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Chen, Maggie Xiaoyang and Moore, Michael

George Washington University

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Maggie Xiaoyang Chen
George Washington University†

Michael O. Moore
George Washington University‡

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Abstract

We examine how multinational firms with heterogeneous total factor productivity (TFP) self-select into different host countries. Both aggregate- and firm-level estimates suggest that more productive French firms are more likely than their less efficient competitors to invest in relatively tough host countries. Countries with a smaller market potential, higher fixed costs of investment or lower import tariffs tend to have higher cutoff productivities and attract a greater proportion of productive multinationals. This self-selection mechanism remains largely robust when we control for unobserved firm and country heterogeneity and address the potential TFP endogeneity.

Key words: multinational firm, location decision, firm heterogeneity, productivity
JEL codes: F23, D24

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†Corresponding Author: Department of Economics/Elliott School, Institute for International Economic Policy, George Washington University, Washington, DC. Email: xchen@gwu.edu.

‡Department of Economics/Elliott School, Institute for International Economic Policy, George Washington University, Washington, DC. Email: mom@gwu.edu.

1 Introduction

Foreign direct investment (FDI) is at the forefront of international policy debates and economic research. In the past few decades, not only has the volume of investments by multinational corporations (MNCs) grown exponentially, the rate at which it increased has outpaced traditional international trade flows. Understanding how individual MNCs choose FDI locations consequently has risen in importance.

While a vast economics literature has been established to examine the determinants of FDI, the majority of studies have focused on the effect of host-country attributes. The role of MNCs' heterogeneity in explaining FDI location decisions has been underemphasized. Our paper addresses the latter issue by investigating how firms with varied levels of total factor productivity (TFP) self-select into different host countries. Instead of assuming host-country characteristics exert a homogeneous effect across individual firms, we explore how the effect of market size, production costs, and trade costs on firms' investment decision varies with firm-level TFP.

We first model firms' decision to invest and produce in foreign countries by building on the work of Helpman *et al.* (2004). We derive a number of testable predictions at both the country- and firm-level. First, the model predicts that the pool of multinationals attracted to each host country varies in productivity. Countries with less attractive attributes exhibit a higher cutoff productivity, leading to a greater proportion of more productive multinationals. At the disaggregated level, the model suggests that firms with different TFP levels will differ in their selection of foreign production locations. More efficient firms are more likely than their less productive counterparts to invest in tougher markets (e.g., markets with a smaller market demand and higher production costs) where the effect of TFP in raising firms' ability to invest is more pronounced.

We use a rich dataset of French manufacturing multinational firms and their worldwide subsidiaries to examine the self-selection mechanism predicted in the model. The French experience is particularly interesting since French firms play an increasingly important role in international FDI outflows. According to the World Investment Report (2006), France experienced the world's largest increase in outward FDI in 2005 and became the second largest source country with an annual flow of $115 billion. Secondly, as a large number of French firms turn to foreign nations as sites of production facilities, the public's concern with the displacement of manufacturing jobs has grown substantially and played a prominent role in the 2007 French presidential elections.

In our empirical investigation, we proceed by first examining the cross-country productivity distribution of French MNCs and then the investment decisions of individual firms. The empirical evidence is broadly consistent with the theoretical predictions at both the country- and firm-level. First, we find that countries with less attractive FDI host attributes, including a smaller market potential, greater production costs, and a lower import tariff, have both higher cutoff productivities and greater average TFPs. In fact, the productivity distribution of firms that decide to invest in these markets first-order stochastically dominate those investing in more attractive host countries.

At the firm level, we find while French multinational firms on average tend to invest in countries with a larger market potential, more productive firms are consistently more likely than their less efficient counterparts to produce in small-market-potential countries. Similarly, firms with higher productivity are more likely to invest in countries that exhibit high entry costs or high fixed costs of investment than their less efficient competitors. Host-country tariffs also have an asymmetric effect: A lower tariff rate discourages less productive firms from investing in the markets and leads to a larger proportion of efficient multinational firms.

Our paper is closely related to a recently growing literature that examines the decision of heterogeneous firms to participate in international markets.[1] This literature builds on the pioneering work of Melitz (2003) and Bernard, Eaton *et al.* (2003), who introduce firm heterogeneity to the decision to engage in international trade, and is developed further by Helpman *et al.* (2004), who bring foreign direct investment decision into the analysis. By investigating heterogeneous firms' choice between exporting and FDI, Helpman *et al.* (2004) show that only the most productive firms can overcome the plant-level fixed cost of investment and become multinationals. This hypothesis has been tested in several empirical studies including Girma *et al.* (2004) and Girma *et al.* (2005), both of which find a significant productivity differential between multinational and non-multinational firms. One notable exception is Head and Ries (2003) who show that when the foreign country is small and offers cost advantage, it is possible that the least productive firms locate abroad whereas more productive ones produce at home.

Three recent studies in this literature, Yeaple (2009), Mayer *et al.* (2007) and Nefussi (2006), are particularly relevant to our work. These papers extend Helpman *et al.* (2004) and examine heterogeneous firms' location choices. Yeaple (2009) uses U.S. MNC data and examines the role of firm heterogeneity in explaining the structure of U.S. FDI activity in 1994. He shows that host-country characteristics affect both the scale and scope of foreign investment. Mayer *et al.* (2007) contribute to the literature by jointly addressing the decision to invest abroad as

[1] Our research also builds on the broader theoretical and empirical literature that examines the determinants of FDI. Classic theoretical work in this area include Markusen (1984), Helpman (1984), and Markusen and Venables (1998, 2000) who have identified market access and comparative advantage as the two main motives to invest abroad. A number of empirical studies, including Brainard (1997), Carr *et al.* (2001), Blonigen (2002), Yeaple (2003) and Head and Mayer (2004), examine the theoretical predictions and find consistent evidence for both types of investment incentives. Blonigen (2005) provides an excellent survey of the literature.

well as the FDI location choice and find that more productive French firms are more likely to invest abroad. Nefussi (2006) modifies the theoretical framework of Helpman *et al.* (2004) by allowing for variable price demand elasticity and finds firms with intermediate productivities are more likely to engage in FDI.

Our paper complements the above studies but differs in important ways. Our focus is on how productivity differences among MNCs may lead to differential effects of host-country attributes and consequently distinct choices of foreign production locations. This contrasts with Yeaple (2009), who focuses on the role of firm productivity in the scale and scope of aggregate FDI and assumes the effect of host-country characteristics is homogeneous across firms and the effect of TFP is uniform across countries. The paper also differs from Mayer *et al.* (2007) who emphasize the role of TFP in raising firms' ability to invest abroad instead of at home. We stress in this study that the positive effect of TFP on firms' ability to invest abroad is more pronounced in less attractive markets.

Another contribution of the paper is to address the ambiguous causality between firm productivity and FDI activity, an issue that has not been considered in the literature. Existing studies have focused mainly on the productivity differential between multinational and non-multinational firms and have not taken into account the possibility that TFP can be both a cause and an effect of the investment decision.[2] We take two steps to disentangle the causal effect. First, we estimate multinational firms' productivity based on their past production performance at home. The use of a time and a spatial lag between the measure of TFP and the location choice reduces the likelihood that productivity is affected by the latter variable. Second, we employ a two-stage control function approach that is developed by Petrin and Train (2005, 2006) and subsequently used by studies such as Liu *et al.* (forthcoming). Specifically, we pair each French MNC with respective reference groups—formed by other French national or multinational firms in the same industry and same region—and use the average productivity of these reference groups as instrumental variables for individual MNCs' productivity.[3] We then recover unobserved firm heterogeneity based on the first-stage estimates and include them in the second-stage estimation. We find controlling for the unobserved factors does not change the main findings of this paper.

Finally, we adopt various procedures to control for unobserved country and firm heterogene-

[2] The issue of causal effect between productivity and participation in foreign markets has been noted in the export literature where a number of studies (see, e.g., Bernard and Jensen, 1999, 2004; Clerides *et al.*, 1998) have been devoted to disentangling the causal effect of productivity and export decision. This literature shows that the productivity difference between exporters and non-exporters can be both ex ante (i.e., more productive firms self-select into export markets) and ex post (i.e., exporting raises firm productivity).

[3] The choice of these instruments is motivated by the large literature on technology spillover and social interaction that has suggested the existence of both industry and regional spillovers across firms.

ity. For example, we use a two-step approach and construct an industry-specific measure of host-country attractiveness to control for unobserved country characteristics. This approach allows us to directly examine how heterogeneous firms sort across markets with varied levels of attractiveness.

The rest of the paper is organized as follows. We first lay out a model in Section 2 to motivate our empirical analysis and derive a number of testable hypotheses. We then provide a detailed description of the data in Section 3 and investigate in Section 4 the productivity distribution of French MNCs across countries. We report the firm-level empirical results in Section 5 and sensitivity analyses in Section 6. Last, we conclude the paper in Section 7.

2 Theoretical framework

2.1 Basic setup

In this section, we build on Helpman *et al.* (2004) and Yeaple (2009) and model multinationals' decision to invest in foreign countries. Suppose the world consists of 2 sectors and $N+1$ countries. One sector produces a homogeneous product while the other sector produces differentiated products. The homogeneous good is the numeraire good and produced in all countries. The $N+1$ countries consist of a home country, denoted as country 0, and N foreign countries denoted as $j = 1, ..., N$.

There is a continuum of firms in each country. Each firm produces a different brand of the differentiated product and possesses a distinct productivity level θ. The cumulative distribution function of firm productivity is denoted as $G(\theta)$.

Given a CES utility function, the demand function of each country for the differentiated product is given by $x_{ij} = a_{ij} A_j {p_{ij}}^{-\varepsilon}$, where x_{ij} is the quantity sold by firm i in country j, a_{ij} is a destination and firm specific demand parameter, A_j the demand level in country j, p_{ij} the price, and $\varepsilon \equiv 1/(1-\alpha) > 1$ the demand elasticity.[4] Following Eaton, Kortum and Kramarz (2008) and Crozet, Head and Mayer (2009), we include a demand parameter to capture cross-country variation in, for example, the preference for each firm's product or the extent of firms' business network. We assume that a_{ij} is distributed with a cumulative distribution function $H(a)$. As shown in Section 2.3, heterogeneity in the demand parameter allows the model to accommodate the possibility that two firms with the same productivity, θ, may differ in their sales in the same country and, moreover, the choice of countries to invest.

[4] Note given the CES utility function, $A_j \equiv E_j / \int_{i \in I_j} a_{ij} p_{ij}^{1-\varepsilon} di$ where E_j measures the total spending of country j on the differentiated product and I_j the set of available brands in j. As in Yeaple (2008), the model here is not closed via free entry condition.

Without loss of generality, we focus on firms in country 0. If firm i in country 0 chooses to produce and sell at home, it must incur a variable cost of production c_0/θ_i, and a fixed cost of production f_0^D. Its profit-maximizing strategy is to set $p_0 = c_0/(\alpha\theta_i)$, which means that the profit is given by

$$\pi_{i0}^D = a_{i0}B_0\left(\frac{c_0}{\theta_i}\right)^{1-\varepsilon} - f_0^D, \tag{1}$$

where $B_0 \equiv (1-\alpha)\alpha^{\varepsilon-1}A_0$.

Firm i may also sell to a foreign country $j = 1, ..., N$. It may either export from home or produce in the foreign country.[5] If firm i chooses to export the product to country j, it must incur a per-unit iceberg trade cost τ_{ij} ($\geqslant 1$), which reflects both the transport cost and the tariff country j imposes on the goods imported from i. The firm must also pay an additional fixed cost f_j^X, which includes the costs of forming a distribution and servicing network in country j. Its profit-maximizing strategy is to set $p_{ij} = \tau_{ij}c_0/(\alpha\theta_i)$, $j = 1, ..., N$, which yields the export profit as

$$\pi_{ij}^X = a_{ij}B_j\left(\frac{c_0\tau_{ij}}{\theta_i}\right)^{1-\varepsilon} - f_j^X, \tag{2}$$

where $B_j \equiv (1-\alpha)\alpha^{\varepsilon-1}A_j$.

If firm i chooses instead to serve the foreign market through local production, it must pay a fixed cost f_j^I for each foreign market j in which it invests. This includes the costs of operating a subsidiary as well as the distribution and servicing network costs embodied in f_j^X, which means that $f_j^I > f_j^X$ and there exist plant-level economies of scale. In this case, the profit firm i receives from investing and producing in foreign country j is

$$\pi_{ij}^I = a_{ij}B_j\left(\frac{c_j}{\theta_i}\right)^{1-\varepsilon} - f_j^I. \tag{3}$$

Following Helpman *et al.* (2004), we assume

$$f_0^D < (\tau_{ij})^{\varepsilon-1}f_j^X < \left(\frac{c_j}{c_0}\right)^{\varepsilon-1} f_j^I \tag{4}$$

for all j.

It is clear that firms will serve a foreign country via FDI only if $\pi_{ij}^I > \pi_{ij}^X$. Given equations

[5] Note we assume in the model that firms would only consider exporting to a foreign country from home, and thus leave out the possibility of exporting from its foreign subsidiaries. In a similar fashion, we assume that firms would always supply their home country through local production and do not consider the case in which firms export their products from foreign subsidiaries to home. For theoretical contributions in this area, see, for example, Motta and Norman (1996), Head and Ries (2003), and Ekholm, Forslid, and Markusen (2007). We do however take into account these possibilities in the empirical analysis by, for example, including a measure of market potential for each host country to capture the demand in their potential export markets.

(2) and (3), this condition implies that firm productivity must satisfy, for any given value of a,

$$\theta_i > \underline{\theta}_j^I \equiv \left[\frac{f_j^I - f_j^X}{aB_j \left({c_j}^{1-\varepsilon} - (c_0 \tau_{ij})^{1-\varepsilon} \right)} \right]^{\frac{1}{\varepsilon-1}} . \tag{5}$$

Conversely, firms would prefer exporting to FDI if $\pi_{ij}^X > \pi_{ij}^I$ and $\pi_{ij}^X > 0$, which implies

$$\left[\frac{f_j^X \left(c_0 \tau_{ij} \right)^{\varepsilon-1}}{aB_j} \right]^{\frac{1}{\varepsilon-1}} \equiv \underline{\theta}_j^X < \theta_i < \underline{\theta}_j^I. \tag{6}$$

Because of the inequality conditions specified in (4), a clear correlation between firm productivity and their participation in domestic and foreign markets is established. The least productive group of firms, i.e., those with $\theta_i < \theta_0^D \equiv \left(f_0^D {c_0}^{\varepsilon-1} / (B_0 a) \right)^{1/(\varepsilon-1)}$, would not produce at all. Firms for which $\underline{\theta}_0^D < \theta_i < \underline{\theta}_j^X$ $(\forall j)$, will produce and supply only the domestic market. Relatively more productive firms sell to both the domestic and foreign countries in which $\underline{\theta}_j^X < \theta_i$ but the supply strategy varies with the level of productivity. In a given market j, firms with an intermediate level of productivity, i.e., $\underline{\theta}_j^X < \theta_i < \underline{\theta}_j^I$, will choose to export, whereas the most productive firms with $\theta_i > \underline{\theta}_j^I$ would prefer to produce locally.

In the rest of Section 2, we derive a number of testable predictions based on the outlined model. First, we examine in Section 2.2 the productivity composition of multinationals across host countries.[6] Then, we investigate different aspects of firm-level decision, in particular, the extensive and intensive margins of firm investment activities.

2.2 Cross-country differences in the productivity distribution

First, we obtain the expected cutoff productivity $\widetilde{\underline{\theta}}_j$. Given the distribution function of the demand parameter (i.e., $H(a)$), we have

$$\widetilde{\underline{\theta}}_j = \left[\frac{f_j^I - f_j^X}{B_j \left({c_j}^{1-\varepsilon} - (c_0 \tau_{ij})^{1-\varepsilon} \right)} \right]^{\frac{1}{\varepsilon-1}} \mu_1 \tag{7}$$

where $\mu_1 \equiv \int_0^\infty a^{-1/(\varepsilon-1)} dH(a)$. Taking natural logs of the above equation yields:[7]

$$\ln \widetilde{\underline{\theta}}_j = \frac{1}{\varepsilon - 1} \left[-\ln B_j - \ln \left({c_j}^{1-\varepsilon} - (c_0 \tau_{ij})^{1-\varepsilon} \right) + \ln \left(f_j^I - f_j^X \right) \right] + \ln \mu_1 . \tag{8}$$

[6] Similar to Yeaple (2008), we also examined the intensive and extensive margins of aggregate FDI. The theoretical and empirical results are reported in the Appendix A of an earlier working paper version (Chen and Moore, 2008).

[7] In the rest of Section 2, we focus on the cutoff productivity to engage in FDI and hence suppress the superscript of $\underline{\theta}_j$.

This equation shows that the entry threshold productivity is a decreasing function of market "attractiveness". Countries with a greater demand for the differentiated good (B_j) have a lower cutoff productivity. Countries with a larger variable cost of production (c_j) or a larger fixed cost of investment (f_j^I) have higher entry thresholds. A greater trade cost (τ_{ij}) raises firms' incentive to choose FDI instead of exporting reducing the minimum productivity required for firms to invest in the market.

Now consider the conditional expected productivity of multinationals that choose to enter a given country. This will be

$$\widetilde{\theta}_j \equiv E\left[\theta|\pi_{ij}^I > \pi_{ij}^X\right] = \frac{\int_0^\infty \int_{\underline{\theta}_j}^\infty \theta dG(\theta) dH(a)}{\Pr\left(\pi_{ij}^I > \pi_{ij}^X\right)}, \tag{9}$$

where $\Pr(\pi_{ij}^I > \pi_{ij}^X)$ represents firm i's probability of investing in country j. We follow the literature and assume that firm productivity follows a pareto distribution, i.e., $G(\theta) = 1-(b/\theta)^k$, where b is the minimum productivity of the industry in country 0 and k is the shape parameter. Given (5), this assumption implies that

$$\widetilde{\theta}_j = \left[\frac{f_j^I - f_j^X}{B_j\left({c_j}^{1-\varepsilon} - (c_0\tau_{ij})^{1-\varepsilon}\right)}\right]^{\frac{1}{\varepsilon-1}} \frac{k}{k-1}(\mu_2/\mu_3), \tag{10}$$

where $\mu_2 \equiv \int_0^\infty a^{(k-1)/(\varepsilon-1)} dH(a)$ and $\mu_3 \equiv \int_0^\infty a^{k/(\varepsilon-1)} dH(a)$. The above equation can be transformed to

$$\ln \widetilde{\theta}_j = \frac{1}{\varepsilon-1}\left[-\ln B_j - \ln\left({c_j}^{1-\varepsilon} - (c_0\tau_{ij})^{1-\varepsilon}\right) + \ln\left(f_j^I - f_j^X\right)\right] + \ln\left(\frac{k}{k-1}\right) + \ln\left(\mu_2/\mu_3\right). \tag{11}$$

Similar to $\widetilde{\underline{\theta}}_j$, the conditional expected productivity $\widetilde{\theta}_j$ is higher in less attractive markets. In Section 5, we estimate equations (8) and (11) and examine how our hypotheses hold in the data.

Note these two attributes of productivity distribution, i.e., $\widetilde{\underline{\theta}}_j$ and $\widetilde{\theta}_j$, can also be expressed in terms of the number of firms that choose to invest in the country (i.e., N_j). This is because in a sufficiently large sample, N_j/N (where N is the total number of firms in country 0) proxies $\Pr(\pi_{ij}^I > \pi_{ij}^X)$. Given the pareto distribution assumption, this implies

$$\widetilde{\underline{\theta}}_j \approx (N_j)^{-1/k}\left(b^k N\mu_3\right)^{1/k} \tag{12}$$

and

$$\widetilde{\theta}_j \approx (N_j)^{-1/k}\left(b^k N\mu_3\right)^{1/k} \frac{k}{k-1}\frac{\mu_2}{\mu_1\mu_3}. \tag{13}$$

Now consider the productivity distribution as a whole. The properties of $\widetilde{\underline{\theta}}_j$ and $\widetilde{\theta}_j$ discussed above also lead to testable hypothesis on the cumulative distribution of MNC productivities across host countries. That is, the productivity distribution of firms that invest in tougher markets should first-order stochastically dominate those that invest in easy markets.

To see this, let $\lambda_j(\theta_z)$ denote the fraction of firms investing in country j with productivity less than or equal to θ_z. Since only firms whose productivity exceeds $\underline{\theta}_j$ will invest in country j, $\lambda_j(\theta_z)$ can be expressed as $\lambda_j(\theta_z) = \int_0^\infty \Pr(\underline{\theta}_j < \theta_i < \theta_z) dH(a) = \int_0^\infty \int_{\underline{\theta}_j}^{\theta_z} dG(\theta) dH(a)$. Given $G(\theta) = 1 - (b/\theta)^k$, we obtain

$$\lambda_j(\theta_z) = \int_0^\infty \left(\underline{\theta}_j^{-k} b^k - \theta_z^{-k} b^k\right) dH(a) = \left[\frac{B_j \left({c_j}^{1-\varepsilon} - (c_0 \tau_{ij})^{1-\varepsilon}\right)}{f_j^I - f_j^X}\right]^{\frac{k}{\varepsilon-1}} b^k \mu_3 - \theta_z^{-k} b^k. \quad (14)$$

It is clear from the above equation that holding constant θ_z, the fraction of firms investing in a market, i.e., $\lambda_j(\theta_z)$, always increases in market attractiveness. This suggests that the productivity distribution of multinationals in countries with a larger market demand, smaller production costs or a greater trade cost is first-order stochastically dominated by those that self-select into relatively less attractive destinations.

2.3 Firm-level decisions

Next, we proceed to investigate firm-level decisions. First, we consider each firm's decision to undertake FDI in a foreign country. Let y_{ij} denote an indicator variable that equals to 1 if firm i decides to invest in country j and 0 otherwise. As discussed in Section 2.1,

$$y_{ij} = \begin{cases} 1 & \text{if} \quad \pi_{ij}^I > \pi_{ij}^X \\ 0 & \text{if} \quad \pi_{ij}^I \leq \pi_{ij}^X \end{cases}. \quad (15)$$

The probability function of $y_{ij} = 1$ is hence given by

$$\Pr(y_{ij} = 1) = \Pr\left\{\theta_i > \left[\frac{f_j^I - f_j^X}{a_{ij} B_j \left({c_j}^{1-\varepsilon} - (c_0 \tau_{ij})^{1-\varepsilon}\right)}\right]^{\frac{1}{\varepsilon-1}}\right\}. \quad (16)$$

The above equation suggests that how a firm's productivity compares to host-country cutoff productivity (captured on the right-hand-side of the inequality) determines that firm's decision to invest in the market. At a given a_{ij}, an increase in the cutoff productivity, resulting from either a smaller market size (B_j), higher production costs (c_j and f_j^I) or a lower trade cost (τ_{ij}), reduces firms' probability to produce in the country. This effect is especially strong for firms with relatively lower productivities. These firms will choose not to enter the difficult markets unless they obtain a sufficiently high demand draw (a_{ij}). In Section 5, the parameter a_{ij} serves as a structural error term in the regression.

Now assume a firm already decided to invest in a country. The affiliate sales this firm will receive is given by

$$s_{ij} = p_{ij}x_{ij} = \frac{1}{1-\alpha} a_{ij} B_j c_j{}^{1-\varepsilon} \theta_i^{\varepsilon-1} \text{ where } \theta_i > \underline{\theta}_j. \tag{17}$$

At a given level of a_{ij}, firms with a greater productivity will have more affiliate sales. Furthermore, the level of affiliate sales increases in host countries' market demand but decreases in the variable cost of production. Similar to equation (16), a_{ij} provides a structural error term for the regression in Section 5.

Finally, we note that the model also derives a testable prediction on the number of foreign countries in which each multinational firm invests when there is no firm variant idiosyncratic demand shock. Suppose we can rank countries $j = 1, ..., N$ based on their cutoff productivities such that country 1 is the easiest market of all and country N is the most difficult. Then, it must be the case that every firm that invests in country j also invests in country $k < j$, implying that firms with a greater productivity invest in a larger number of countries. This hierarchy will not hold, however, when there is sufficiently large firm variation in the demand shock.[8]

3 Data

We employ a dataset of French manufacturing firms to examine the empirical regularities in multinationals' location decision. This dataset records the financial and subsidiary information of French public and private firms. It is drawn from AMADEUS, a comprehensive database that contains companies of 38 European countries. The information is collected by providers including national public bodies in charge of collecting the annual accounts (e.g., Institut National de la Propriete Industrielle (National Institute for Industrial Property) in the case of France).

The financial information in the dataset reports each French firm's balance and income statements. We use revenue, value added, fixed asset, employment, and material cost to estimate each firm's total factor productivity, a primary variable of the paper. In particular, we use

[8] Another source of deviation from the hierarchy arises from the possibility of export-platform FDI. If the model allows multinationals to serve other countries from their foreign production locations and assumes a sufficiently large plant-level scale economy, the predicted number of countries in which each firm invests is likely to be smaller. But because of the different levels of productivity and varied country characteristics, firms may still self-select into different markets. This expectation is consistent with evidence in the empirical section that suggests a systematic self-selection mechanism in French MNCs' location decision.

firms' unconsolidated financial data in the period 1993 and 2001 to derive estimates of production function and productivity.[9] The estimation methodology employed in the paper is the semiparametric estimator developed by Levinsohn and Petrin (2003).[10] Based on this approach, we estimate the production function for each SIC 3-digit industry and obtain the productivity for each firm based on the industry-specific production function estimates.

We employ three strategies to establish the causal effect of TFP on multinational firms' location choices. First, we use firms' unconsolidated financial data and measure TFP solely based on their production activities *at home*. Second, we use firms' average TFP in the period of 1997-2001 to explain their decision to invest abroad in a later period.[11] Third, we adopt a control-function approach in Section 6.2 and address the potential endogeneity of TFP. Note we also use firms' relative TFP to deal with the cross-industry variation in productivity estimates. Specifically, we regress the TFP estimates (obtained from the production function estimations) on a group of industry dummies and use the fitted residuals as the measure of within-industry heterogeneity.

The subsidiary section of the dataset lists the location and activities of each French firm's foreign subsidiaries in 2005. As discussed above, the time lag between TFP and choice of subsidiary locations mitigates possible reverse causality between the two variables. Furthermore, given the main focus of this paper is to examine firms' decision of where to invest abroad, we limited our sample to firms that have at least one subsidiary overseas in 2005.[12] This results in a final sample of 1302 individual French multinationals, for which both financial and subsidiary information are available.

In addition to firm heterogeneity, we take into account a number of host-country characteristics that have traditionally been used to explain multinationals' location choices. First, we follow Head and Mayer (2004) and Blonigen *et al.* (2007) and include a measure of market potential to control for the impact of the size of both the domestic and potential export markets on the MNCs' choice of host countries. Specifically, we calculate, for each country j, the sum of its

[9] Value added, material costs, and capital are all deflated by their respective deflators, taken from the French National Institute for Statistics and Economics Studies (INSEE).

[10] Details of the estimation are reported in the Appendix B of Chen and Moore (2008). We also considered a number of approaches to obtain estimates of TFP, including instrumental variables estimation and semiparametric estimation. Van Biesebroeck (2008) provides a comprehensive comparison of these methods and finds that they produce similar productivity estimates. Similar to Van Biesebroeck (2008), we did not find significant differences in the estimates of TFP obtained from either the IV or the semiparametric estimation. We report the results based on the semiparametric estimator introduced in Levinsohn and Petrin (2003).

[11] We also used firms' TFP in 2001 and average TFP in 1999-2001 as alternatives. The results were largely similar.

[12] The dropped firms would be needed if we were to compare the productivity of multinationals with other types of firms. However, since our paper does not focus on this issue but rather on heterogeneous multinational firms' location choice abroad, we only consider existing and new multinational firms. The potential bias in TFP resulted from sample selection will be addressed in Section 6.2 where we deal with the potential endogeneity of TFP.

GDP and GDP of all other countries, each weighed by their distance to j, i.e., $\sum_l (1/d_{jl})\, GDP_l$, where d_{jl} is the great circle distance between j and l's largest cities taking into account each country's internal distance and GDP_l is country l's real GDP in 2001 (measured in 2000 U.S. dollars). We obtain the GDP and distance data from the World Development Indicators and the CEPII distance database, respectively.[13]

Second, we control for host countries' marginal production cost by including real unit labor cost, where each industry is weighed by its output share. We obtain the labor cost and output data from the World Bank Trade and Production Database. We also include each firm's labor intensity measured by the labor cost share of value added and interact it with host-country real unit labor cost to examine whether firms with a higher labor intensity have a greater probability to invest in low-labor-cost countries. Furthermore, we control for host countries' tax policy using the maximum corporate tax rate, obtained from the U.S. Office of Tax Policy Research.[14]

We also consider various measures of fixed cost of investment. First, we use the costs of starting a business, available from the World Development Indicators, as a proxy for entry cost. Second, we include the distance between France and the host country with the expectation that subsidiaries located in distant markets are likely to require a larger monitoring cost. A similar hypothesis applies to countries that are contiguous to France. Third, we include host countries' governance quality as a measure of costs of doing business. Countries with a poorer governance may require a greater fixed cost of investment and are thus less likely to attract MNC investment. The index of governance quality is the average of three indices: control of corruption, regulator quality, and government effectiveness, all of which are obtained from the Polity IV database.

Finally, we control for several aspects of trade costs. We include the distance and contiguity between a potential host and France and tariff rates set by host and home countries as in the gravity equation literature.[15] Specifically, we include the tariff rate set by a potential host country on a French firm's primary product with the expectation that the higher this tariff, the more incentive the French firm will have to produce the product inside the host country.[16] We also use a dummy variable to distinguish EU members from the rest of the world and capture

[13] We also considered using sectoral outputs as a measure of demand at the industry level. However, the data of sectoral outputs have many missing values and would reduce our sample size substantially.

[14] Ideally, we would like to use the applied corporate tax rate in each host country. But this data consists of a large number of missing values for the countries in our sample.

[15] Note distance and contiguity also affect the fixed cost of investment, which adversely affects MNCs' investment decision. Furthermore, for firms that engage in intra-firm trade between home and host countries, transport cost can reduce their incentive to produce abroad. As a result, the net effect of distance and contiguity is ambiguous.

[16] The results were qualitatively similar when we used the average tariff rate imposed on the firm's primary and secondary products.

the other trade cost differences between EU and non-EU destinations.[17] Moreover, we include the tariff rate France sets on the host-country exports and expect multinationals that seek to export their products back to France would be adversely affected by this tariff. Both French and host-country tariff data are applied tariff rates measured at the SIC 3-digit level and obtained from the WITS database. Note that preferential tariffs within the EU and those between the EU and other countries are reflected in the data. Table 1 describes the source and summary statistics of the above variables.[18]

[Table 1 about here]

4 Cross-country differences in the productivity distribution

We start our empirical investigation by first examining the cross-country differences in the productivity distribution. In particular, we take equations (8), (11) and (14) to the data and compare them with the empirical evidence.

The results of Section 2.2 suggest that countries with more attractive attributes have lower cutoff productivities and consequently lower average productivities. The model also predicts a negative correlation between host-country cutoff (and average) productivity and the number of multinationals. We first examine the latter hypothesis by plotting the minimum productivity of French MNCs in each host country against the number of French MNCs operating in that market (i.e., host-country popularity). As shown in Figure 1, the entry threshold productivity is indeed negatively associated with the popularity of the market. We also observe a negative, albeit less significant, correlation between average TFP and number of MNCs which suggests that firms investing in less popular markets are on average more efficient.

[Figure 1 about here]

Now we directly estimate the cutoff and average TFPs as a function of host-country characteristics based on equations (8) and (11). Specifically, we identify $\widetilde{\underline{\theta}}_{jk} \approx \min_{i \in \Omega_{jk}} \theta_i$ and $\widetilde{\theta}_{jk} \approx \sum_{i \in \Omega_{jk}} \theta_i / N_{jk}$ for each host country j and industry k, where Ω_{jk} is the set of French firms in industry k and investing in j.[19] As shown in Table 2, both the cutoff and average TFPs

[17] All countries that joined the EU before 2005 are treated as EU members.

[18] We also take two measures to address the possibility of omitted host-country characteristics. First, we use a country fixed effect to control for all host-market attributes. Second, we construct an industry-specific measure of host-country attractiveness in Section 6.3 to capture all the country-industry factors that can affect multinationals' location decision.

[19] Note when estimating the average TFP, the number of MNCs in each host country will be inversely proportionate to the variance of the error term and lead to heteroskedasticity. We therefore adopt generalized least squares (GLS) estimation where we use the number of MNCs in each host country as the weight.

are negatively correlated with the host-country market potential.[20] This is consistent with the theoretical prediction that the entry threshold productivity is greater in countries with a smaller market demand. The cutoff productivity is also positively correlated with host-country unit labor cost, a result that is again consistent with the theory. Specifically, a 100-percent increase in unit labor cost raises the entry threshold by 62 percent. Only the relatively more productive firms will find it profitable to invest in countries with a larger variable cost of production. This is similarly true for countries with a greater fixed cost of investment, indicated by the positive parameters of entry cost and distance. The entry threshold productivity is 7 percent higher in countries where the distance to France is 100 percent greater. Finally, a lower import tariff in host countries also results in a higher cutoff productivity for multinational firms as exporting becomes less costly.[21]

[Table 2 about here]

Next, we examine the cross-country differences in the distribution of firm productivities indicated by equation (14). We predict in Section 2.2 that the productivity distribution of firms that enter tougher markets should first-order stochastically dominate those that invest in easy markets. The predicted sorting of multinational firms is supported in the data. Figure 2 shows that the productivity distribution of firms that invest in countries with above-average market potential appears to be first-order stochastically dominated by firms that have subsidiaries in countries with below-average market potential. Similarly, firms that invest in countries with a below-average unit labor cost or a below-average fixed cost as measured by either the entry cost (i.e., cost of starting a business) or distance are less productive than other multinational firms. Figure 3 illustrates the case of entry cost.

[Figures 2-3 about here]

These distribution differences are also statistically significant. We first perform a two-sided Kolmogorov-Smirnov test to examine the equality of the two distributions, i.e., $\lambda_1(\theta) = \lambda_2(\theta)$. If the equality hypothesis is rejected, we then use a one-sided Kolmogorov-Smirnov test to examine the first-order stochastic dominance, i.e., $\lambda_1(\theta) \leqslant \lambda_2(\theta)$. If we fail to reject this hypothesis and

[20] Our hypotheses are summarized in the second column of Table 2 (and all the following tables).

[21] Note that both the cutoff and average productivities are only observed for countries and industries that have at least one French multinational firm. In other words, they are not observable in countries with prohibitive cutoff productivities, which can give rise to a sample selection issue. We hence also considered using the Heckman (1979) selection model and proceeding in two stages. First, we estimated the probability of having at least one French MNC in a host country and a given industry. Then, we estimated the cutoff and average productivities, taking into account the selection bias reflected in the inverse mills ratio obtained from the first stage. We found the estimated effect of host-country characteristics remains similar.

given $\lambda_1(\theta) \neq \lambda_2(\theta)$ (obtained from the first step), we conclude that $\lambda_1(\theta) < \lambda_2(\theta)$, i.e., $\lambda_2(\theta)$ is first-order stochastically dominated by $\lambda_1(\theta)$.[22]

We find that, first, consistent with the literature there is a significant productivity differential among domestic, exporting and multinational firms. Not only are multinationals more productive than the other types of firms, those that invest in multiple host countries also exhibit a productivity premium compared to an average MNC. Moreover, the cross-country productivity differential predicted in Section 2.2 is also largely confirmed. The productivity distribution of firms that invest in tougher markets significantly dominates the productivity distribution of those investing in easier markets.

5 Main econometric results

In this section, we directly examine our firm-level hypotheses, i.e., equations (16)-(17), and investigate individual firms' investment decisions. First, we estimate, at individual firm level, the relationship between productivity and the intensive and extensive margins of investment.[23] Then we move to firm-country level and examine the primary question of the paper—how firm and country heterogeneity jointly explain individual French firms' investment decisions.

[Table 3 about here]

We find in Table 3 that TFP is positively correlated with firms' average affiliate sales (i.e., $\widetilde{s}_i = \sum_j s_{ij}/M_i$, where M_i denotes the number of countries in which a firm i invests). This is consistent with the prediction in Section 2.3: More efficient firms sell more in each country. Table 3 also indicates a positive relationship between TFP and the number of countries in which investment occurs (i.e., M_i). This suggests more productive firms enter more host countries relative to an average MNC.

Now we turn to the central part of the analysis, which is to investigate how firms with varied levels of productivity differ in their foreign production location choice. Based on Section 2.3, we consider the following baseline equation

$$\Pr(y_{ij} = 1) = \Phi(\alpha + \delta_j + \gamma_j \theta_i + \varepsilon_{ij}) \qquad (18)$$

where $\Pr(y_{ij} = 1)$ represents the probability of firm i investing in country j, $\Phi(.)$ is the logistic cumulative distribution function, δ_j represents either βX_j (where X_j is a vector of host-country

[22] This approach has been adopted in the past by, for example, Girma *et al.* (2004) and Girma *et al.* (2005) to compare the productivity of domestic, exporting and multinational firms.

[23] Because affiliate sales data are not available for all subsidiaries, we do not examine the intensive margin at subsidiary level. We focus instead on firms' average affiliate sales for which there are fewer missing values.

characteristics) or a vector of host-country dummies, θ_i denotes firm i's relative productivity (in natural logs) in a lagged period, and γ_j is the effect of productivity across host countries (which we estimate as either a vector of country dummies or a function of host-country attributes). The error term ε_{ij} captures residuals including the demand parameter from Section 2 (a_{ij}).[24]

We begin with Table 4 where we assume that the effect of TFP is uniform across countries, i.e., $\gamma_j = \gamma$ for all j, (and equivalently the effect of host-country attributes is homogeneous across firms). We find that both TFP and host-country characteristics exert a significant effect on multinationals' location decision. First, there is a positive correlation between TFP and firms' probability to have foreign subsidiaries. More productive firms are more likely than their less efficient counterparts to produce in a foreign country. This result is also robust when we include a country fixed effect in the last column of Table 4 (instead of the vector of country attributes).[25]

[Table 4 about here]

In terms of the effect of host-country attributes, we find that firms are more likely to have subsidiaries in countries with more attractive attributes as expected from the theory. For example, French firms have a greater probability to invest in countries with a larger market potential. They also tend to choose countries with a lower unit labor cost as their production locations, suggesting a significant comparative advantage motive in their investment decision. Countries with higher entry cost are less likely to be selected by French MNCs, a result that is similarly true for countries remote from France and with poor governance. Finally, both host- and home-country tariffs exert a significant effect on French firms' location choice. Consistent with the tariff-jumping motive theory, French MNCs are more likely to produce in countries

[24] Inspecting equation (16) reveals a potential negative relationship between the productivity of multinationals that self-select into a host country and the idiosyncratic demand shock (a_{ij}) captured in the error term. This is because firms with high productivity may invest in a foreign country even with relatively low draws of a_{ij} whereas low-productivity firms will need sufficiently high draws of a_{ij} to enter the same country. This negative correlation has been noted by Crozet *et al.* (2009) for the case of export decision and can lead to a downward bias to the parameter of θ_i when estimating the level of sales. While we do not perform affiliate sales estimation (at firm-country level), we address the general concern of potential correlation between productivity and error term in Section 6.2 using a control-function approach. This approach allows us to recover unobserved firm heterogeneities and control for them in the estimation of location decision.

[25] Two strategies have often been used to estimate a fixed-effect binary choice model. One can either include a vector of dummy variables in the estimation or use a conditional-logit model. The former may give rise to the incidential parameter problem that exists in Maximum Likelihood Estimators, but the associated bias is relatively small when the number of observations per group is sufficiently large (Greene, 2009) as is the case here. We considered both estimators in the paper and found the results were largely similar. The estimates presented here are obtained from the conditional-logit model. Note because of the nature of conditional-logit model, including a country fixed effect in the analysis drops out all the host countries where no French multinationals are present and reduces the sample size.

that impose a higher tariff on French exports. They also tend to prefer countries where the tariff of selling back to France is relatively low.

One result not predicted analytically is the positive correlation between the host-country corporate tax rate and multinationals' incentive to invest in a foreign country. This may reflect the possibility that the maximum official tax rate used in the paper is not the rate actually applied to foreign firms. Unfortunately, these applied tax rates are not available on a systematic basis and would substantially reduce the sample size.

Now we explore how the effect of TFP can vary across host countries. We first interact firm TFP with a vector of host-country dummies as in equation (18) and estimate both δ_j and γ_j. As in Section 2.3, suppose we can rank countries $j = 1, ..., N$ based on their cutoff productivities such that country 1 is the easiest market of all and country N is the most difficult. This would suggest that $\delta_1 > \delta_2 > ... > \delta_{N-1} > \delta_N$. If the effect of TFP diminishes in market attractiveness, we should then have $\gamma_1 < \gamma_2 < ... < \gamma_{N-1} < \gamma_N$. As shown in Figure 4, we observe a clear negative correlation between estimated country attractiveness, i.e., $\widehat{\delta}_j$, and the effect of TFP, i.e., $\widehat{\gamma}_j$. In fact, the negative relationship is significant at 1 percent level. This suggests that the effect of TFP in raising firms' ability to invest abroad is stronger in less attractive markets, i.e., markets with smaller $\widehat{\delta}_j$. In countries such as Germany, UK, Spain, Belgium, US and China where the estimated attractiveness is relatively high, the effect of TFP is relatively small.

[Figure 4 about here]

The above finding leads us to examine next how the effect of TFP varies with specific host-country attributes, i.e., how does firm productivity lead to differential effect of host-country attributes across individual firms? We proceed by interacting TFP with host-country characteristics, i.e., replacing $\gamma_j \theta_i$ in equation (18) with $\gamma \theta_i + \widetilde{\gamma} X_j \cdot \theta_i$ where X_j is the vector of host-country characteristics. As shown in Table 5, we find the impact of country characteristics varies systematically across individual firms.[26] Specifically, while a smaller market potential on average reduces multinationals' incentives to invest in a foreign country, its effect is smaller for firms with greater productivities. Based on estimates reported in column (1), for an average-productivity multinational firm the probability of investing in a foreign country is 0.8 percentage points lower when the country's market potential is 50 percent smaller than the average. This effect decreases to 0.3 percentage points for multinationals whose TFP is 100 percent greater than the average and 0.2 for firms in the top 90th percentile of productivity distribution. Firms

[26] Note, as pointed out by Ai and Norton (2003), interpreting the parameters of the interaction terms requires additional attention when a nonlinear model is used. We followed the procedure described in Ai and Norton (2003) and computed the marginal effect for firms that belong to different percentiles of the productivity distribution.

in the bottom 10th percentile are affected most: a 50-percent decrease in market potential reduces these firms' probability to invest by 1.7 percentage points. This implies that more efficient firms are more likely than their less efficient competitors to enter countries with a small market demand.

[Table 5 about here]

The effect of our various measures of fixed costs is also asymmetric across firms. While firms on average are less likely to invest in a country with high entry costs, its adverse effect is significantly smaller for more productive firms. Similarly, the effect of distance diminishes in productivity. Compared to an average-productivity firm whose probability of investing in a foreign country decreases by 0.3 percentage points when host-country distance increases by 100 percent, MNCs with twice the average TFP will only see a decrease of 0.1 percentage points. The above effect falls below 0.1 for firms in the top 90th percentile of productivity distribution but amounts to 0.5 percentage points for the least productive (i.e., 10th percentile) group.

The role of host-country tariffs in prompting firms to invest in a foreign country also varies with the productivity level. More productive firms are more likely than their less efficient rivals to invest in the foreign country with low tariffs. While the likelihood of an average-productivity MNC investing in a foreign country is 0.1 percentage points lower when tariff falls by 50 percent, it has little impact on MNCs with twice the TFP (and those in the top 90th percentile). For firms whose productivity belongs to the 10th percentile, however, it can decrease the investment probability by 0.2 percentage points. The intuition behind this result is that a lower tariff raises the expected export profit and only firms with a relatively high productivity will still find it more profitable to invest than to export. French sectoral tariffs also exert an asymmetric effect on firms' incentive to invest abroad. More productive French firms are less likely to invest abroad when the cost of exporting products back to France is high.[27] The above results remain largely robust when we include a country fixed effect and control for all country specific factors.

6 Sensitivity analysis

In this section we address the potential concern of unobserved heterogeneities and reverse causality. This is important given the main goal of this paper is to establish the causal effect of TFP on firms' location choice.

[27] This result is not part of our hypotheses as we did not endogenize the mode of supplying home country and suggests a possible extension of the analysis that is worth exploring.

6.1 New entries of multinational firms

We previously used firms' lagged productivity — estimated based on their home production activities — to explain current subsidiary locations. However, some subsidiaries may have existed before or when the TFP was observed and therefore have a spillover effect on firms' performance at home. We modify our dataset in this subsection to mitigate the possibility of reverse causality between TFP and firms' location choice. Specifically, we modify the dataset such that the set of countries available for each individual firm to set up subsidiaries includes only those where this firm has not invested before 2001 (the latest year the TFP was observed). Thus, the analysis here is focused on MNCs' decision to enter a host country market between 2001 and 2005.[28]

The estimation results are largely similar to Table 5.[29] The effect of TFP in stimulating MNC entry is stronger in countries with less attractive attributes. More productive firms are significantly more likely than their rivals to set up new subsidiaries in countries with a small market potential. They are also more likely to enter countries that require a large entry cost, are geographically distant from France, and have poor governance, all of which may lead to a large fixed cost of investment. Furthermore, countries that set relatively low tariffs also attract the entry of firms with higher TFP.

6.2 Endogeneity of TFP

The concern noted above about a possible correlation between TFP and firms' past investment activities can be generalized to a broader econometric issue, that is, the endogeneity of firm productivity. TFP is endogenous when it is correlated with the residuals of the equation, which may include either past investment activities or other unobserved firm attributes such as business networks, credit constraints or political assets. We use two approaches to address this potential concern.

First, we control for all firm characteristics with a firm fixed effect. This does not lead to significant changes in the results. More productive firms are still significantly more likely than their less efficient competitors to invest in countries with a relatively small market potential, a great fixed cost of investment and a low tariff.

Next we employ a control function approach to further address the potential endogeneity of TFP. This control function method is developed by Petrin and Train (2005, 2006) to control for

[28] We also considered an alternative modification in which we constrain the sample to include only new MNCs, i.e., firms that started investing abroad after 2001. This modification, while significantly reducing the sample size, further mitigates the possibility of reverse causality as the included firms did not have any investment activities until after 2001. The results were largely similar to what is reported here.

[29] The results are suppressed in the paper and available upon request from the authors.

unobserved factors in differentiated products models and correct for the endogeneity of prices. They exploit the information contained in the endogenous variable (e.g., prices) to recover unobserved variables, which are then used to form controls in the main estimation equation to condition out the dependence of the endogenous variable on the error term.[30] This approach has recently been adopted by Liu *et al.* (forthcoming) who use the average wage rate of state-owned enterprises as an instrumental variable to address the potential endogeneity of regional wage and its effect on MNCs' location choice in China.

Formally, our objective is to deal with the bias that exists in the following equation:

$$\Pr\left(y_{ij}=1\right)=\Phi\left(\alpha+\delta_j+\gamma_j\theta_i+\sigma_j\vartheta_i+\varepsilon_{ij}\right), \tag{19}$$

where ϑ_i represents an unobserved firm variable that is correlated with firm productivity (θ_i) and, similar to productivity, can affect firms' location decision. We proceed in two stages. First, we derive an estimate of ϑ_i based on

$$\widehat{\vartheta}_i=\theta_i-E(\theta_i|Z_i), \tag{20}$$

where Z_i is the instrument vector we use to estimate firm productivity.

Plausible instruments in this case include the average productivity of French firms in the same industry, same region or both. The motivation for using these instruments comes from the large economics literature on technology spillover, including the recent studies by Jovorcik (2004), Haskel *et al.* (2007), and Keller and Yeaple (forthcoming).[31] It is also related to studies on social interaction, such as the recent work by Guiso and Schivardi (2007) who find strong evidence of social interaction in firms' structural adjustment especially for firms in the same industry and geographic district. In light of these findings, we construct two reference groups for each French firm in the sample: (i) firms located in the same region (département) of France;[32] (ii) firms from the same SIC 4-digit industry and same region. Note our TFP measure has already been deflated by the (SIC 4-digit) industry average. We construct the two reference groups using all French manufacturing firms available from the AMADEUS database (excluding the firm of interest), which include both multinational and national firms.[33] If there exists (positive)

[30] Note that the control function approach leads to the usual IV estimator in standard linear models, but offers distinct advantages relative to the IV estimator in nonlinear models.

[31] The majority of the above studies focus on the technology spillovers from foreign MNCs to domestic firms. For our purpose here, we consider all the firms producing in France as a potential source of spillover without distinguishing the structure of their ownership.

[32] We consider firms from the same département as one geographic group. Départements, analogous to English counties, are administrative units of France and many former French colonies. Our sample consists of firms from totally 92 départements.

[33] In the construction of the instrumental variables, firms that are the only observation in their industry and

regional spillover, the productivity of an individual firm should be (positively) correlated with the productivity of its reference group (i). When there is also an intra-industry spillover (due to, for example, technology transfer), the productivity correlation should be strongest for firms that are in not only the same region but also the same industry (group (ii)).[34]

Based on the first stage, we obtain an estimate of ϑ_i, i.e., $\widehat{\vartheta}_i$. This estimate is then included in the second stage to proxy for unobserved firm heterogeneities that are correlated with TFP. In doing so, we mitigate the potential correlation between ε_{ij} and $\gamma_j\theta_i$. Formally, we estimate the following equation:

$$\Pr(y_{ij}=1) = \Phi\left(\alpha + \delta_j + \gamma_j\theta_i + \sigma_j\widehat{\vartheta}_i + \varepsilon_{ij}\right), \tag{21}$$

where $\widehat{\vartheta}_i$ is interacted with either a vector of host-country dummies or host-country attributes, i.e., X_j.

[Table 6 about here]

We find in the first stage that firm productivity is significantly and positively correlated with the average productivity of its peers in the same region. This correlation is particularly strong for peers in the same industry, even when we control for region fixed effect. In the second stage, correcting for the endogeneity does not change our estimates significantly. When we interact TFP (and $\widehat{\vartheta}_i$) with a vector of host-country dummies and estimate equation (21), we find again a negative correlation between the effect of TFP, i.e., $\widehat{\gamma}_j$, and the estimated attractiveness of the market, i.e., $\widehat{\delta}_j$, as in Section 5. In fact, the correlation becomes stronger after we control for the effect of unobserved firm heterogeneities. The above result is also supported in Table 6 where we interact TFP (and $\widehat{\vartheta}_i$) with host-country characteristics.[35] Our previous findings that more productive firms are more likely to invest in countries with a small market potential, a high fixed cost of investment, and a low tariff remain largely robust.

6.3 Unobserved host-country attributes

So far we have used country dummies in some of our estimations to control for host-country attributes. The issue of unobserved host-country attributes can still arise, however. For example,

region were dropped because of the lack of reference group (ii). This reduces the number of firms included in the sample. We also considered excluding multinational firms in the formation of reference groups. The results remain largely similar.

[34] We also considered including firm age as an additional instrumental variable and found the results remain largely similar.

[35] Because the estimation consists of fitted values obtained from an earlier stage, we use bootstrapping to correct the standard errors.

host countries' sectoral market structure is likely to exert a significant effect on multinationals' location decision and this effect is likely to vary across firms. But data on sectoral market structure is often missing and difficult to obtain for all host countries. To address this issue, we adopt a two-step procedure to construct an industry specific measure of host-market attractiveness. This approach is inspired by Head and Mayer (2004) and Head and Ries (2008), who estimate a trade and FDI equation, respectively, with origin and destination fixed effects and construct a measure of destination-market attractiveness to control for unobserved country characteristics.

The procedure proceeds in two steps. First, we estimate an FDI equation where the dependent variable is an indicator variable that equals to 1 if there is at least one multinational firm from country h and industry k investing in country j.[36] Specifically, we consider the following equation:

$$Y_{hjk} = \mu_{hk} + \delta_{jk} + \lambda\tau_{hjk} + \varepsilon_{hjk}, \tag{22}$$

where $\lambda\tau_{hjk} \equiv \lambda_1 \ln d_{hj} + \lambda_2 B_{hj}$. In the above equation, μ_{hk} represents the home country-industry fixed effect, δ_{jk} represents a vector of host country-industry dummies, and τ_{hjk} is a vector of bilateral market access variables including distance (d_{hj}) and contiguity (B_{hj}). The dataset we use to estimate equation (22) is obtained from AMADEUS and includes the original EU 15 members as home countries and 127 EU and non-EU countries as host countries. One of the motives to consider EU members as home countries is the uniform trade policy they set on foreign countries and the uniform treatment they receive. This means that δ_{jk} will capture not only host-country specific attributes, such as market size, production cost and market structure, but also bilateral trade policy variables that do not vary across EU, such as host-country tariffs on EU members and EU's external tariffs on a foreign country.

[Table 7 about here]

In the second step, we use the estimates of δ_{jk} obtained from the first step, i.e., $\widehat{\delta}_{jk}$, as an industry specific measure of host-market attractiveness, to estimate individual French MNCs' location decisions. As shown in Table 7, the parameters of $\widehat{\delta}_{jk}$ and $\widehat{\delta}_{jk} \cdot \theta_i$ are both significant. French firms are more likely to invest in countries with a greater (estimated) attractiveness. But this effect is significantly smaller for more productive firms, as indicated by the negative parameter of $\widehat{\delta}_{jk} \cdot \theta_i$. This again implies that firms with a higher productivity have a greater probability to enter tough markets.

[36] We also considered the number of multinationals and the total volume of affiliate sales (from country h, industry k and investing in country j) as alternative dependent variables and found the results qualitatively similar.

7 Conclusion

Foreign direct investment and firm heterogeneity are two prominent research areas that have attracted a substantial amount of attention from both economists and policy makers. We contribute to these strands of literature by examining the interplay of country asymmetry and firm heterogeneity in determining multinationals' location decisions—how firms' differences in productivity can lead to distinct choices of foreign production locations.

We find, at both the aggregate- and firm-level, that there is a systematic relationship between firm productivity and selection of foreign production location. The aggregate-level evidence indicates that the productivity of French MNCs varies significantly across host countries. Markets with less attractive attributes, including a relatively small market potential, a high unit labor cost, a large fixed cost of investment and a low import tariff, tend to have higher cutoff productivities and attract a greater proportion of productive multinationals. Furthermore, the productivity distribution of firms that invest in these countries first-order stochastically dominates those that invest in easy markets.

These findings are also supported by the firm-level evidence. We find that firms' choice of host countries varies significantly with their total factor productivity. More productive firms are significantly more likely to invest in countries with a small market potential, high entry barriers and large fixed costs of investment. The probability of investing in countries that set relatively low tariffs is also higher for these firms.

To establish the causal effect of TFP, we perform a number of sensitivity analyses. First, we seek to mitigate the concern of reverse causality by limiting the analysis to new entries of multinationals. Second, we address the potential endogeneity of firm productivity using a control function approach. In this approach, we pair each French multinational firm with respective reference groups, formed by other French national and multinational firms in the same region and the same industry, and use the average productivity of the reference groups as instruments. The causal effect of productivity on multinationals' location decision remains largely robust—firms with varied productivity are systematically sorted into different types of host markets. Finally, we construct an industry-specific measure of host-country attractiveness to control for unobserved country attributes. We find the results are qualitatively similar.

These findings convey an important message to host-country policy makers: Changes in investment or trade policies will affect not only the volume of foreign direct investment but also the productivity distribution of multinational firms that decide to enter the host country. For example, an increase in tariffs may in fact stimulate FDI but does so by increasing the entry of less productive firms. To the extent that there might be domestic productivity spillovers from foreign MNCs, it is crucial to be aware that the productivity composition of multinationals is not homogeneous and there can be decreasing returns to using trade policy as means of attracting multinational firms.

While this paper focuses on exploring the role of firm heterogeneity in multinationals' location decision, it can be extended in two main directions. First, like the majority of the literature, this paper has assumed that a firm's decision to invest in one location is independent of their locations in third countries. This assumption is increasingly challenged by real world observations as more multinational firms adopt complex integration strategies. For example, many firms today engage in export-platform FDI, in which case the decision to invest in a foreign country does not only depend on the costs of exporting to that country from multinationals' home but also the costs of exporting from subsidiaries abroad. Blonigen *et al.* (2007) and Baltagi *et al.* (2007), who investigate third-country effects in the pattern of U.S. outward FDI, are two leading studies in this area. However, firm-level evidence obtained with detailed information on individual MNCs' subsidiary network is still largely missing.

Second, most analyses in this area have treated multinationals' location decision as static, despite the fact that firms often adjust their location choices by expanding in new markets and contracting in less attractive locations. While this paper has examined the entry of multinational firms into new host countries (in Section 6.1) as an attempt to disentangle the causality between productivity and location choice, the relationship between firm productivity and location adjustments is a question that can be further explored with the facilitation of additional time series data.

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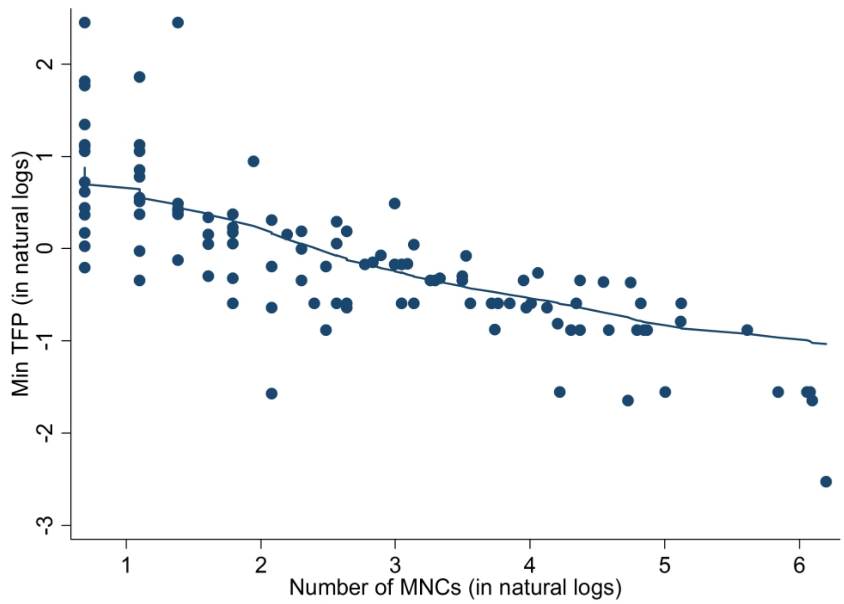

Figure 1: The relationship between host-country popularity and minimum TFP (with lowess smoother)

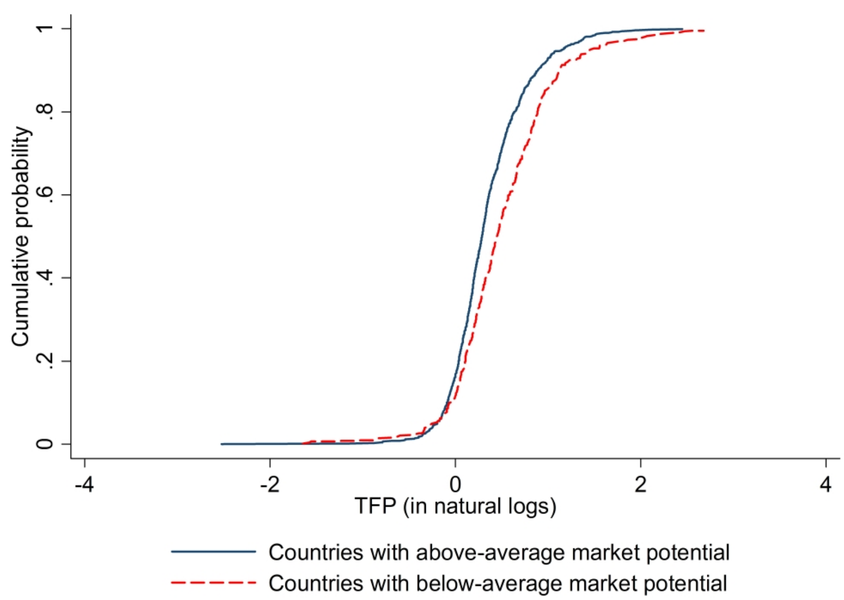

Figure 2: Host-country market potential and MNC productivity distribution

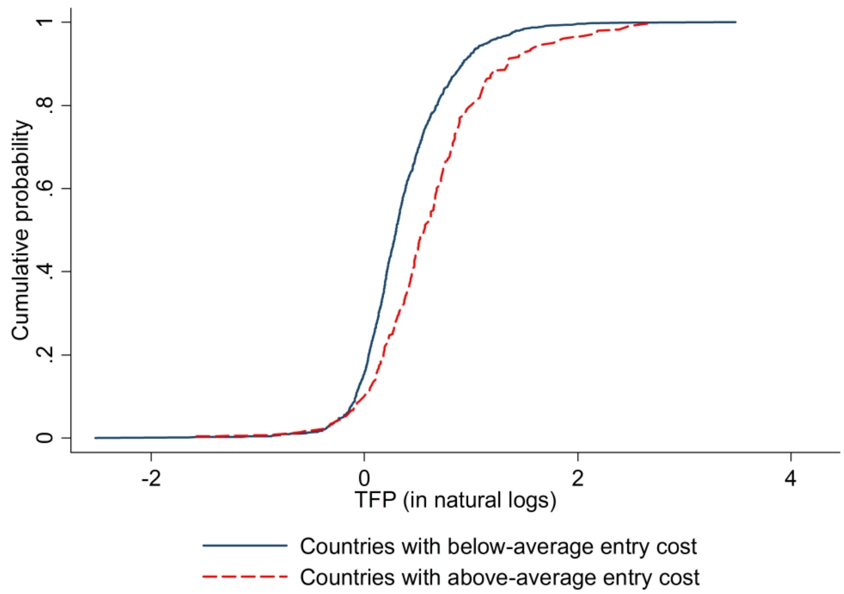

Figure 3: Host-country entry cost and MNC productivity distribution

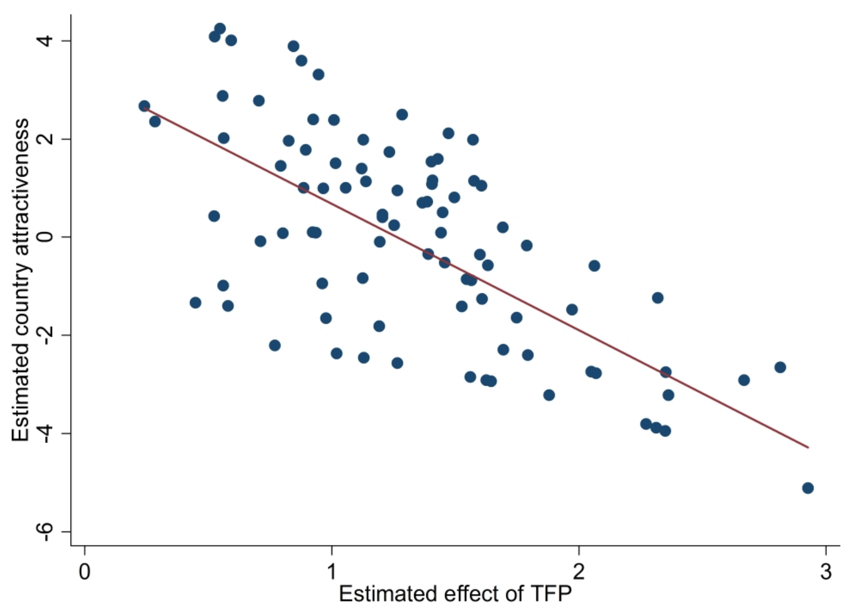

Figure 4: The relationship between the estimated effect of TFP and country attractiveness

Table 1: Summary Statistics

Variables	Source	Mean	Std. dev.	Min	Max
location	AMADEUS	0.02	0.14	0	1
market potential	WDI, CEPII	22.6	0.56	21.7	24.2
unit labor cost	World Bank	0.15	0.07	0.002	0.52
labor intensity	AMADEUS	0.66	0.19	0	0.99
corporate tax	Office of Tax Policy Research	-1.21	0.27	-2.41	-0.61
entry cost	WDI	3.35	1.52	0	7.16
distance	CEPII	8.29	0.93	5.57	9.85
contiguity	—	0.04	0.20	0	1
EU	—	0.17	0.37	0	1
governance	POLITY	0.13	0.99	-2.16	2.28
host-country tariff	COMTRADE	1.77	1.26	0	5.56
home-country tariff	COMTRADE	0.50	0.78	0	3.71

Note: All variables except location, contiguity, and EU are in natural logs.

Table 2: Minimum and average TFP

Dependent variable	H_0	min TFP		ave TFP	
		coef.	s.e.	coef.	s.e.
market potential	−	-0.06***	(0.02)	-0.04**	(0.02)
unit labor cost	+	0.62**	(0.33)	0.53**	(0.27)
corporate tax	+	0.01	(0.04)	-0.03	(0.04)
entry cost	+	0.05***	(0.01)	0.03**	(0.01)
distance	+/−	0.07***	(0.02)	0.06***	(0.02)
contiguity	+/−	-0.36***	(0.04)	-0.14***	(0.02)
EU	+/−	0.13***	(0.04)	0.08*	(0.04)
governance	−	-0.02	(0.02)	-0.04*	(0.02)
host-country tariff	−	-0.02*	(0.01)	-0.02*	(0.01)
home-country tariff	+	-0.002	(0.02)	-0.02	(0.02)
industry fixed effect		yes		yes	
No. of observations		1,724		1,724	
R square		0.50		0.74	
Prob>F		0.00		0.00	

Notes: (i) robust standard errors are reported in the parentheses; (ii) ***, **, and * respectively represent significance at 1%, 5%, and 10%; (iii) GLS estimates are reported for ave TFP.

Table 3: Firm-level decisions

Dependent variable	H_0	ave affiliate sales		num of countries	
		coef.	s.e.	coef.	s.e.
TFP	+	2.62***	(0.19)	3.26***	(0.57)
No. of observations		1,302		1,302	
R square		0.18		0.10	
Prob>F		0.00		0.00	

Notes: (i) robust standard errors are reported in the parentheses; (ii) ***, **, and * respectively represent significance at 1%, 5%, and 10%; (iii) OLS estimates are reported.

Table 4: Effect of TFP and host-country attributes on subsidiary locations

Dep. variable: location	H_0	(1)		(2)	
		coef.	s.e.	coef.	s.e.
TFP	+	1.07***	(0.14)	1.15***	(0.08)
market potential	+	0.46***	(0.04)		
unit labor cost	−	-6.09***	(1.24)		
labor intensity	+	0.52	(0.41)	0.61*	(0.37)
unit labor cost × labor intensity	−	-2.01	(1.90)	-2.53	(2.63)
corporate tax	−	0.25***	(0.09)		
entry cost	−	-0.43***	(0.02)		
distance	+/−	-0.42***	(0.04)		
contiguity	+/−	2.06***	(0.06)		
EU	+/−	-0.85***	(0.09)		
governance	+	0.47***	(0.03)		
host-country tariff	+	0.08***	(0.02)	-0.13	(0.10)
home-country tariff	−	-0.15**	(0.06)	-0.07	(0.07)
country fixed effect		no		yes	
No. of observations		85,328		79,236	
Log pseudo-likelihood		-11,576.4		-10,423.3	
Pseudo R square		0.17		0.22	

Notes: (i) standard errors are clustered at firm level and reported in the parentheses; (ii) ***, **, and * respectively represent significance at 1%, 5%, and 10%; (iii) Logit estimates are reported.

Table 5: Asymmetric effect of TFP and host-country attributes on locations

Dep. variable: location	H_0	(1)		(2)	
		coef.	s.e.	coef.	s.e.
TFP	+	1.06	(2.18)	2.61	(2.66)
market potential	+	0.54***	(0.07)		
unit labor cost	−	-5.50***	(1.85)		
labor intensity	+	0.85**	(0.46)	0.90**	(0.48)
unit labor cost × labor intensity	−	-3.98**	(2.21)	-4.18*	(2.37)
corporate tax	−	0.35***	(0.15)		
entry cost	−	-0.52***	(0.03)		
distance	−	-0.63***	(0.06)		
contiguity	+	2.30***	(0.11)		
EU	+/−	-0.81***	(0.13)		
governance	+	0.47***	(0.05)		
host-country tariff	+	0.19***	(0.04)	-0.02	(0.06)
home-country tariff	−	0.04	(0.08)	0.14	(0.09)
TFP×					
market potential	−	-0.12*	(0.07)	-0.15*	(0.09)
unit labor cost	+	0.74	(0.83)	0.26	(0.93)
corporate tax	+	-0.15	(0.15)	-0.05	(0.14)
entry cost	+	0.13***	(0.03)	0.11***	(0.04)
distance	+	0.33***	(0.06)	0.27***	(0.07)
contiguity	−	-0.40***	(0.15)	-0.48***	(0.16)
EU	+/−	-0.05	(0.15)	-0.21	(0.18)
governance	−	0.00	(0.05)	0.06	(0.08)
host-country tariff	−	-0.16***	(0.04)	-0.16***	(0.04)
home-country tariff		-0.28***	(0.12)	-0.35***	(0.14)
country fixed effect		no		yes	
No. of observations		85,328		79,236	
Log pseudo-likelihood		-11,511.8		-10,513.5	
Pseudo R square		0.17		0.23	

Notes: (i) standard errors are clustered at firm level and reported in the parentheses; (ii) ***, **, and * respectively represent significance at 1%, 5%, and 10%; (iii) Logit estimates are reported.

Table 6: Endogeneity of TFP: control function approach (stage 2)

stage 2: location	H_0	(1)		(2)	
		coef.	s.e.	coef.	s.e.
TFP×					
market potential	−	-0.06*	(0.03)	-0.28**	(0.15)
unit labor cost	+	3.26	(3.64)	1.05	(1.06)
corporate tax	+	0.32	(0.69)	-0.05	(0.28)
entry cost	+	0.48***	(0.19)	0.10	(0.08)
distance	+	0.54**	(0.27)	0.39***	(0.11)
contiguity	−	-1.07***	(0.45)	-0.19	(0.18)
EU	+/−	0.52	(0.67)	0.26	(0.27)
governance	−	-0.21	(0.30)	0.11	(0.13)
host-country tariff	−	-0.49***	(0.17)	-0.23***	(0.06)
home-country tariff		-0.53*	(0.30)	-0.37***	(0.12)
$\hat{\xi}_i X_{ij}$		yes		yes	
firm fixed effect		yes		yes	
No. of observations		79,933		79,933	
Log pseudo-likelihood		-7,487.3		-7,486.3	
Pseudo R square		0.22		0.22	

Notes: (i) standard errors are clustered at firm level and reported in the parentheses; (ii) ***, **, and * respectively represent significance at 1%, 5% and 10%; (iii) Logit estimates are reported.

Table 7: Unobserved country sectoral characteristics

Dep. variable:	H_0	location		entry	
		coef.	s.e.	coef.	s.e.
TFP		1.18***	(0.09)	1.05***	(0.09)
estimated attractiveness		0.14***	(0.03)	0.14***	(0.02)
distance		—			
contiguity		—			
TFP×					
estimated attractiveness	−	-0.08***	(0.03)	-0.14***	(0.04)
distance	+	0.002**	(0.001)	0.006***	(0.001)
contiguity	−	-0.04***	(0.01)	-0.13***	(0.04)
country fixed effect		yes		yes	
No. of observations		114,600		109,153	
Log pseudo-likelihood		-11,273.5		-9,825.3	
Pseudo R square		0.05		0.05	

Notes: (i) standard errors are clustered at firm level and reported in the parentheses; (ii) ***, **, and * respectively represent significance at 1%, 5% and 10%; (iii) Logit estimates are reported.