁸Ghandi et al (2012) show that the methods suggested by Akerberg, Caves, and Frazer (2006), and Wooldrige (2009), which are based on a quasi-fixed assumption on the inputs included in the production function, maintain the same identification problems.

¹⁹Van Biesebroeck (2008) and Syverson (2011) provide a comparison of several different productivity estimation methods and show them to produce similar productivity estimates.

positive and significant relationship in both absolute levels and growth rates. Specifically, countries with greater growth rates of multinational activity experience, on average, greater TFP growth. In the empirical analysis, we divide the 6-year period into two sub-periods, 2002-2004 and 2005-2007, and investigate how new multinational entry affects host-country TFP growth.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 within and across domestic firms.

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 (19):

$$\Pr [entry_{kij_s} = 1] = \Phi \left[\ln \theta_{ki} + \left(\frac{1}{\varepsilon - 1} \right) \ln \varphi_{kij_s} + FE_{ijs} > 0 \right], \quad (26)$$

where $entry_{kij_s}$ represents the binary decision of a multinational firm k (headquartered in country i) to invest in a given host country j and industry s in 2005-2007, θ_{ki} is the lagged productivity of multinational firms estimated on the basis of headquarters activities in 2002-2004, φ_{kij_s} is the change in firm k headquarters' cash flow measured in the host-country PPP value, and FE_{ijs} is a vector of country-pair-industry dummies that control for all country-pair-industry factors that could affect multinationals' entry decisions including the possibility that multinationals are attracted to host countries with higher productivity growth. Because we examine the entry decision in a single period, the time dimension is suppressed in the fixed effect. In addition, firm-level clustering is used to allow for correlations of errors within each firm. As discussed earlier, changes in multinationals' real financial constraints in investing in a host country, a factor that could influence multinationals' fixed cost, serve 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 (26).²¹ We find that, as expected in

²⁰Table A.1 reports the summary statistics of the main variables. 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.

²¹We use a linear probability model to avoid the incidental parameter problem that arises in fixed-effect maximum likelihood estimators.

Section 2, more productive firms exhibit a greater likelihood of entering foreign countries, a result consistent with, for example, Helpman, Melitz and Yeaple (2004), Yeaple (2009), and Chen and Moore (2010). Further, firms that experience a positive financial shock are more likely to enter new host countries. These findings are robust to the inclusion of either host-country-industry or country-pair-industry fixed effects, which control for all (time-variant and time-invariant) country-industry and country-pair-industry factors. Based on the estimates, we then obtain the predicted probability of entry for each multinational firm $\widehat{\Pr}[\text{entry}_{kij_s} = 1]$ and the expected number of new multinational firms in each host country $\widehat{z}_{Mj_s} \equiv \sum_{k,i} \widehat{\Pr}[\text{entry}_{kij_s} = 1]$, 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.²² 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 one-standard-deviation increase in the probability of new multinational entry is associated with a 0.02-standard-deviation increase in average domestic productivity, as opposed to a 0.05-standard-deviation increase according to the OLS results. Second, as our theoretical framework shows, increases in average domestic productivity can arise from both within-firm productivity improvement and between-firm selection and 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 assess their relative importances.

²²Given that firm productivity and MNC entry are both obtained from first-stage estimations, we bootstrap the standard errors in all the estimations.

4.2 Within-Firm Productivity Improvement

First, we assess the extent of within-firm productivity improvement by examining the productivity distribution of domestic firms following equation (20):

$$\ln \theta'_{js}(q) - \ln \theta_{js}(q) = \beta_{\theta} \widehat{z}_{Mjs} + FE_j + FE_s, \quad (27)$$

where $\ln \theta'_{js}(q) - \ln \theta_{js}(q)$ is the log change of productivity of the q th bin of domestic firms in host country j and industry s , \widehat{z}_{Mjs} is the predicted number of new multinational entries obtained from the first-stage equation (26), β_{θ} captures the magnitude of the within-firm productivity improvement, and FE_j and FE_s are vectors of country and industry dummies, respectively, controlling for all (time-variant and time-invariant) country and industry factors. In addition, we include country-industry clustering to allow for correlations of errors within each cluster.

Table 3 reports the results. The estimates suggest that a higher probability of new multinational firms, on average, increases the within-firm productivity of domestic firms with β_{θ} around 0.02. This effect is witnessed throughout the productivity distribution—for domestic firms with different levels of initial productivity, implying a 0.2-percent rightward shift of the productivity distribution when the probability of new multinational entry increases by 10 percentage points.

4.3 Between-Firm Selection

Now we move on the between-firm selection effect by examining the survival of individual domestic firms below:

$$\Pr [survival_{kjs} = 1] = \Phi [\beta_0 + \beta_1 \ln \theta_{kjs} + \beta_2 \ln \underline{\theta}_{Djs} + \beta_Z \widehat{z}_{Mjs} + FE_j + FE_s], \quad (28)$$

where $survival_{kjs}$ represents whether a domestic firm k operating in industry s and country j continues production in 2005-2007, θ_{kjs} is the lagged productivity of the domestic firm, $\underline{\theta}_{Djs}$ is the lagged cutoff domestic productivity in country j and industry s , \widehat{z}_{Mjs} is the predicted number of new multinational entries, and FE_j and FE_s are vectors of country and industry dummies, respectively. The estimate of β_Z represents the cumulative effect of new multinational entry on the survival probability of domestic firms, including both the within-firm productivity effect and the between-firm factor market reallocation effect. Again, we include country-industry clustering to allow for correlations of errors within each cluster.

Table 4 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 the between-firm reallocation effect dominates the within-firm productivity effect in explaining the aggregate impact of multinational entry on domestic firms' survival.

Alternatively, we examine the following specification:

$$\ln \theta_{kjs} = \beta_s \text{survival}_{kjs} \cdot \widehat{z}_{Mjs} + \beta'_s \text{survival}_{kjs},$$

where β_s captures the selection effect of multinational entry, i.e., the ex-ante productivity difference between domestic firms that survive multinational entry and those that exit after multinational entry (in addition to the general productivity difference between surviving and exiting domestic firms measured by β'_s). As shown in Table 5, we find significant evidence of a tougher selection from multinational entry. Not only are surviving domestic firms, on average, more productive than exiting domestic firms, the ex-ante productivity difference between the two groups is also 1.2 percent greater when there is a 10-percentage-point higher probability of a new multinational entry. The selection effect is also reflected in terms of the ex-ante revenue difference between surviving and exiting firms. Surviving firms are, on average, greater than exiting firms ex ante, especially in cases of multinational entry.

As another check, we also estimate directly changes in the cutoff productivity of domestic firms in each country and industry following equation (23) in Section 2.5:

$$\ln \underline{\theta}'_{Djs} - \ln \underline{\theta}_{Djs} = \beta_D \widehat{z}_{Mjs}. \quad (29)$$

There are a number of ways to define cutoff productivity, including the minimum productivity of surviving firms, the maximum productivity of exiting firms, or less strict measures such as the productivity of the bottom 10th-percentile of surviving firms and the mean productivity of the bottom 10 percent of surviving firms. We considered all the above definitions and found the results qualitatively similar. Below we show the results based on the minimum productivity of surviving firms. In Section 5, we further examine the robustness of the results by focusing on countries with comprehensive coverage and performing a falsification test.

Column (1) of Table 6 suggests that a higher probability of multinational entry leads to a significant increase in the minimum productivity of surviving domestic firms. In particular, we find $\beta_D \equiv \frac{1}{\varepsilon-1} \ln \frac{c'}{c} + \ln \frac{P}{P'} = 0.83$, implying that a 10-percentage-point increase in the

probability of a new multinational entry is associated with a 8.3-percent increase in the cutoff. Domestic firms whose productivity falls between the ex-ante and the new, higher productivity thresholds would be forced to exit the market.

Similarly, we can estimate changes in the cutoff revenue of domestic firms by examining the following equation adopted from equation (24) in Section 2.5:

$$\ln r'_{Djs} - \ln r_{Djs} = \beta_c \widehat{z}_{Mjs} \quad (30)$$

where $\ln r'_{Djs} - \ln r_{Djs}$ is the change in the cutoff revenue of domestic firms in each country j and industry s and $\beta_c \equiv \ln(c'/c)$, expected to be positive, captures the effect of foreign multinational production on capital price and subsequently the cutoff revenue. As shown in column (2) of Table 6, we find that a higher probability of multinational entry significantly increases the minimum revenue of surviving domestic firms. Specifically, $\beta_c \equiv \ln(c/c_A) = 0.49$, which implies that a 10-percentage-point increase in the likelihood of a new multinational entry is associated with a 4.9-percent increase in the cutoff revenue.

4.4 Between-Firm Market Reallocation

To evaluate the market reallocation effect of multinational production, we first assess changes in the revenue distribution of surviving domestic firms, based on equation (25):

$$\ln \left(\frac{r'_{Dkj}(q)}{E} \right) - \ln \left(\frac{r_{Dkj}(q)}{E} \right) = (\varepsilon - 1) (\beta_P + \beta_\theta) \widehat{z}_{Mjs}, \quad (31)$$

where $\beta_P \equiv \ln(P'/P)$ and $\beta_\theta \equiv \ln(\theta'_j/\theta_j)$. Given that we expect $\beta_P < 0$ and $\beta_\theta > 0$ from the model, the effect of multinational entry on the revenue share of domestic firms is expected to be ambiguous. Table 7 shows that a higher likelihood of multinational entry leads to a decrease in the average revenue share of domestic firms, especially for the least productive firms. The effect on the most productive domestic firms, in contrast, is insignificant. This result suggests that the positive within-firm TFP effect of multinational entry is more than offset by the negative factor market reallocation effect, resulting in a reallocation of product market share from domestic to multinational and from the less productive to the more productive firms.²³

The above finding is similarly pronounced when we examine directly labor market real-

²³While the monopolistic competition model adopted in the paper abstracts from reallocation through product market competition (due to the CES specification), the latter is captured 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.

location by looking at labor employment outcomes. We first examine the employment share distribution of domestic firms. Section 2 predicts a reallocation of labor from domestic to multinational firms, motivating us to assess shifts of the employment distribution. As shown in Table 8, we find that new multinational entry leads to a decrease in the average employment share of domestic firms and shifts the entire distribution leftward. This effect, again especially strong for the least productive domestic firms and insignificant for the most productive domestic firms, lends direct support to the prediction of labor market reallocation.

We also 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 9, we find that a 10-percentage-point increase in the probability of new multinational entry leads to a 0.2-percent increase in average wage rate.

Table 10 summarizes the above estimated effects of multinational entry on the various performance indicators of domestic firms.

5 Discussion and Robustness Analysis

5.1 Measure of Productivity

In our main analysis, we estimate firm productivity using a new methodology developed by Ghandi et al. (2012). We have also compared our results using productivity estimates obtained based on Levinsohn and Petrin (2003), Akerberg, Caves, and Frazer (2006), and simple labor productivity, and found the results to be qualitatively similar, all suggesting market reallocation to constitute an important source of gains from multinational production.

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.²⁴

It is important to note, however, the central, broader point we emphasize in this paper—that between-firm selection and reallocation could be an important source of gains from multi-

²⁴Note 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.

national production—is established by exploring various other characteristics—such as revenue, employment, wage rate, and survival—of domestic firms and thus does not depend on the measures of productivity. Considering within-firm productivity improvement 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 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 within-firm productivity improvement 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. In industries with relatively homogeneous products, the concern that revenue-based productivity is systematically correlated with prices or markups is mitigated. The shift of the productivity distribution is more likely to reflect changes in productivity. We hence re-estimate equation (32) for industries that are classified as relatively homogeneous by Rauch (1999). We find the results to remain qualitatively similar (the first panel of Table 11). The within-firm productivity of domestic firms improves, on average, by 0.4 percent when the probability of new multinational entry increases by 10 percentage points in these industries. The productivity distribution shifts rightward, especially for the least productive domestic firms, where the magnitude of the improvement (1.2 percent) is significantly greater than the earlier results in Table 3 (0.3 percent). We also reassess the effect of multinational entry on the cutoff productivity and the cutoff revenue and find the effects remain positive and significant in the relatively homogeneous industries (the first panel of Table 12).

5.2 Data Coverage

The dataset used in our empirical analysis spans over 30 developed and developing 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.

For example, national public registries, an important source of our data, vary in their data reporting criteria. Some registries impose certain minimum-size criteria on, for example, revenue, censoring the data on the left tail. Such data censoring issues are likely to make it difficult to identify the market reallocation effect through exploring changes in the left truncations of the productivity and the revenue distributions, as the left truncations of these distributions should have little change over time.

In this subsection, we take several measures to address possible data sampling issues, including focusing on countries with arguably relatively better data coverage and performing falsification tests by manually truncating the data in all countries. First, we restrict the analysis to the top 5 countries with the largest number of domestic firms, namely, China, Spain, France, Italy and Romania. Our earlier results remain qualitatively robust. For example, the productivity distribution of domestic firms shifts rightward by 0.2 percent when there is a 10-percentage-point increase in the probability of a multinational entry (the second panel of Table 11). Further, the same increase in the probability of a multinational entry is associated with a 6-percent increase in cutoff productivity and a 2.2-percent increase in cutoff revenue (the second panel of Table 12).

We then perform a falsification test by truncating the data at the left tail in both time periods and including only firms with more than 10 employee. When the data are censored at the left tail and the smallest firms are dropped from the sample, our estimated effects of multinational entry on cutoff productivity and cutoff revenue—now obtained based on firms above a minimum size—should be adjusted downward. The bottom panel of Table 12 confirms the hypothesis: the cutoff productivity and the cutoff revenue witness a more moderate rise after multinational entry.

5.3 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 cash flow shock. Our analysis shows that foreign multinational entry exerts significant within-firm productivity and between-firm reallocation effects even when we take into account the potential endogeneity issue. Second, we explicitly controlled for export 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.

On a related note, 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 regardless of the final sales destinations, our main qualitative point—that market reallocation constitutes an important source of gains from multinational production—should remain valid. However, we acknowledge that the degrees of product market competition, relationships with domestic upstream and downstream industries, and productivity 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.

5.4 Between-Industry Productivity Spillover and Factor Reallocation

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 productivity spillovers and factor reallocations.

We first explore the possibility of between-industry productivity spillover 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 productivity 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_{ss'}* and *Forward linkage_{ss'}*, to measure the extent of the input-output relationships between each pair of industries. *Backward linkage_{ss'}* measures the share of a downstream industry s' inputs that come from an upstream industry s and *Forward linkage_{ss'}* the share of a downstream industry s inputs that come from an upstream industry s' . 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 s' and compute the weighted sum of multinational production in downstream and upstream industries, respectively.

Our results suggest significant productivity spillovers via both backward and forward linkages, from downstream foreign multinational firms to upstream domestic firms and vice versa (Table 13). However, interestingly we find that the productivity spillover through backward linkage is pronounced primarily for the less productive domestic firms while the spillover through forward linkage is witnessed for the middle- and the high-productivity domestic firms. Overall, our findings are consistent with evidence from existing studies.

Next we examine 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_{ss'}*. 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 the correlation of each industry pair s and s' 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* $_{ss'}$. 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 the similarity of each using-industry pair s and s' 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 s' and compute the weighted sum of multinational production in industries with similar labor and capital-good demand. The results are reported in Table 14. 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 (2), 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.

6 Quantifying the Productivity Gains from Multinational Production

In this section, we quantify the aggregate as well as the decomposed productivity gains from greater multinational production. Specifically, we follow Pavcnik (2002) by decomposing the weighted aggregate productivity measure $\tilde{\theta}_W$ into two parts: the unweighted aggregate productivity measure $\bar{\theta}_t$ and the total covariance between a firm's share of the industry output

s_{it} and its productivity θ_{it} :

$$\tilde{\theta}_t^w = \sum_i s_{it} \theta_{it} = \bar{\theta}_t + \sum_i (s_{it} - \bar{s}_t)(\theta_{it} - \bar{\theta}_t). \quad (32)$$

Comparing the weighted aggregate productivity measure $\tilde{\theta}_W$ in two periods yields:

$$\Delta \tilde{\theta}_t^w = \Delta \bar{\theta}_t + \Delta \sum_i (s_{it} - \bar{s}_t)(\theta_{it} - \bar{\theta}_t).$$

Given that we abstract from new entering firms in the analysis, the above equation can be further written as:

$$\Delta \tilde{\theta}_t^w = \underbrace{\left(\bar{\theta}_t^{surviving} - \bar{\theta}_{t-1}^{surviving} \right)}_{within-firm} + \underbrace{\left(\bar{\theta}_{t-1}^{surviving} - \bar{\theta}_{t-1}^{all} \right)}_{selection} + \underbrace{\Delta \sum_i (s_{it} - \bar{s}_t)(\theta_{it} - \bar{\theta}_t)}_{reallocation}. \quad (33)$$

The first component on the right hand side, $\bar{\theta}_t^{surviving} - \bar{\theta}_{t-1}^{surviving}$, represents the contribution of within-firm productivity improvement (among surviving domestic firms) to the aggregate weighted productivity gain and is positive as we show in Section 4.2 that multinational entry induces significant within-firm productivity improvement. In particular, we find that a 10-percentage-point higher probability of multinational entry leads to, on average, 0.2 percent increase in within-firm productivity. The second component, $\bar{\theta}_{t-1}^{surviving} - \bar{\theta}_{t-1}^{all}$, represents the contribution of the selection effect to the aggregate productivity gain. Given that in Section 4.3 we find that more productive domestic firms are more likely to survive after multinational entry and, in particular, the average productivity of surviving firms is 1.2 percent higher than that of exiting firms when the probability of a multinational entry is 10 percentage points higher, this second term is positive as well. The third component, $\Delta \sum_i (s_{it} - \bar{s}_t)(\theta_{it} - \bar{\theta}_t)$, represents the contribution of the market reallocation effect to the aggregate productivity gain. In Section 4.4, we find significant evidence of market reallocation as the least productive domestic firms experience the sharpest decline in revenue share. To evaluate the magnitude of the reallocation effect, we compute $\Delta \sum_i (s_{it} - \bar{s}_t)(\theta_{it} - \bar{\theta}_t)$ at the country-industry level and find the covariance to be, on average, 0.2 percent greater when there is a 10-percentage-point higher probability of multinational entry.

The above results suggest that it is important to take into account the role of between-firm selection and reallocation in determining the productivity gains from multinational production. Our analysis shows that between-firm selection, in particular, contributes the most to aggregate productivity gain. Ignoring the selection and the market reallocation channels can

lead to significant biases in understanding the nature and the magnitude of productivity gains from multinational production.

7 Conclusion

Assessing productivity 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 within-firm productivity improvement and from between-firm selection and 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 heterogeneous firms and multinational production to address simultaneously the endogenous entry of multinational firms and the within- and between-firm effects of multinational production.

Our theoretical framework suggests that, while both within-firm productivity improvement and between-firm reallocation 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, revenue and employment distributions of domestic firms. Within-firm productivity improvement implies a rightward shift of the productivity and revenue distributions; between-firm selection and reallocation, in contrast, cause a leftward shift of the revenue and employment distributions and an increase in the cutoff productivity and revenue.

Evaluating these predictions using a cross-country firm panel dataset, we show that multinational production leads to not only within-firm productivity improvement but also between-firm selection and market 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. Following the entry of multinational firms, the revenue distribution of domestic firms shifts leftward, especially for the least productive domestic firms. 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 a new multinational entry increases by 10 percentage points, the aggregate domestic productivity increases by 1.6 percent, with between-firm selection and reallocation alone ac-

counting for 1.4 percent. These results suggest that it is critical to take into account the role of selection and reallocation 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, the effects of multinational production 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 could explore the heterogeneous gains from multinational production across countries. For example, how might domestic labor-market rigidities and financial markets 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 productivity 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.

References

- [1] Acemoglu, Daron, Ufuk Akcigit, Nicholas Bloom, and William R. Kerr. "Innovation, Reallocation and Growth." NBER Working Paper 18993.
- [2] Akerberg, D., Caves, K., and Frazer, G. 2006. "Structural Identification of Production Functions." mimeo.
- [3] Aghion, Philippe, Mathias Dewatripont, Luosha Du, Ann Harrison, and Patrick Legros. 2012. "Industrial Policy and Competition." *American Economic Journal: Macroeconomics*, forthcoming.
- [4] Aitken, Brian, and Ann Harrison. 1999. "Do Domestic Firms Benefit from Foreign Direct Investment? Evidence from Venezuela." *American Economic Review* 89(3), 605-618.
- [5] Aitken, Brian, Ann Harrison, and Richard E. Lipsey. 1996. "Wages and Foreign Ownership: A Comparative Study of Mexico, Venezuela and the United States." *Journal of International Economics* 40(3-4), 345-371.
- [6] Alfaro, Laura and Andrew Charlton. 2009. Intra-Industry Foreign Direct Investment. *American Economic Review* 99(5): 2096-2119.
- [7] Alfaro, Laura, Andrew Charlton, and Fabio Kanczuk. 2009. "Plant-Size Distribution and Cross-Country Income Differences." In *NBER International Seminar on Macroeconomics 2008*. Cambridge, MA: NBER.

- [8] Alfaro, Laura, Areendam Chanda, Sebnem Kalemli-Ozcan, and Selin Sayek. 2004. "FDI and Economic Growth: The Role of Local Financial Markets." *Journal of International Economics* 64(1), 89-112.
- [9] Alfaro, Laura, Areendam Chanda, Sebnem Kalemli-Ozcan, and Selin Sayek. 2010. "Does Foreign Direct Investment Promote Growth? Exploring the Role of Financial Markets on Linkages." *Journal of Development Economics* 91(2), 242-256.
- [10] Antras, Pol and Stephen R. Yeaple. 2013. "Multinational Production and the Structure of International Trade." Draft in preparation for the 4th Edition of the *Handbook of International Economics*.
- [11] Arnold, Jens and Beata Javorcik. 2009. "Gifted Kids or Pushy Parents? Foreign Direct Investment and Plant Productivity in Indonesia." *Journal of International Economics* 79(1), 42-53.
- [12] Bao, Ge and Maggie X. Chen. 2014. "When Foreign Rivals are Coming to Town: Firm Responses to Multinational Investment News." mimeo.
- [13] Bilir, Kamran, Davin Chor, and Kalina Manova. 2014. "Host-Country Financial Development and Multinational Activity." NBER Working Paper 20046.
- [14] Bloom, Nick, Mark Schankerman and John Van Reenen. 2013 "Identifying Technology Spillovers and Product Market Rivalry." *Econometrica* 81(4): 1347-1393.
- [15] Borenszteina Eduardo, Jose De Gregorio, and Jong-Wha Lee. 1998. "How Does Foreign Direct Investment Affect Economic Growth." *Journal of International Economics* 45, 115-135.
- [16] Carluccio, Juan and Thibault Fally. 2013. "Foreign Entry and Spillovers with Technological Incompatibilities in the Supply Chain." *Journal of International Economics* 90 (1): 123-135.
- [17] Chen, Maggie X. and Michael Moore. 2010. "Location Decision of Heterogeneous Multinational Firms." *Journal of International Economics* 80(2), 188-199.
- [18] Combes, Pierre-Philippe, Gilles Duranton, Laurent Gobillon, Diego Puga and Sébastien Roux, 2012. "The Productivity Advantages of Large Cities: Distinguishing Agglomeration From Firm Selection," *Econometrica* 80(6), 2543-2594.
- [19] De Loecker, Jan. 2011. "Product Differentiation, Multi-Product Firms and Estimating the Impact of Trade Liberalization on Productivity." *Econometrica*, 79(5), 1407-1451.
- [20] Ellison, Glenn, Edward Glaeser, and William Kerr. 2010. "What Causes Industry Agglomeration? Evidence from Coagglomeration Patterns." *American Economic Review* 100, 1195-1213
- [21] Feenstra, Robert C., and Gordon H. Hanson. 1997. "Foreign Direct Investment and Relative Wages: Evidence from Mexico's Maquiladoras." *Journal of International Economics* 42(3-4), 371-394.

- [22] Froot, Kenneth and Jeremy Stein. 1991. "Exchange Rates and Foreign Direct Investment: an Imperfect Capital Market Approach." *Quarterly Journal of Economics* 106, 1191–1217.
- [23] Ghandi, Amit, Salvador Navarro, and David Rivers. 2012. "On the Identification of Production Functions: How Heterogeneous is Productivity." mimeo.
- [24] Graham, Edward and Paul Krugman. 1991. *Foreign Direct Investment in the United States*. Washington D.C.: Institute for International Economics.
- [25] Guadalupe, María, Olga Kuzmina, and Catherine Thomas. 2012. "Innovation and Foreign Ownership." *American Economic Review* 102(7), 3594-3627.
- [26] Harrison, Ann and Margaret McMillian. 2003. "Does Foreign Direct Investment Affect Domestic Firm Credit Constraints?" *Journal of International Economics* 61(1), 73-100.
- [27] Harrison, Ann, Inessa Love, and Margaret McMillian. 2004. "Global Capital Flows and Financing Constraints." *Journal of Development Economics* 75(1), 269-301.
- [28] Harrison, Ann and Andrés Rodríguez-Clare. 2011. "Trade, Foreign Investment, and Industrial Policy." In *Handbook of Development Economics*, edited by Dani Rodrik and Mark Rosenzweig. Amsterdam: Elsevier, 4039-4214.
- [29] Helpman, Elhanan, Marc Melitz, and Stephen Yeaple. 2004. "Export versus FDI with Heterogeneous Firms." *American Economic Review* 94(1), 300-316.
- [30] Hsieh, Chang-Tai and Peter Klenow. 2009. "Misallocation and Manufacturing TFP in China and India." *Quarterly Journal of Economics* 124(4), 1403-1448.
- [31] Irarrazabal, Alfonso, Andreas Moxnes, and Luca David Opromolla. 2012. "The Margins of Multinational Production and the Role of Intra firm Trade." mimeo.
- [32] Javorcik, Beata. 2004. "Does Foreign Direct Investment Increase the Productivity of Domestic Firms? In Search of Spillovers through Backward Linkages." *American Economic Review* 94(3), 605-627.
- [33] Keller, Wolfgang and Stephen Yeaple. 2009. "Multinational Enterprises, International Trade, and Productivity Growth: Firm-Level Evidence from the United States." *Review of Economics and Statistics* 91(4), 821-831.
- [34] Kose, M. Ayhan, Eswar Prasad, Kenneth Rogoff, and Shang-Jin Wei. 2011. "Financial Globalization and Economic Policies." In *Handbook of Development Economics*, edited by Dani Rodrik and Mark Rosenzweig. Amsterdam: Elsevier, 4283-4359.
- [35] Kosova, Renata. 2010. "Do Foreign Firms Crowd out Domestic Firms? Evidence from the Czech Republic." *Review of Economics and Statistics* 92(4): 861-881.
- [36] Levinsohn, James and Amil Petrin. 2003. "Estimating Production Functions Using Inputs to Control for Unobservables." *Review of Economic Studies* 70(2), No. 243, 317-342.
- [37] Lipsey, Richard E. 2002. "Home and Host Country Effects of FDI." NBER WP 9293.

- [38] Markusen, James. 2002. *Multinational Firms and the Theory of International Trade*. Cambridge: MIT Press.
- [39] Markusen, James and Anthony J. Venables. 1999. "Foreign Direct Investment as a Catalyst for Industrial Development." *European Economic Review* 43(3), 335-338.
- [40] Melitz, Marc. 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica* 71(6), 1695–1725.
- [41] Melitz, Marc and Giancarlo I. P. Ottaviano. 2008. "Market Size, Trade, and Productivity." *Review of Economic Studies*, 295-316.
- [42] Melitz, Marc and Stephen J. Redding. 2013. "Heterogeneous Firms and Trade." Draft in preparation for the 4th Edition of *the Handbook of International Economics*.
- [43] Olley, G. Steven and Ariel Pakes. 1996. "The Dynamics of Productivity in the Telecommunications Equipment Industry." *Econometrica* 64(6), 1263–1297.
- [44] Pavcnik, Nina. 2002. "Trade Liberalization, Exit, and Productivity Improvement: Evidence from Chilean Plants." *Review of Economic Studies* 69(1), 245-76.
- [45] Ramondo, Natalia. 2009. "The Effects of Foreign Plants on Industry Productivity: Evidence from Chile." *Scandinavian Journal of Economics* 111(4), 789–809.
- [46] Syverson, Chad. 2011. "'What Determines Productivity?'" *Journal of Economic Literature*, 49:2, 326–365
- [47] Van Biesebroeck, Johannes 2008. "The Sensitivity of Productivity Estimates: Revisiting Three Important Debates." *Journal of Business and Economic Statistics* 26(3), 321-338.
- [48] Wooldridge, Jeffrey M. 2009. "On Estimating Firm-level Production Functions Using Proxy Variables to Control for Unobservables." *Economics Letters* 104(3), 112-114.
- [49] Yeaple, Stephen. 2009. "Firm Heterogeneity and the Structure of U.S. Multinational Activity: An Empirical Analysis." *Journal of International Economics* 78(2), 206-215.

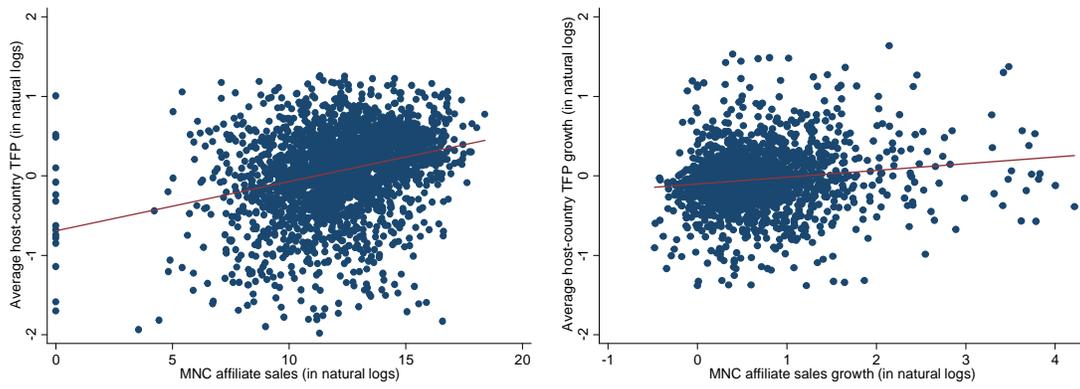


Figure 1: The relationship between multinational production and host-country TFP

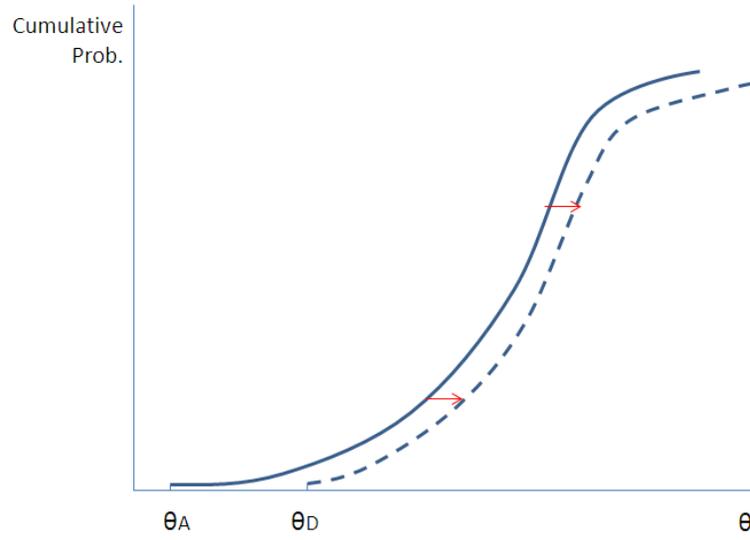


Figure 2: The productivity distribution before and after multinational entry

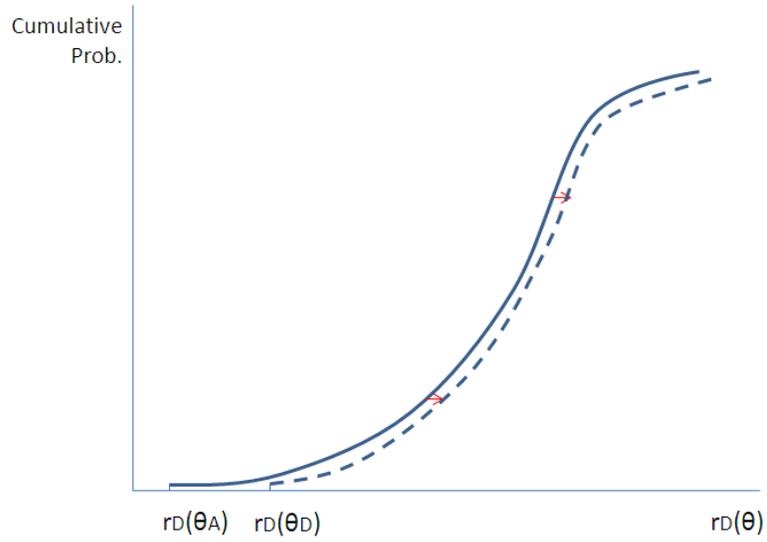


Figure 3: The revenue distribution before and after multinational entry (case I)

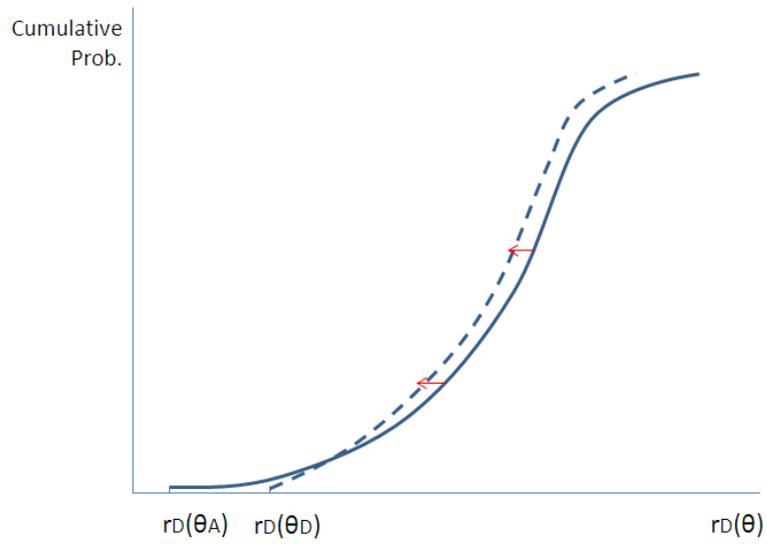


Figure 4: The revenue distribution before and after multinational entry (case II)

Table 1: The Entry Decision of Multinational Firms (Firm-Country Level)

Dependent variable:	(1)	(2)
	MNC entry	MNC entry
HQ TFP	0.002*** (0.001)	0.001* (0.000)
Financial shock	0.002*** (0.001)	0.003*** (0.001)
Host-country-ind FE	Yes	Yes
Country-pair-ind FE	No	Yes
Firm cluster	Yes	Yes
Obs	405,728	405,728
R square	0.04	0.33

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 Entry and Change in Average Productivity (Country-Industry Level)

Dependent variable:	(1)	(2)
	Change in ave TFP	Change in ave TFP
MNC entry	0.01*** (0.004)	
MNC entry (predicted)		0.02** (0.01)
Beta coefficients	0.05	0.02
Host country FE	Yes	Yes
Industry FE	Yes	Yes
Obs	3,730	3,730
R square	0.52	0.52

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: The Shift of Domestic Productivity Distribution

Dependent var.:	(1)	(2)	(3)	(4)	(5)
Change in TFP	All	Bin 1 (<25%)	Bin 2 (25-50%)	Bin 3 (50-75%)	Bin 4 (>75%)
MNC entry (predicted)	0.021*** (0.001)	0.029*** (0.002)	0.017*** (0.001)	0.020*** (0.001)	0.019*** (0.002)
Host-country FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Obs	397,618	99,997	99,104	100,068	98,449
R square	0.05	0.06	0.07	0.06	0.06

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

Table 4: The Survival of Domestic Firms

Dependent variable:	(1)	(2)
	Survival	Survival
MNC entry (predicted)	-0.0004*** (0.0001)	-0.001*** (0.0003)
Cutoff TFP (lagged)	-0.0001*** (0.0000)	-0.0001*** (0.0000)
Firm TFP (lagged)	0.001*** (0.0001)	
Firm Revenue (lagged)		0.003*** (0.0001)
Host country FE	Yes	Yes
Industry FE	Yes	Yes
Obs	407,975	616,270
R square	0.06	0.10

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 5: The Ex-ante Productivity Difference of Surviving and Exiting Firms

Dependent variable:	(1)	(2)
	Firm TFP (lagged)	Firm revenue (lagged)
Survival	0.547*** (0.089)	0.045 (0.061)
Survival * MNC entry (predicted)	0.117*** (0.005)	0.132*** (0.006)
Host-country-industry FE	Yes	Yes
Obs	407,975	616,270
R square	0.21	0.11

Notes: (i) bootstrapped standard errors are reported in the parentheses; (ii) ***, **, and * represent statistical significance at 1, 5, and 10 percent, respectively.

Table 6: Changes in Cutoff TFP and Revenue (Country-Industry Level)

Dependent variable:	(1)	(2)
	Change in cutoff TFP	Change in cutoff revenue
MNC entry (predicted)	0.83*** (0.09)	0.49*** (0.07)
Host country FE	Yes	Yes
Industry FE	Yes	Yes
Obs	3,730	5,300
R square	0.37	0.36

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 7: The Shift of Domestic Revenue Distribution

Dependent var.:	(1)	(2)	(3)	(4)	(5)
Change in revenue share	All	Bin 1 (<25%)	Bin 2 (25-50%)	Bin 3 (50-75%)	Bin 4 (>75%)
MNC entry (predicted)	-0.035*** (0.006)	-0.069*** (0.017)	-0.021*** (0.006)	-0.035*** (0.011)	-0.009 (0.008)
Host-ountry FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Obs	407,145	103,233	101,245	102,181	100,486
R square	0.20	0.24	0.10	0.26	0.14

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

Table 8: The Shift of Domestic Employment Distribution

Dependent var.:	(1)	(2)	(3)	(4)	(5)
Change in employment share	All	Bin 1 (<25%)	Bin 2 (25-50%)	Bin 3 (50-75%)	Bin 4 (>75%)
MNC entry (predicted)	-0.037*** (0.007)	-0.067*** (0.022)	-0.027*** (0.008)	-0.038*** (0.013)	0.002 (0.008)
Host-country FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Obs	388,704	98,498	97,089	97,839	95,278
R square	0.22	0.29	0.19	0.22	0.16

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

Table 9: Changes in the Average Wage Rate of Domestic Firms (Country-Industry Level)

Dependent variable:	(1) Change in ave wage
MNC entry (predicted)	0.033*** (0.003)
Host country FE	Yes
Industry FE	Yes
Obs	3,407
R square	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 10: Estimated Effects of Multinational Entry

Variable	Est. parameter
Within-firm productivity (bin 1)	0.03
Within-firm productivity (bin 2)	0.02
Within-firm productivity (bin 3)	0.02
Within-firm productivity (bin 4)	0.02
Cutoff productivity	0.83
Cutoff revenue	0.49
Revenue share (bin 1)	-0.07
Revenue share (bin 2)	-0.02
Revenue share (bin 3)	-0.03
Revenue share (bin 4)	0.00
Employment share (bin 1)	-0.07
Employment share (bin 2)	-0.03
Employment share (bin 3)	-0.04
Employment share (bin 4)	0

Notes: The table summarizes the estimated effects of multinational entry.

Table 11: Robustness: The Shift of Domestic Productivity Distribution

Dependent var.:	(1)	(2)	(3)	(4)	(5)
Change in TFP	All	Bin 1 (<25%)	Bin 2 (25-50%)	Bin 3 (50-75%)	Bin 4 (>75%)
Robustness 1: Homogeneous industries					
MNC entry (predicted)	0.038*** (0.001)	0.118*** (0.009)	0.023*** (0.006)	0.014*** (0.005)	0.006 (0.007)
Host-country FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Obs	44,128	11,014	11,031	11,113	10,970
R square	0.07	0.11	0.09	0.08	0.08
Robustness 2: Top countries					
MNC entry (predicted)	0.020*** (0.001)	0.026*** (0.003)	0.015*** (0.002)	0.020*** (0.002)	0.020*** (0.002)
Host-country FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Obs	236,745	59,056	59,327	59,397	58,965
R square	0.07	0.11	0.09	0.06	0.05

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

Table 12: Robustness: Changes in Cutoff TFP and Revenue (Country-Industry Level)

Dependent variable:	(1)	(2)
	Change in cutoff TFP	Change in cutoff revenue
Robustness 1: Homogeneous industries		
MNC entry (predicted)	0.662** (0.335)	0.453*** (0.167)
Host-country FE	Yes	Yes
Industry FE	Yes	Yes
Obs	262	357
R square	0.22	0.43
Robustness 2: Top countries		
MNC entry (predicted)	0.600** (0.307)	0.225* (0.141)
Host-country FE	Yes	Yes
Industry FE	Yes	Yes
Obs	524	563
R square	0.32	0.39
Robustness 3: Left censoring (employment > 10)		
MNC entry (predicted)	0.215** (0.109)	0.297** (0.144)
Host-country FE	Yes	Yes
Industry FE	Yes	Yes
Obs	3,473	5,248
R square	0.18	0.36

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 13: Robustness: Within- and Between-Industry Productivity Spillovers

Dependent var.:	(1)	(2)	(3)	(4)	(5)
Change in TFP	All	Bin 1 (<25%)	Bin 2 (25-50%)	Bin 3 (50-75%)	Bin 4 (>75%)
MNC entry (predicted) in the same industry	0.015*** (0.001)	0.026*** (0.033)	0.012*** (0.002)	0.015*** (0.002)	0.010*** (0.002)
in related industries					
- Backward linkage	0.119*** (0.019)	0.284*** (0.049)	0.126*** (0.031)	0.047 (0.030)	0.002 (0.038)
- Forward linkage	0.109*** (0.021)	-0.039 (0.053)	0.092*** (0.034)	0.128*** (0.033)	0.259*** (0.041)
Host-country FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Obs	397,618	99,997	99,104	100,068	98,449
R square	0.05	0.06	0.07	0.06	0.06

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

Table 14: Robustness: Within- and Between-Industry Reallocations

Dependent var.:	(1)	(2)
	Change in cutoff TFP	Change in cutoff rev
MNC entry (predicted) in the same industry	0.727*** (0.105)	0.379*** (0.076)
in related industries		
- Labor similarity	0.024*** (0.009)	0.007 (0.006)
- Capital similarity	0.005 (0.009)	0.012** (0.006)
Host-country FE	Yes	Yes
Industry FE	Yes	Yes
Obs	3,751	5,300
R square	0.37	0.36

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 A.1: Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
entry dummy	0.18	0.39	0	1
entry sum	0.48	1.84	0	42
survival	0.99	0.04	0	1
TFP change	0.08	0.48	-9.28	14.15
revenue share change	-0.001	0.02	-0.99	0.97
employment share change	-0.002	0.02	-0.99	0.99
min TFP change	-0.46	1.63	-10.38	10.6
min revenue change	-0.79	2.16	-14.83	10.07