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The effects of cultural distance on multi-unit firms

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The effects of cultural distance on multi-unit firms

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Preliminary working paper.

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Abstract

In this paper we develop a model to analyze the effects of (country-pair-specific) costs of creating, transferring and accessing intangible assets for multi-unit firms. These costs might vary with the cultural distance between countries, such as the difference in language, work ethics or other moral values. We argue that these costs are an important factor to explain why most firms are single unit firms, most multi-unit firms have only one affiliated unit and why multinational firms are only a tiny fraction of all firms in a country. Therefore, we develop a model with heterogeneous firms that produce differentiated goods in different firm units. The number of units depends on the costs of transferring intangible assets. If these costs are relatively high, most firms will be single unit firms. Furthermore, if costs of transferring intangible assets to an affiliated firm in a foreign country are even higher, only the most productive firms will be multinational firms. Additionally, multinational firms will be open more affiliated firms in countries that are culturally closer to their home country. These findings square with stylized facts and estimation results presented in the paper.

JEL classification : F23, L11, L25

Key Words : MNC, MNE, Outsourcing, Organizational capital

1 Introduction

Intangible assets are not only an important component of firms' overall assets but they contain vital components ranging from organizational and managerial capital to knowledge as well as intellectual property and corresponding rights. Earlier research pointed to a key role of intangibles for the choice of the integration of firms as multi-product and multi-plant units (see Audia et al., 2001; Head and Ries, 2008; Nocke and Yeaple, 2013) and as national (and potentially exporting) versus multinational units (see Carr et al., 2001; Markusen, 2001, 2004; Markusen and Maskus, 2008; Awokuse et al., 2012; He and Maskus, 2012; Gumpert, 2014). One key insight of this literature is that the degree to which intangibles are available to all product lines and production units (domestic or foreign) in a firm strongly depends on the firms' costs of creating, accessing and transferring them. In this paper we argue that the costs of transferring or accessing intangible assets are country-pair-specific depending on cultural factors, such as language, work ethics or other moral values, i.e. the cultural distance, see Siegel et al. (2013).

In contrast to Grossman and Helpman (2005) and Grossman and Rossi-Hansberg (2012) these country-pair-specific costs of transferring intangibles introduce an additional trade-off (besides general production costs differentials and trade costs) for firms in their decision to locate production in foreign countries. We argue that these costs are an important factor to explain the structure and location decisions of multi-unit firms.¹

Based on Eckel and Neary (2010), Arkolakis and Muendler (2010), Nocke and Yeaple (2013) and Mayer et al. (2014) we develop a tractable (heterogenous) multi-unit firm model, in which (parent) firms face monopolistic competition and decide to expand their product (variety) scope by open new plants and in which country they allocate them.² Intangible assets are an input in the production of each variety, increasing intangibles in an affiliated firm, decreases the marginal costs of production for this variety. Costs of accessing intangible assets increases with the number of plants in a country and additionally has a country-pair-specific component. Thus, it becomes more expansive for the firm to extend their scope in terms of intangible assets, and marginal costs of production are increasing for each additional affiliated firm of the (parent) firm. At some point the marginal costs of an additional domestic affiliated firm are higher than producing this variety in a foreign country. Thus, it is optimal for the (parent) firm to operate affiliated firms in a foreign country, being a multinational

¹This can reconcile the behavior of multinational firm from rich countries that operate most of their plants in foreign countries with relative high GDP and GDP per capital, see Antràs and Yeaple (2015). In general countries that are very culturally very similar have as well similar per capita incomes.

²In the paper we use product, affiliate firm or plant as synonymes, hence we assume that an affiliated firm has one plant that produces one product.

firm.

Within the model we show that almost all firms in a country are single-unit firms, while domestic multi-unit firms and multinational firms represent only a tiny fraction of firms in a country, see Bernard et al. (2010) and Bernard et al. (2011). The scope of multi-unit firms is very small, typically additionally unit. Moreover, we find that more productive firms produce more output, have more affiliates, higher sales, and earn higher profits. This is consistent with Helpman et al. (2004) who find that only the most productive firms operate units in foreign countries, are multinational firms. As in Caliendo and Rossi-Hansberg (2013) changes in exogenous variables such as entry costs, wages and the possibility to produce in foreign countries changes the allocation of intangible assets and the structure of firms in the economy. Entry costs for firm, setup costs of varieties and costs of accessing intangible assets, have strong effects on the entry decision as well as the firm-plant distribution. Allowing for foreign production increases number of firms in the market and increases competition as firms can introduce cheaper products produced in the foreign country. Having plants in foreign countries makes firms more profitable, which in turn makes entry more attractive. We can decompose the domestic and foreign profits, as well as sales. Last, we show that unit costs are an important factor in the location decision of firms – entering a foreign market and how many affiliated firms to have in the foreign market. Nevertheless, bilateral cultural distance is as well an important factor.

The predictions of the theoretical model squares with many empirical features of the firm (plant) distributions observed in a wide set of countries. In the paper we present some stylized facts for the distribution of parent firms in selected European countries as well as an empirical estimation of the determinants to enter a foreign country and how many affiliated firms to operate in the foreign country.

The paper is structured as follows: Section 2 presents some descriptive statistics about multinational firms. In section 3 we develop a multi-product (multi-plant) model for a country in autarky and we numerically solve the model in autarky and show how changes in key variables change the distribution of plants per firm as well as the entry decision. In section 4 we introduce a second country focus on the outsourcing decision of the firm. Again we numerically solve the model for the two country case. Section 5 shows how the model can be extended for multiple countries. Section 6 presents some empirical results. Finally, section 7 concludes.

2 Stylized Facts

2.1 Definition of firm types

In this section we present some stylized facts about single- versus multi-unit parent firms to motivate key features of the theoretical model.³

We use Amadeus data from the Bureau van Dijk and our analysis is based on parent firms with their headquarters in Europe. Moreover, we restrict our sample to manufacturing firms which identify their main activity as to fall in divisions 10 to 34 of the Nace Rev. 2 industry classification. We define a multi-unit (parent) firm as one that has controlling power over at least one legally independent firm.⁴ We consider three types of firms: no-affiliate parent firms (national enterprise parent-only, NEP); parent firms with only domestic affiliates (national enterprise with domestic affiliates, NEA); and multinational firms with at least one foreign affiliate (MNE). We assume that affiliates correspond to production units and varieties. In this sense, we consider the number of production units (parent plus affiliates) to be reflective of the multi-product or multi-variety operations of firms. We use the expression *firm*, when referring to the consolidated firm, which includes all affiliated firms, while the term *parent firm*, only refers to the part of the firm that controls all affiliated, usually the headquarter.

2.2 Prevalence of firm types in the data

In this subsection, we present statistics for parent firms in selected European countries for the year 2007 in Table 1. In that table, we present the number of (parent) firms by country in the Amadeus data set in the column *Obs.*. In columns *NEP*, *NEA*, and *MNE* we present percentages of all parent firms which belong in the groups of national enterprises which are parents only and do not control affiliates, national enterprises which control only domestic affiliates, and multinational enterprises, respectively.

According to the data utilized in Table 1 most European parent companies with their main activity in manufacturing do not control affiliated firms at all, i.e., they are NEPs.⁵ In all countries but Great Britain and Germany, the percentage of single-unit NEPs is over 95%. Multinational firms (MNEs) constitute only a very small percentage in the sample, being well below one 1% in most countries. This reconciles with findings of Bernard et al. (2010) and Barefoot and Mataloni (2011), who report that only 0.5% of all firms are MNEs in the

³Yeaple (2013) focuses mostly on US multinational firms, while we show that most of the findings can be applied to a broad set of developed countries. Moreover, we emphasize the difference between single-unit and multi-unit firms.

⁴Parent firms are defined by their dispersed ownership, i.e., no other firm has a controlling interest in the firm and, hence, the firm is formally *independent* in its decisions. Additionally we consider firms that are owned by one known individual or family as *independent* as well.

⁵Notice that this is evident from the table, even though the data underlying it clearly over-represent larger firms which should have a higher propensity of the multi-unit type (either an NEA or an MNE).

United States.

Country	Obs.	Percentage of		
		NEPs	NEAs	MNEs
Austria	719	95.27	2.78	1.95
Switzerland	7902	99.66	0.01	0.33
Germany	9182	91.88	6.55	1.57
Spain	15898	98.90	0.62	0.39
Finland	2295	99.31	0.59	0.10
France	12193	98.95	0.54	0.40
Great Britain	6317	92.39	6.53	1.08
Croatia	1598	99.38	0.18	0.44
Hungary	4928	99.13	0.85	0.02
Italy	22741	99.45	0.19	0.36
Lithuania	5135	99.96	0.04	0.02
Netherlands	8679	99.67	0.18	0.15
Poland	2150	98.65	1.03	0.33
Portugal	5717	99.21	0.62	0.17
Romania	4329	98.96	0.95	0.09
Sweden	3658	99.23	0.36	0.41
Slovenia	2608	99.81	0.04	0.15
Weighted average		99.32	1.32	0.47

Table 1: Shares of (manufacturing) NEPs, NEAs and MNEs in selected European countries. Year 2007. Amadeus Data.

2.3 Multi-unit firms in the data

We analyse some further details on the frequency of multi-unit firms in more detail for German (DE), Spanish (ES), French (FR), and English (GB) parents.⁶ Figure 1 shows the distribution of firms by total number of affiliates, conditional on having at least one affiliate. For all four countries, about 50% of all multi-unit firms (NEAs and MNEs) control only one affiliated firm. The frequency of multi-unit firms declines drastically with the number of affiliates controlled in all four countries considered. This pattern is similar for parents with domestic affiliates only (NEAs) in Figure 2 and for parents with at least one foreign affiliate (MNEs) in Figure 3.⁷ Overall, the distribution of firms with affiliated firms is severely positively skewed (with a long right tail of the distribution).

Not surprisingly, the pattern of foreign affiliates held per MNE supports a similar pattern of host countries, where those foreign affiliates are held. Figure 4 shows distribution of numbers of foreign host countries in which MNEs are active.

MNEs do not only control affiliated firms abroad but also at home. Figure 5 shows a scatter

⁶The (absolute) number of firms with at least one affiliate is very small for most countries in our data-set. For illustrative reasons we focus on these four major European economies.

⁷Notice that we count only foreign affiliates with MNEs in Figure 3.

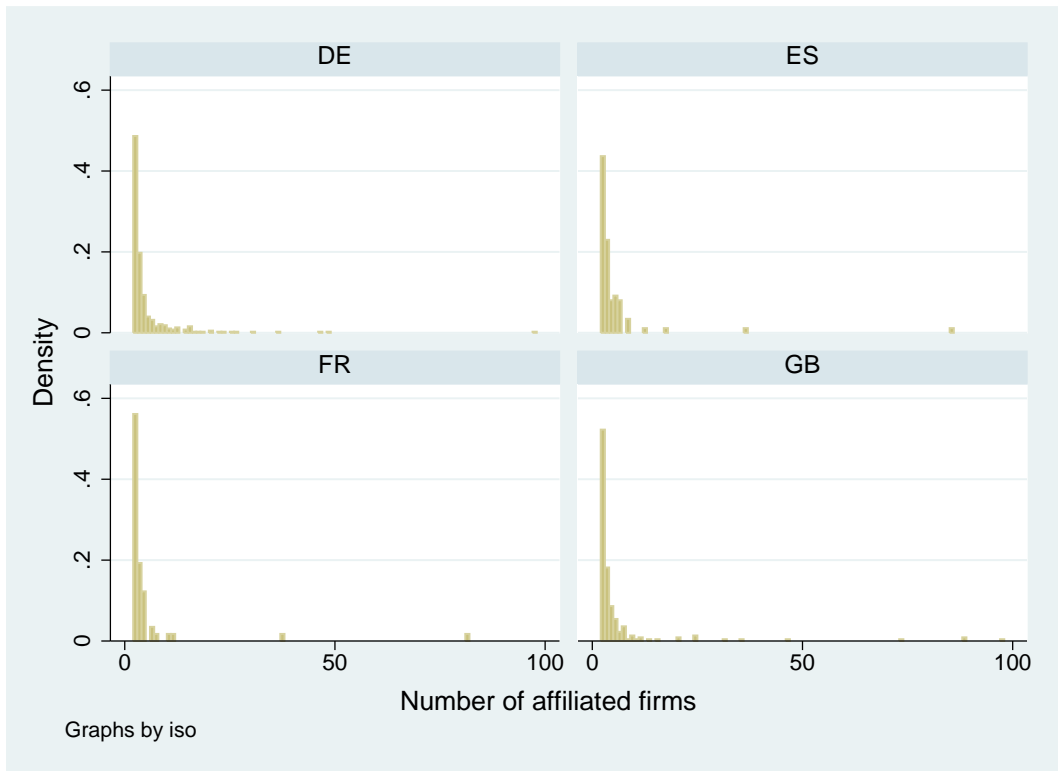


Figure 1: Number of affiliated firms per NEA and MNE. Manufacturing parent firms only. Truncated at 100 affiliated firms. Year 2007.

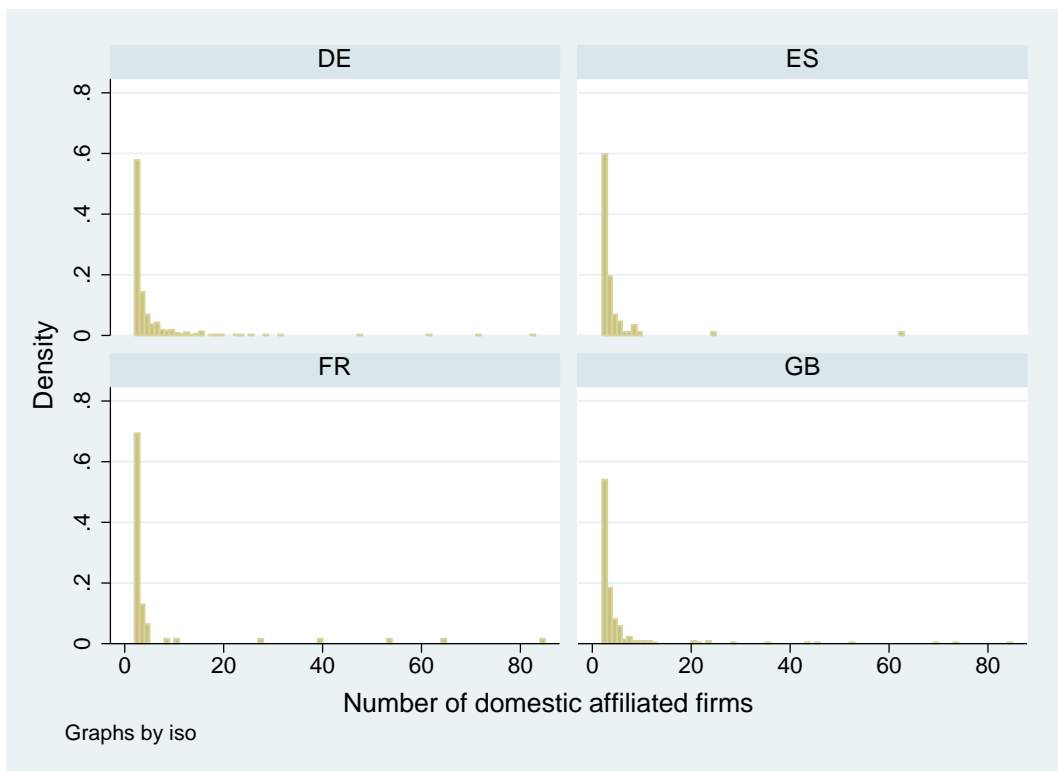


Figure 2: Number of affiliated firms per NEA. Manufacturing parent firms only. Truncated at 100 affiliated firms. Year 2007.

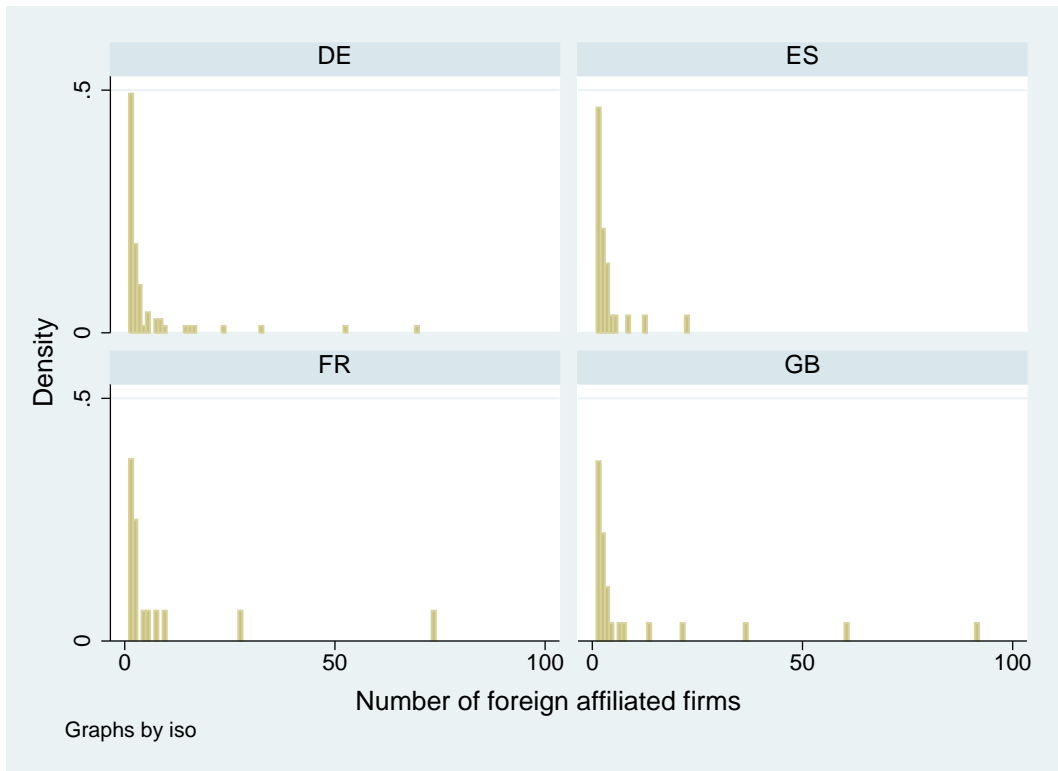


Figure 3: Number of foreign affiliates per MNE. Manufacturing parent firms only. Truncated at 100 affiliated firms. Year 2007.

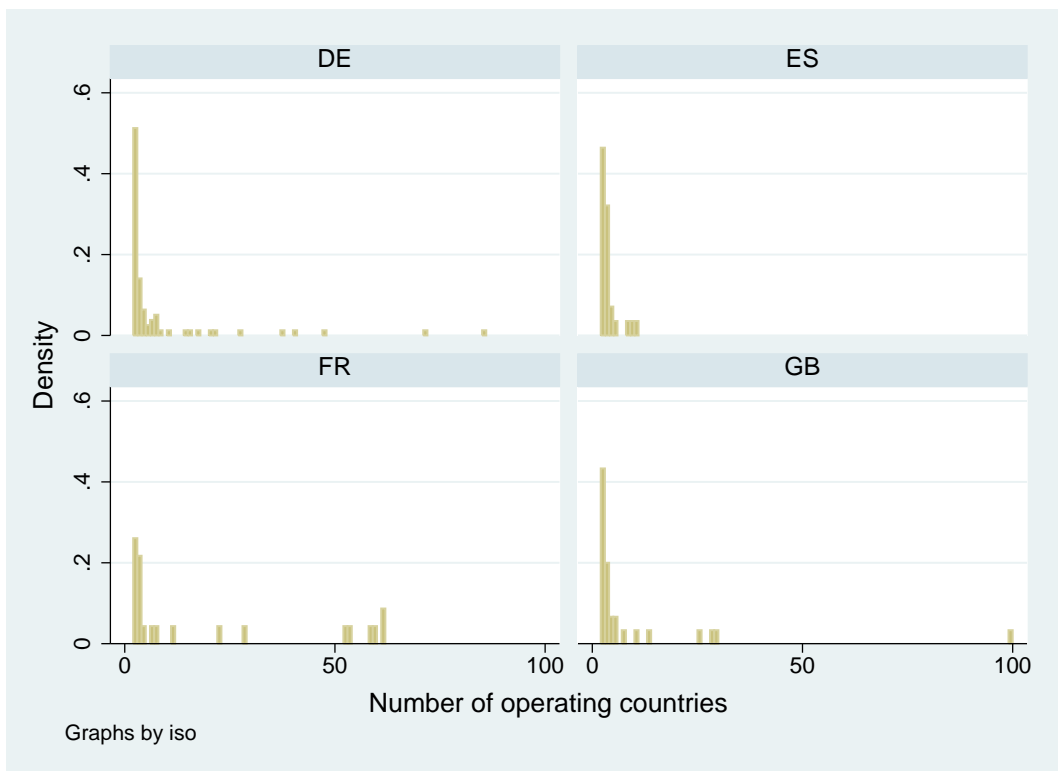


Figure 4: Number of foreign host countries per MNE. Manufacturing parent firms only. Truncated at 100 countries. Year 2007.

plot of the number of domestic affiliates against the number of foreign affiliates for MNE parents in France, Germany, Great Britain, and Spain. Clearly, there is a strong and positive correlation (83.94%) between the domestic and foreign affiliates held per firm. Hence, while engaging in offshoring to some extent, MNEs hold a considerable part of the affiliated firms and, in turn, of their production, in the home country.

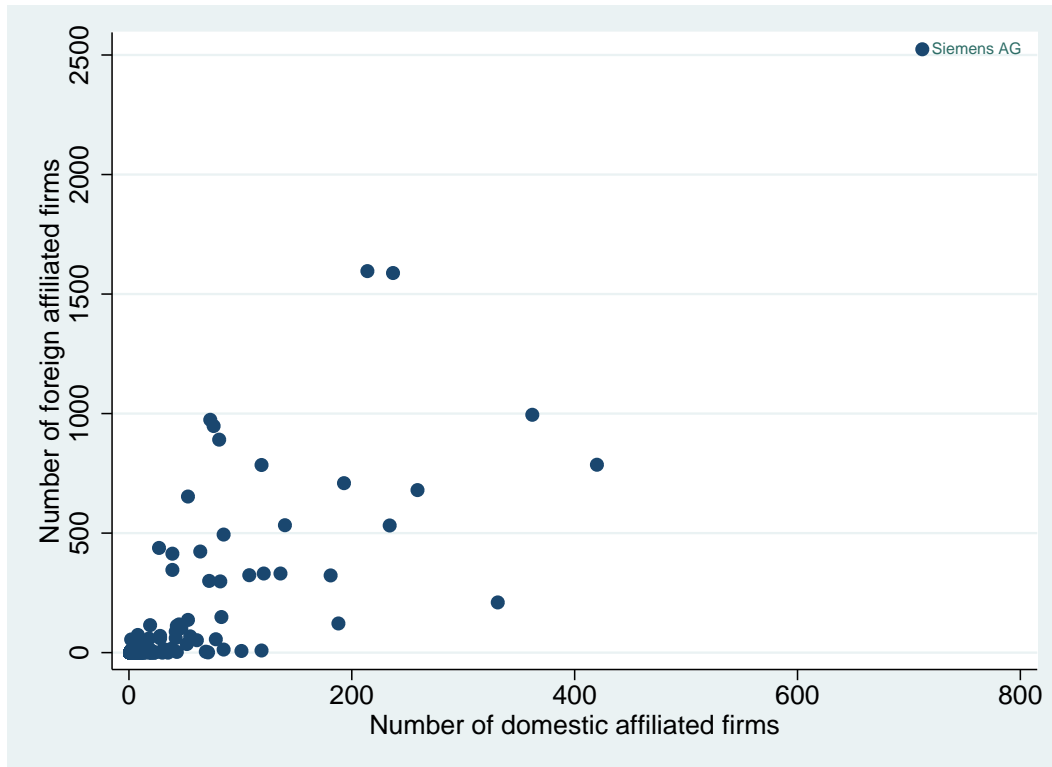


Figure 5: Number of domestic versus foreign affiliated firms for France, Germany, Great Britain, and Spain. Manufacturing parent firms only. 2007.

To summarize, most parent firms are single-unit operations. MNEs represent only a tiny fraction of firms in all countries in our data. Since most MNEs control only a single foreign affiliate, they also operate in only one foreign country.

2.4 Productivity across firm types

The literature on extensive firm margins and globalization emphasizes the importance of productivity. According to that literature, only the most productive firms engage in foreign-affiliate ownership (see Helpman et al., 2004).⁸ Figure 6 plots the productivity of a parent

⁸We construct our measure of productivity as follows. First, we compute country- and industry-specific markup, $\mu_{jl} = \frac{\text{Sales}_{jl}}{\text{Sales}_{jl} - \text{Profit}_{jl}}$, where Sales_{jl} and Profit_{jl} are the average sales and (gross) profits of firms in country j and industry l . Second, we construct for each firm i the $\widehat{\text{Sales}}_i$ based on the observed Profit_i and the country- and industry-specific markup, $\widehat{\text{Sales}}_i = \frac{\text{Profit}_i}{\mu_{ol}}$. Third, labor productivity is given by $\frac{\widehat{\text{Sales}}_i}{\text{Workers}_i}$, where Workers_i is the number of workers employed in the firm i . All variables are taken from the balanced sheet data provided in the Amadeus data.

firm against the total number of affiliates of this firm. Apparently, the number of affiliated firms per parent firm is positively correlated with the level of productivity of the parent firm. Domestic firms NEPs and firms with only domestic affiliated firms (NEAs) display the lowest level of productivity in general.⁹ MNEs tend to have the higher productivity levels. Thus, only the most productive firms have foreign affiliated firms.

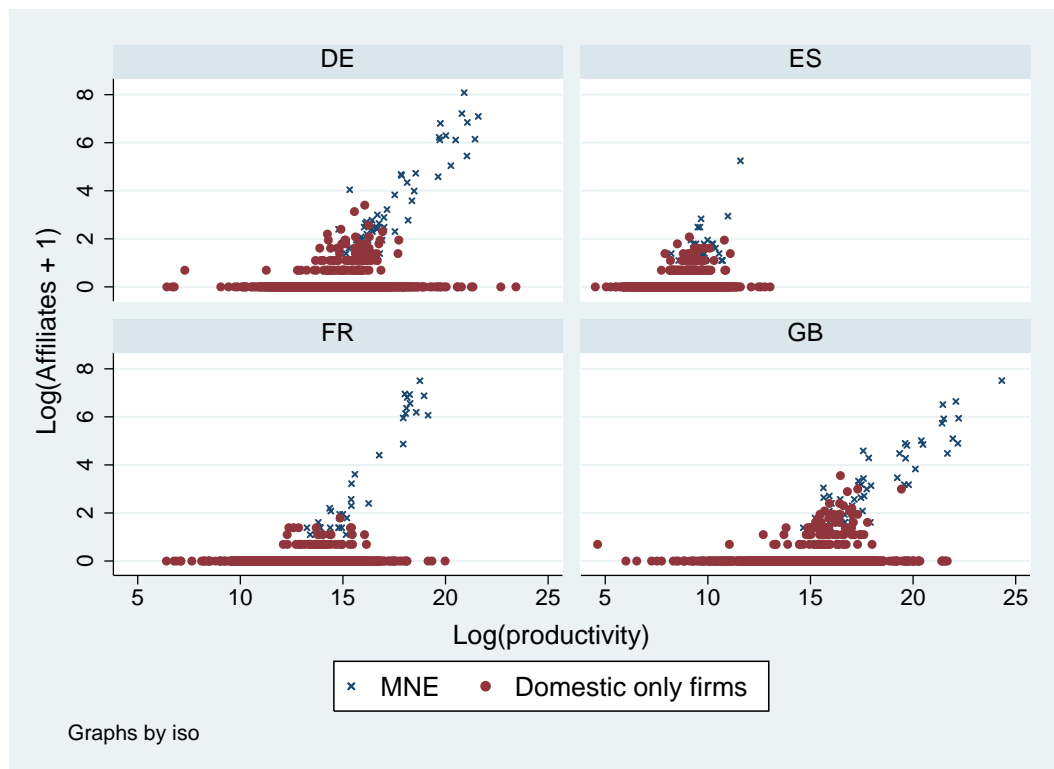


Figure 6: Log number of firms and log productivity of parent firms by country and firm type. Manufacturing parent firms only. France, Germany, Great Britain, and Spain. 2007.

Following the proximity-concentration hypothesis, see Markusen (1984) and Brainard (1997), parent firms run foreign affiliates to save transportation costs, when entering foreign markets. The latter flows from the single-product property of MNEs in those models, where the parent and affiliated firms produce the same variety (see Markusen, 1984; Markusen and Venables, 2000). In reality, a great share of firms are of the multi-product type (see Gorecki, 1975; Bernard et al., 2010), and affiliated firms produce different varieties from the parent firm (see Markusen and Maskus, 2008). Considering the four-digit level aggregation of Nace Rev. 2 divisions, almost 70% of all foreign affiliates operate in a different sector from their parent. Clearly, when using higher industry aggregations, this percentage decreases, but exceeds 40% even when using the two-digit aggregation level.¹⁰ Thus, more productive firms are more

⁹Note that the Amadeus data provides only an incomplete list of links between independent parent firms and affiliated firms. Thus, some of the observations with high productivity and without affiliated firms could be a type II error.

¹⁰However, notice that some of the four-digit categories within the same three-digit division are already

likely to be multi-product firms, as suggested by Grossmann (2007).

3 Model in autarky

In this section we develop a model for NEPs and NEAs under autarky. Parent firms do not decide about the location but only on the number of affiliated firms at home (domestic scope). This basic model is similar to Eckel and Neary (2010) and Nocke and Yeaple (2013). In two subsequent sections we extend the model to account for two or even (countably) many countries. Then, parent firms will have to decide upon both the (domestic and foreign) location as well as the number of affiliates.

3.1 Outline

Utility:

All individuals in the economy have the following utility function:

$$U = u(x)^\gamma u(b)^{1-\gamma}, \quad (1)$$

where $u(b)$ represents the utility received from consumption of a good b that is produced by an outside sector at constant returns to scale, and $u(x)$ is an aggregator function with constant elasticity of substitution (CES) over a set Ω of products:

$$u(x) = \left(\int_{(\varphi, g) \in \Omega} x(\varphi, g)^{\frac{\sigma-1}{\sigma}} d(\varphi, g) \right)^{\frac{\sigma}{\sigma-1}}, \quad (2)$$

where $\sigma > 1$ is the elasticity of substitution between varieties and $x(\varphi, g)$ indicates a variety g that is produced by a firm at labor productivity φ .¹¹ Ω is the set of all available varieties produced by all firms in the economy. The (residual) budget constraint is

$$\int_{(\varphi, g) \in \Omega} x(\varphi, g) p(\varphi, g) d(\varphi, g) \leq \gamma Y, \quad (3)$$

where the share of total income spent on x -varieties is given by γ and $Y = wL$ is total income of all individuals in the economy. Notice that wL is fixed since the wage rate w is pinned down by the constant returns to scale outside sector, and L is the constant total labor in

considerably different. E.g., firms in sector Nace Rev. 2 2822 produce lifting and handling equipment such as cranes or escalators, while firms in sector 2823 produce office machinery and equipment such as cash registers, photocopy machines, etc. Moreover, affiliated firms do not only operate in a different industry as their parent firm, but industry classifications are as well dispersed among affiliates, as we show in the Appendix.

¹¹As productivity will be a continuous measure that varies across parent firms, φ can be interpreted as a parent firm index. Moreover, we take also g as a continuous variable.

the economy. The demand for a variety is given by

$$x(\varphi, g) = \frac{p(\varphi, g)^{-\sigma}}{P^{1-\sigma}} \gamma Y, \quad (4)$$

where $P = \left(\int_{(\varphi, g) \in \Omega} p(\varphi, g)^{1-\sigma} d(\varphi, g) \right)^{\frac{1}{1-\sigma}}$ is the common price index.

Firms:

There are two types of firms: NEPs that only have one production site at the location of the parent firm (being single-unit firms), and NEAs that have one or more affiliated firms in addition to the parent firm. NEPs will only produce one variety, while NEAs will be multi-product firms with the number of products or varieties being the same as the number of production units. We index the parent firm by $g = 0$ so that demand for the parent firm's variety is $x(\varphi, 0)$. Multi-product NEAs additionally produce varieties (and run affiliates) with index $g > 0$. The (consolidated) profits of a firm with productivity φ are given by

$$\pi(\varphi) = \int_{g=0}^G (x(\varphi, g)p(\varphi, g) - \widetilde{MC}(\varphi, g)x(\varphi, g) - f) dg + F^e, \quad (5)$$

where f are the variety-specific setup costs, F^e are fixed entry costs at the overall parent firm level. The fixed entry costs F^e are sunk costs for the parent firm, while the setup costs f only occur per variety g , if the firm decides to produce it. G indicates the one-off mass of varieties the firm produces, where $G = 0$ would indicate an NEP. $\widetilde{MC}(\varphi, g)$ denotes the marginal costs of producing variety g , and labor productivity φ is drawn from a known random distribution.

Production units (plants):

Each variety of a parent firm with productivity φ is uniquely identified by $g \geq 0$. Therefore, we may for the moment skip φ to simplify notation. The profits from selling variety g are given by

$$\pi(g) = x(g)p(g) - \frac{w}{\varphi} o(g)^{-\beta} x(g)^{1+\beta} - \beta \frac{w}{\varphi} (g+h)^\epsilon o(g) - f. \quad (6)$$

Note that the costs of a plant have a variable part, $\frac{w}{\varphi} x(g)^{1+\beta} o(g)^{-\beta}$, and two fixed parts, $\beta \frac{w}{\varphi} o(g)(g+h)^\epsilon$, and f . The variable costs are a function of wages, w , productivity, φ , and an intangible asset, $o(g)$.¹² These costs are increasing in total output, $x(g)$, while a larger amount of intangible assets, $o(g)$, reduce the marginal costs. Still, for the firm it is costly to increase intangible assets $o(g)$ in the parent or an affiliated firm. The costs of accessing (or creating) intangible assets, $\beta \frac{w}{\varphi} (g+h)^\epsilon$, depend on wages, productivity, and an access cost

¹²The intangible asset could be managerial knowledge, the organizational structure or best practice, we could even interpret it akin to Markusen (2001) as intellectual property or claims thereof.

parameter, h . The latter indicates the costs of accessing the parent-firm-specific intangible assets by any production unit or plant, including the one attached to the headquarters. In subsequent sections, h will vary with the location (country) of the plant. If a plant is located in a region or country that is culturally very different from the location of the parent, where intangible assets are created, h will be higher and, hence, the costs of accessing (in that case, transferring) intangible assets will be higher. The costs of accessing intangible assets will be independent of output so that they represent a fixed-cost component in a firm's cost structure. Lastly, the costs are assumed to increase with g (the number of production units held). Later we show that the firm will start to operate affiliated firms with low g first, i.e. that in equilibrium the marginal costs are increasing in g . The management literature showed that firms find it increasingly difficult to manage their firm specific intangible assets and managerial knowledge, as the firm expands, see Nonaka and Takeuchi (1995) and Bray (2007). Transferring intangible assets to products with higher g becomes more expensive and firms with more affiliated firms will have more intangible assets in each plant than firms with less affiliated firms.¹³ We restrict the parameters $\beta > 0$ and $\epsilon > 0$.

In contrast to common multi-product models, see Arkolakis and Muendler (2010), Eckel and Neary (2010), Nocke and Yeaple (2013), the productivity for a product (of a plant) does not decline per se with a broadening of the scope of a firm (i.e., the set-up of further plants and the production of further varieties). However, in the present model it declines due to the fact that the accessibility and transfer of intangible assets becomes more expensive as the firm expands at the extensive product and plant margin. In this sense, the present model alludes to the source of increasing costs of production with rising firm scope in multi-product firms.

Firm decisions:

The parent firm faces the following decisions:

1. Pay the fixed entry costs, F^e , and draw a productivity parameter φ .
2. Decide to enter the market given φ , open at least the parent firm (headquarters) and one production unit attached to it.
3. Decide how many products (varieties) to produce, G .
4. Decide about the optimal pricing of each product (variety), $p(g)$.
5. Decide about the amount of intangible assets to allocate to the parent firm and the affiliated firms, $o(g)$.

¹³As the network of production sites of a firm expands more intangible assets are needed to integrate the new plant in the existing production structure which increases the costs of the affiliated firm. Location risks can be an alternative explanation. As the firm opens more affiliated firms in a country, the country risk is increasing and it takes more intangible assets to decrease these risks.

We solve the firm's problem by backward induction.

Optimal provision of intangible assets:

The optimal level of intangible asset provision is derived at the product (or plant) level. The firm maximizes profits at the product level given the number of varieties produced (or plants operated) by the firm, the price of each variety, and the decisions of all other firms in the market. This leads to the following first order condition:

$$\frac{\partial \pi(g)}{\partial o(g)} = 0 \rightarrow o(g)^{-\beta-1} x(g)^{1+\beta} = (g+h)^\epsilon, \quad (7)$$

$$o(g) = x(g)(g+h)^{-\frac{\epsilon}{1+\beta}} \quad \forall g. \quad (8)$$

Substituting back into the product-specific profit equation (6) yields

$$\pi(g) = x(g)p(g) - (1+\beta)\frac{w}{\varphi}(g+h)^{\frac{\beta\epsilon}{1+\beta}}x(g) - f. \quad (9)$$

The (optimal) marginal costs per product are

$$MC = (1+\beta)\frac{w}{\varphi}(g+h)^{\frac{\beta\epsilon}{1+\beta}}. \quad (10)$$

The marginal costs are constant for each product, but they increase with the number of affiliated firms, g . In the case of autarky, this expression corresponds to the marginal cost structure in Eckel and Neary (2010). Later, if h is country-specific variable this will lead to firm choices of the production location.

Optimal product pricing:

The firm has monopoly power for each variety it produces. Given the demand per variety in equation (4), the firm sets the price $p(g)$ to maximize product-level profits at

$$p(g) = \frac{\sigma}{\sigma-1} MC = \frac{\sigma}{\sigma-1} (1+\beta)\frac{w}{\varphi}(g+h)^{\frac{\beta\epsilon}{1+\beta}}. \quad (11)$$

The profits for each product are given by

$$\pi(g) = \frac{1}{\sigma} \left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma} MC^{1-\sigma} P^{\sigma-1} Y - f. \quad (12)$$

To simplify notation and allow for tractability, we assume that $\epsilon = \frac{1+\beta}{\beta} \frac{2}{\sigma-1} > 0$, which yields:

$$\pi(g) = \frac{1}{\sigma} \left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma} (1+\beta)^{1-\sigma} \left(\frac{w}{\varphi} \right)^{1-\sigma} (g+h)^{-2} P^{\sigma-1} Y - f. \quad (13)$$

Everything else equal, affiliates with higher g face higher (constant) marginal costs and consequently are less profitable for the firm. Consolidated firm profits are given by

$$\pi(\varphi) = \int_{g=0}^G \pi(g) dg = \frac{1}{\sigma} \underbrace{\left(\frac{\sigma}{\sigma-1} \right)^{1-\sigma} (1+\beta)^{1-\sigma} P^{\sigma-1} Y}_{\kappa(P)} \left(\frac{w}{\varphi} \right)^{1-\sigma} \int_{g=0}^G (g+h)^{-2} dg - fG - F^e. \quad (14)$$

Using that $g \geq 0$ is a continuous variable, we can solve the integral and express total firm profits as a function of wages, firm productivity, fixed costs, the intangible accessing cost parameter h , and the scope of the firm G :

$$\pi(\varphi) = \frac{\kappa(P)}{h} \left(\frac{w}{\varphi} \right)^{1-\sigma} \frac{G}{(G+h)} - fG - F^e. \quad (15)$$

Optimal scope:

The firm maximizes its total profits with respect to the total mass of products, G , considering the optimal pricing rule and optimal level of intangible assets as given. This yields the following first order condition:

$$\frac{\partial \pi(\varphi)}{\partial G} = 0 \rightarrow \kappa(P) \left(\frac{w}{\varphi} \right)^{1-\sigma} (G+h)^{-2} = f, \quad (16)$$

and the optimal scope, G , of the firm is

$$G = \left(\frac{\kappa(P, Y)}{f} \left(\frac{w}{\varphi} \right)^{1-\sigma} \right)^{\frac{1}{2}} - h. \quad (17)$$

The optimal scope declines in f , w , and h , and it increases in φ . Substituting G back into the firm profit equation (15) yields

$$\pi(\varphi) = \frac{1}{h} \left(\left(\kappa(P) \left(\frac{w}{\varphi} \right)^{1-\sigma} \right)^{\frac{1}{2}} - f^{\frac{1}{2}} h \right)^2 - F^e, \quad (18)$$

which again declines in f , w , and h , and it increases in φ .

Entry decision:

A firm will only enter the market if its productivity draw, φ , is sufficiently high to operate at least the parent firm with one attached production unit in the market. Recall that this is indicated by $g = 0$. As fixed entry costs are sunk, this implies that there is some $\bar{\varphi}$ such that

$$\frac{1}{h} \left(\left(\kappa(P) \left(\frac{w}{\bar{\varphi}} \right)^{1-\sigma} \right)^{\frac{1}{2}} - f^{\frac{1}{2}} h \right)^2 = 0. \quad (19)$$

Solving for $\bar{\varphi}$ yields

$$\bar{\varphi} = w \left(\frac{fh^2}{\kappa(P)} \right)^{\frac{1}{\sigma-1}}, \quad (20)$$

which is a function of the price index P .

Equilibrium:

In equilibrium, the expected profits of a firm have to be equal to the fixed entry costs F^e . For simplicity, we assume that $z = \varphi^{\frac{\sigma-1}{2}}$ is single-parameter Pareto distributed with a known probability density function, $K(z)$, with scale parameter ($\theta = 0, \bar{z} = \bar{\varphi}^{\frac{\sigma-1}{2}}$) and shape parameter $\alpha > 2$. We can then write the expected profits of a firm as

$$\begin{aligned} E(\pi(\varphi)) &= \frac{1}{h} E \left(\left(\left(\kappa(P) \left(\frac{w}{\varphi} \right)^{1-\sigma} \right)^{\frac{1}{2}} - hf^{\frac{1}{2}} \right)^2 \right) = F^e, \\ &= \frac{1}{h} \left(\text{var} \left(\left(\kappa(P) \left(\frac{w}{\varphi} \right)^{1-\sigma} \right)^{\frac{1}{2}} \right) + \left(E \left(\left(\kappa(P) \left(\frac{w}{\varphi} \right)^{1-\sigma} \right)^{\frac{1}{2}} \right) - hf^{\frac{1}{2}} \right)^2 \right) = F^e, \\ &= \frac{1}{h} \left(\kappa(P) w^{1-\sigma} \text{var}(\varphi^{\frac{\sigma-1}{2}}) + \kappa(P) w^{1-\sigma} (E(\varphi^{\frac{\sigma-1}{2}}))^2 - 2hf^{\frac{1}{2}} \left(\kappa(P) w^{1-\sigma} \right)^{\frac{1}{2}} E(\varphi^{\frac{\sigma-1}{2}}) + fh^2 \right) = F^e, \\ &= \text{var}(z) + (E(z))^2 - 2h^2 \left(\frac{fw^{\sigma-1}}{\kappa} \right)^{\frac{1}{2}} E(z) = \frac{h}{\kappa(P)} w^{\sigma-1} (F^e - fh), \\ &\frac{\bar{z}^2}{\alpha - 2} - 2h^2 \left(\frac{fw^{\sigma-1}}{\kappa(P)} \right)^{\frac{1}{2}} \bar{z} = \frac{\alpha - 1}{\alpha} \frac{h}{\kappa(P)} w^{\sigma-1} (F^e - fh). \end{aligned} \quad (21)$$

Using equation (20), we have a system of two equations and two unknowns, which we can solve for the cutoff value $\bar{\varphi}$ (or correspondingly, \bar{z}) and the price index P .

In equilibrium, the free entry condition determines the relationship between the mass of firms in the market, M , and the mass of firms that draw a productivity, M^e :

$$M\sigma E(\pi(\varphi)) + M^e F^e = \gamma Y, \quad (22)$$

where $E(\pi(\varphi)) = F^e$ by equation (21) and

$$M^e = \frac{M}{1 - K(\bar{z})}. \quad (23)$$

Solving for M yields

$$M = \frac{\gamma Y (1 - K(\bar{z}))}{(\sigma(1 - K(\bar{z})) + 1) F^e}. \quad (24)$$

Given the cutoff value, \bar{z} , this determines the number of firms in the market, whereby the model is closed.

3.2 Numerical analysis in autarky

The system of equations cannot be solved analytically for the price index P and the cutoff productivity \bar{z} (or $\bar{\varphi}$), so that we have to resort to numerical analysis. For this, we use the baseline calibration of parameters given in Table 2. The calibration tries to match some of the stylized facts mentioned in Section 2, specifically, the high share of NEPs, the fact that most NEAs have operate only one affiliated firm, and that the distribution of affiliated firms per parent firm is positively skewed. Based on the calibrated model, we illustrate how fundamental variables of the model – such as accessing costs of intangible assets, h , variety setup costs, f , fixed entry costs, F^e , and total income Y – affect the number of firms and the distribution of affiliated firms.

Variable	Y	w	f	F^e	σ	β	α	h	θ
Value	100,000	10	10	10	1.5	0.5	2.5	0.25	1.e-0.4

Table 2: Baseline calibration values.

We proceed in steps as follows to solve the model. First, we solve for the entry cutoff, $\bar{\varphi}$, and the price index, P , using equations (20) and (21). Second, given the entry cutoff, we solve for the number of firms in the market, M , from equation (24). Third, from equation (23) we obtain the number of firms drawing a productivity from the Pareto distribution, M^e . Fourth, we draw for each of the potential entrants, M^e , a labor productivity, φ from the known Pareto distribution. Fifth, for each of the (parent) firms with a productivity greater or equal to the cutoff productivity, $\bar{\varphi}$, we compute the optimal number of affiliated firms using equation (17). From this, we obtain the distribution of affiliated firms per parent firm. We repeat steps five and six one-hundred times and average the distribution to make the histograms for different calibrations comparable.

Baseline calibration:

Figure 7 shows the distribution of parent firms with G plants in the left panel and the distribution conditional on being a NEA (having at least one affiliated firm) on the right panel.¹⁴ In the baseline calibration, 1,748 firms draw their productivity from a Pareto distribution. Of those, 1,678 firms decide to enter the market, having a productivity draw higher than the cutoff productivity, $\bar{\varphi} = 0.0190$. Over 98% of the firms are NEAs. The density decreases strongly with the number of affiliated firms. Of the parent firms with at least one affiliated firm, over 77% have one affiliated firm and again the density decreases strongly with the

¹⁴In our theoretical model we consider g to be continuous, while in all graphs we use integer numbers, as it is difficult to imagine 1.8 affiliated firms. In the graphs we round the number of affiliated firms always to the lower integer. Alternatively, we could interpret decimal numbers as equity shares. So 1.8 affiliated firms would be 100% equity of the first affiliated firm and 80% of the second affiliated firm.

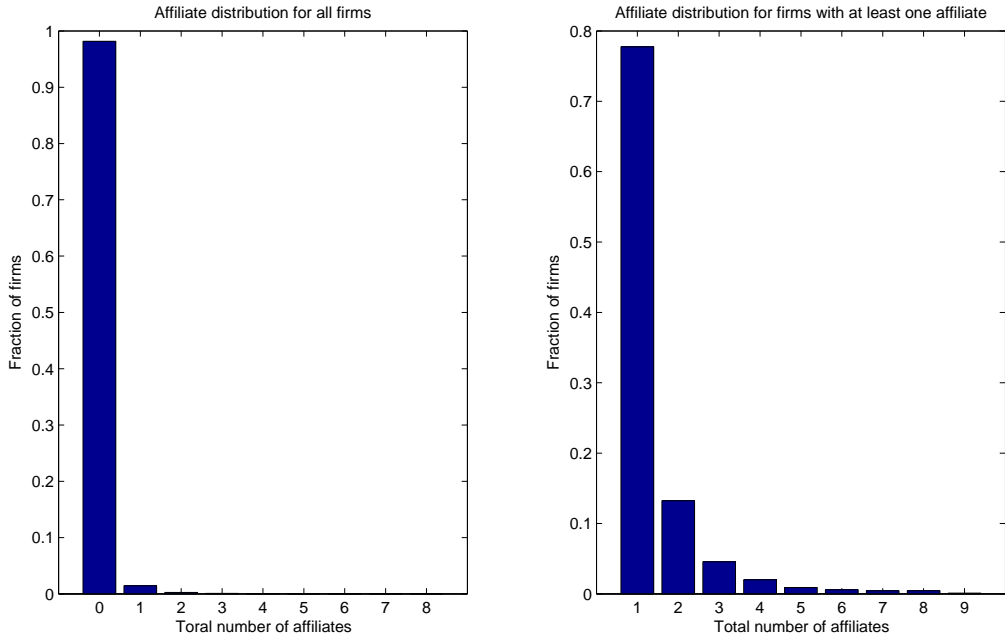


Figure 7: Baseline model

number of affiliated firms. The general pattern in the baseline calibration squares with the stylized facts described for France, Germany, Great Britain, and Spain in Section 2. The chosen calibration of the autarky model overstates the number of parent firms with only one affiliated firm, which should be closer to 55% in the right panel, according to the stylized facts (which are based on open economies).

Higher accessing costs of intangible assets:

We now consider the case of higher accessing costs of intangible assets, $h = 2.5$, in Figure 8 the histograms which should be compared to the original ones in Figure 7. The firm distributions with this parameter configuration are apparently very different from the ones associated with the baseline calibration. With higher accessing costs, h , the model understates the number of parent firms without any affiliated firm (58%), but now the relative frequency of parent firms with only one affiliated firm is with 48% larger and more in accordance with the stylized facts than the result based on the benchmark calibration. In general, the right tail of the distribution got thicker due to the increase in h . This can be explained by two reasons. First, increasing the accessing costs, h , raises the entry cutoff, $\bar{\varphi}$, to 0.0237. Recall that an increase in h affects even single-variety parent firms which produce one variety, $g = 0$, and also multi-variety (multi-plant), $g > 0$. Higher transfer costs reduce the profitability of all products and make entry less profitable. This explains the increased cutoff value relative to the benchmark calibration. Second, as less firms enter the

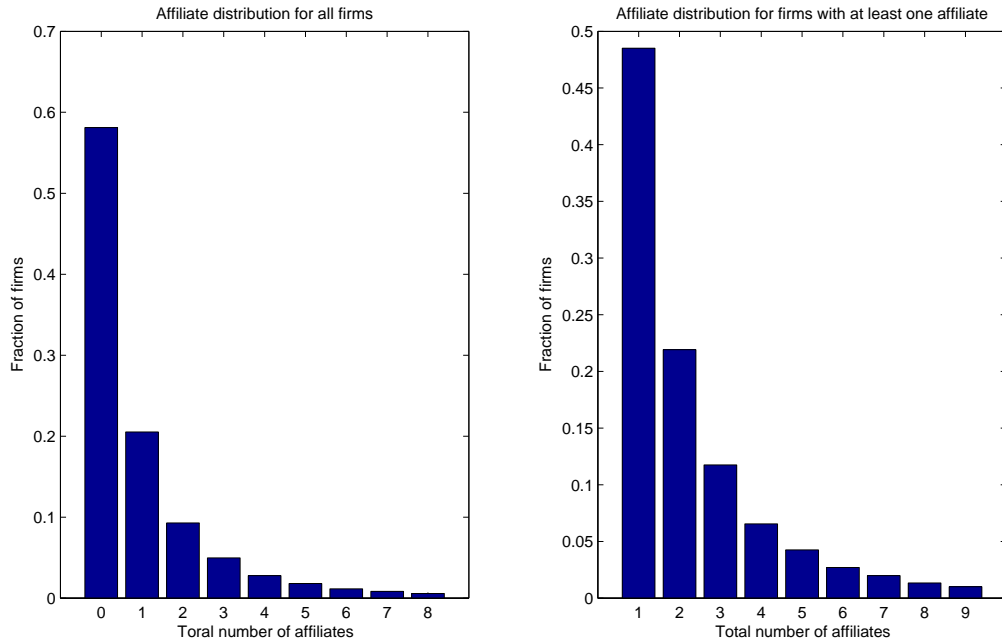


Figure 8: $h = 2.5$

market, competition decreases and expanding the firm scope (producing more varieties and running more plants) becomes more profitable for firms in the market. Hence, conditional on being in the market, firms will operate more affiliated firms than in the outset, as a result.

Higher fixed entry costs and higher variety setup costs:

As the standard Melitz (2003) model of heterogeneous firms suggests, increasing F^e raises the cutoff productivity and leads to less entry and competition in the market. This effect reduces the share of NEAs and increases the number of affiliated firms for NEPs. Similarly, increasing product setup costs, f , raises the cutoff productivity and additionally increases the costs of opening new affiliated firms.

Higher total income:

Raising total income raises the number of entrants in the market proportionally, but it leaves the entry cutoff productivity and the firm distribution unchanged.

4 The model with two countries

4.1 General outline for countries

Now consider the case, where firms can decide on both the scope of the firm (the number of plants and varieties) and the location of affiliated firms at home or abroad. To simplify

the analysis, we consider free trade between the two countries.¹⁵ We use the convention of a star index to indicate variables and parameters pertaining to the foreign country.

A firm will only locate an affiliated firm abroad, if the marginal costs of production are lower there than in the domestic country. We assume that the parent firm always faces the lowest marginal costs in the domestic country.¹⁶ Furthermore, we assume that g is country-specific, and the first foreign plant (or affiliate) of the parent with $g = 0$ is denoted by $g^* = 0$.¹⁷ A parent firm will *only* open domestic affiliated firms if $\text{MC}(g) \geq \text{MC}(g^* = 0)$. Let us denote the (marginal) domestic affiliated firm for which this weak inequality holds with equality as \hat{g} . Equalizing the expressions for the marginal costs of the domestic affiliated firm with \hat{g} and the first foreign affiliated firm with $g^* = 0$ yields

$$(1 + \beta) \frac{w^*}{\varphi} h^{*\eta} = (1 + \beta) \frac{w}{\varphi} (\hat{g} + h)^\eta,$$

where $\eta = \frac{2}{\sigma-1}$. Next, we can express \hat{g} as a function of relative wages and intangible asset accessing cost parameters:

$$\hat{g} = h^* \left(\frac{w^*}{w} \right)^{\frac{1}{\eta}} - h. \quad (25)$$

If the foreign wage rate, w^* , increases, or if the costs of accessing intangible assets to foreign affiliates, h^* , increase, \hat{g} increases and the firm will have more domestic affiliated firms before opening the first foreign affiliate. This illustrates that the firm does not only consider the relative wage in the two countries, when deciding about the location of an affiliated firm, but it will also consider how costly it is to access intangible assets.

Alternatively, we can determine the multinational firm productivity cutoff, $\hat{\varphi}$, using the entry condition into the foreign market:

$$G^* = \left(\frac{\kappa(P, Y)}{f} \left(\frac{w^*}{\hat{\varphi}} \right)^{1-\sigma} \right)^{\frac{1}{2}} - h^* = 0. \quad (26)$$

Then, the multinational firm productivity cutoff, $\hat{\varphi}$, is

$$\hat{\varphi} = \left(w^{*\frac{\sigma-1}{2}} \left(\frac{f h^{*2}}{\kappa(P, Y)} \right)^{\frac{1}{2}} \right)^{\frac{2}{\sigma-1}}. \quad (27)$$

¹⁵Alternatively, we could interpret the wage rate in the country as the trade-cost-adjusted wage rate.

¹⁶For this reason, we consider a foreign country where the wage rate is lower than at home, but (due to cultural differences) intangible asset accessing costs are higher, $w > w^*$ and $h < h^*$. More specifically we assume that $\frac{w}{w^*} < \left(\frac{h^*}{h} \right)^{\frac{2}{\sigma-1}}$. This will ensure that the parent firm is always in the domestic country.

¹⁷We could think of the foreign affiliate $g^* = 0$ as the parent firm's regional headquarters abroad. Affiliate $g^* = 0$ will have the highest productivity level among all foreign affiliates of the same parent firm, should there be more than one. It turns out to be convenient for the model outline to use separate running indices for domestic and foreign affiliates per parent firm.

The necessary productivity to operate at least one foreign affiliated firm increases with f , w^* , and h^* .

Note that for the firm it may still be profitable to operate more than \hat{g} domestic affiliates as long as $\hat{g} < G$, where G denotes the marginal domestic plant which covers its fixed costs exactly by its operating profits. The parent firm is indifferent between opening the domestic plant \hat{g} or foreign plant $g^* = 0$. With a continuum of firms, domestic affiliate \hat{g} and foreign affiliate $g^* = 0$ will be opened simultaneously. If $\hat{g} < G$, the parent firm will operate more than \hat{g} domestic and more than $g^* = 0$ foreign affiliates. This implies a positive correlation – but not necessarily a proportional relationship – between the number of domestic and foreign affiliated firms.

Optimal scope with foreign production:

The profits of an MNE are given by

$$\begin{aligned}\pi(\varphi) &= \int_{g=0}^G \pi^d(g) dg + \int_{g^*=0}^{G^*} \pi^*(g^*) dg^* \\ &= \kappa(P, Y) \left(\left(\frac{w}{\varphi} \right)^{1-\sigma} \int_{g=0}^G (g+h)^{-2} dg + \left(\frac{w^*}{\varphi} \right)^{1-\sigma} \int_{g^*=0}^{G^*} (g^*+h)^{-2} dg^* \right) - f(G+G^*) - F^e,\end{aligned}\tag{28}$$

where $\pi(g)$ are the profits from domestic plants and $\pi^*(g)$ are the ones of foreign affiliates. Note that the firm's profits are perfectly separable into domestic and foreign profits by assumption. As shown in equation (27), only firms with $\varphi > \hat{\varphi}$ will be MNEs. This implies that the optimal scope of the firm is given by

$$\text{Scope} = \bar{G} = \begin{cases} \left(\frac{\kappa(P, Y)}{f} \left(\frac{w}{\varphi} \right)^{1-\sigma} \right)^{\frac{1}{2}} - h, & \text{if } \bar{\varphi} \leq \varphi < \hat{\varphi}. \\ \left(\frac{\kappa(P, Y)}{f} \varphi^{\sigma-1} \right)^{\frac{1}{2}} \left(w^{\frac{1-\sigma}{2}} + w^{*\frac{1-\sigma}{2}} \right) - h - h^*, & \text{if } \varphi \geq \hat{\varphi}. \end{cases}\tag{29}$$

Note that with $\frac{w^*}{w} > \left(\frac{h}{h^*} \right)^\eta$ the entry decision of NEPs and NEAs only depends on the costs of producing at the parent firm, $g = 0$, and, hence, the (general) firm entry cutoff, $\bar{\varphi}$, is still given by $\bar{\varphi} = w \left(\frac{fh^2}{\kappa(P, Y)} \right)^{\frac{1}{\sigma-1}}$.

Figure 9 illustrates the location decision and scope decision of the firm graphically. For simplicity we assume that the marginal costs functions are linear in the number of plants and have the same slope in both countries, but different intercepts with the y-axis.¹⁸ The dotted line gives the marginal costs curve for domestic plants, and the dashed-dotted line is the marginal cost function of foreign affiliated firms. Adding both functions, we obtain

¹⁸A simple example for this could be obtained by setting $\sigma = 3$, which ensures linear marginal cost functions. Considering country-specific β s, the slope of the two cost functions would be the same if $\beta = 1$ and $\beta^* = 2 \frac{w}{w^*} - 1$. Last, the intercept of the foreign affiliate cost function will be higher if $h^* > h$.

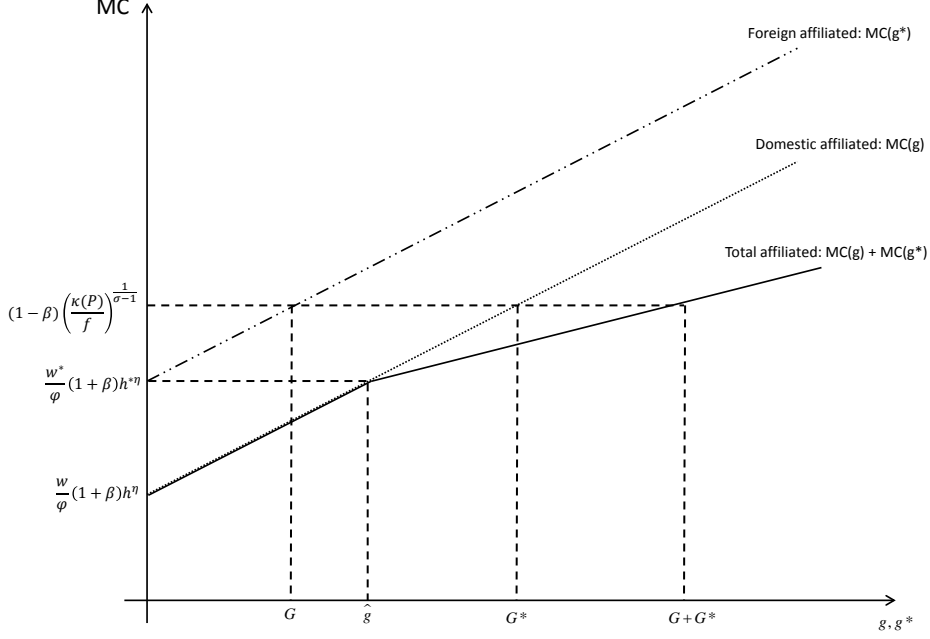


Figure 9: Number of affiliated firms as a function of marginal costs. Domestic country, foreign country and firm's scope.

the (aggregated) marginal cost function of the firm for the scope of the firm. Only if the marginal costs of an domestic affiliated firm exceed $\frac{w^*}{\varphi}(1 + \beta)h^{\eta}$, the firm starts to open foreign affiliated firms. Until this point the aggregate function coincides with the domestic marginal cost function. Afterwards the slope of the aggregate function is one half of the slope of the domestic (foreign) marginal cost function. Given the marginal costs the graph shows the number of domestic affiliated firms, foreign affiliated firms and the sum of both. Increasing w^* or h^* will increase the intercept of the foreign marginal cost curve and implies more domestic affiliated firms and less foreign affiliated firms for a given marginal costs.

Equilibrium with foreign production:

The total expected profits, $E(\bar{\phi})$ for a firm (possibly) operating in both countries is given by

$$\begin{aligned}
 E(\bar{\pi}(\varphi)) = & \frac{\kappa(P, Y)}{h} w^{1-\sigma} \left(\text{var}(z) + (E(z))^2 + 2h^2 \left(\frac{f w^{\sigma-1}}{\kappa(P, Y)} \right)^{\frac{1}{2}} (E(\hat{z}) - E(z)) - \text{var}(\hat{z}) - (E(\hat{z}))^2 \right) + \\
 & \frac{\kappa(P, Y)}{h^*} w^{*(1-\sigma)} \left(\text{var}(\hat{z}) + (E(\hat{z}))^2 - 2h^{*2} \left(\frac{f w^{*(\sigma-1)}}{\kappa(P, Y)} \right)^{\frac{1}{2}} E(\hat{z}) \right) - f h^* = F^e,
 \end{aligned} \tag{30}$$

where the expression in the first line corresponds to the expected profits from domestic affiliated firms, which we denote by $E(\pi^d(\varphi))$, and the second line are the expected profits

from foreign affiliated firms, which we denote by $E(\pi^*(\varphi))$. \bar{z} and \hat{z} (or $\bar{\varphi}$ and $\hat{\varphi}$, respectively) are given by equations (20) and (27), respectively. Accordingly, we can write the expression in equation (30) as an implicit function of P and solve numerically for the price index, \bar{z} and \hat{z} .

We assume that all profits of foreign affiliated firms are consolidated in the domestic country. Thus, in equilibrium the income spent on goods in the domestic country corresponds to the number of firms paying the fixed entry costs plus total revenues of domestic and foreign affiliated firms:

$$\gamma Y = M\sigma E(\pi(\varphi)) + M^e F^e, \quad (31)$$

where $M^e = \frac{M}{1-K(\bar{z})}$.

4.2 Numerical analysis with two countries

We solve the model with the possibility of foreign affiliated firms analogously to the case of autarky. Once the price index and the entry cutoffs are determined, all other variables can be recursively recovered. To make the autarky and two-open-country scenarios comparable, we assume that, relative to autarky the option of producing with foreign affiliated firms becomes available and we add a second country with $w^* = 7$ and $h^* = 2.5$, while leaving all other parameters unchanged. As for autarky, we compute the firm distribution for 100 draws of labor productivity from the known, single-parameter Pareto distribution and average the obtained firm distributions across the draws.

With possible foreign production, more firms want to draw from the Pareto distribution (2,380; this number was 1,748 in autarky) due to a larger (world) market available to them. Entering the market becomes more profitable for high-productivity firms as they can reduce their (cross-plant) average marginal costs through the set-up of foreign affiliates. Moreover, with MNEs the entry cutoff is lower than in the baseline calibration, 0.0142 (it was 0.0190 in autarky), which leads to more firms in the market (1,967 instead of 1,678). The foreign affiliated firm cutoff is 0.0314 (hence, the most productive firms become MNEs, as in Helpman, Melitz, and Yeaple, 2004). Figure 10 shows the distribution of firms by number of affiliates. The simulation results are broadly aligned in relative terms with the basic descriptive statistics from Table 1. For instance, few firms (98.3%) of the firms have no affiliated firms at home or abroad and are NEPs. Moreover, among all the non-NEPs, about 54% of the parent firms have only one affiliate (at home or abroad).¹⁹ The frequency of multinational firms with at least one foreign affiliate in all firms is about 0.7%. Hence, MNEs occur relatively

¹⁹The distribution with just two countries is not continuous. In our example, the (across draws) averaged probability density function is non-monotonic in the number of affiliates per firm. Including more countries with different, country-specific foreign affiliated firm cutoffs smoothes the distribution and makes it more monotonically decreasing in the number of affiliates operated.

infrequently.

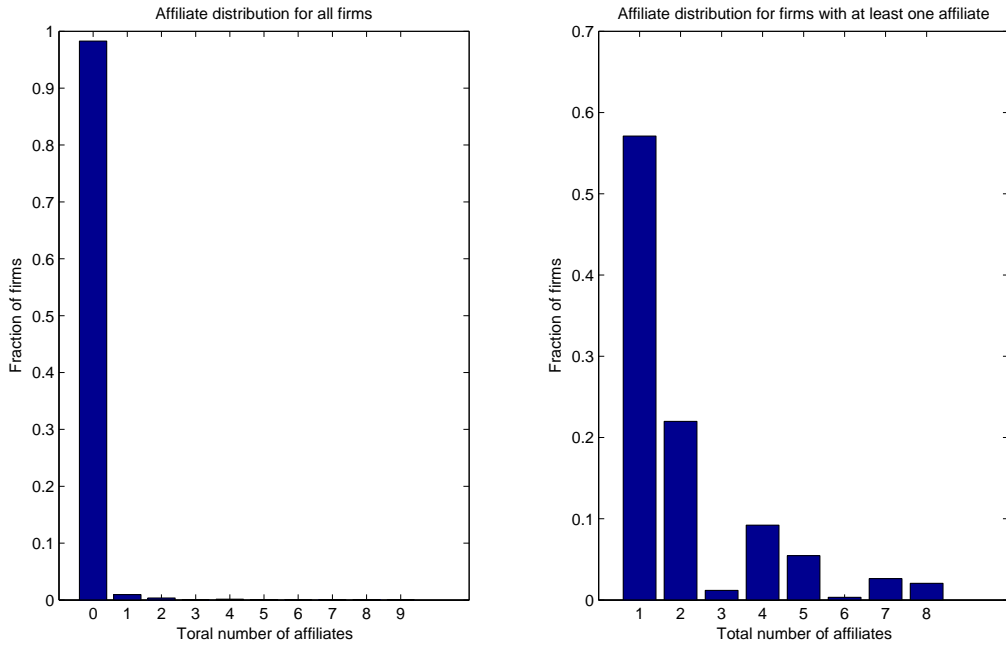


Figure 10: Firm distribution with foreign affiliated firms.

Figure 11 shows the fraction of parent firms with respect to domestic and foreign plants conditional on having at least one affiliated firm. In general parent firms with more domestic affiliates have (disproportionately) more foreign affiliates, which reconciles with the positive relationship found in Figure 5.

In general, the model with possible foreign affiliate setup is able to match some generic features of empirical firm distributions mentioned in Section 2. Especially, this is the case for the high concentration of firms in the left tail of the distribution of affiliate numbers. A key determinant of the distributional form in the numerical analysis are the intangible accessing costs from the parent (or headquarters) to its production units (or from managers to workers), h and h^* .

Changes in the costs of accessing intangible assets

As shown in Section 3.2 changes in the costs of accessing intangibles, h , have strong effects on the distribution of firms in the case when we only consider an economy in autarky. An increase of h strongly reduces the share of parent firms without any affiliated firms and the tails of the distribution become thicker. If we increase h^* the share of parent firms without any affiliated increases slightly and the left tail of the distribution becomes thicker. Moreover, the share of parent firms having foreign affiliated firms decreases, as it becomes more costly to open plants in the foreign country.

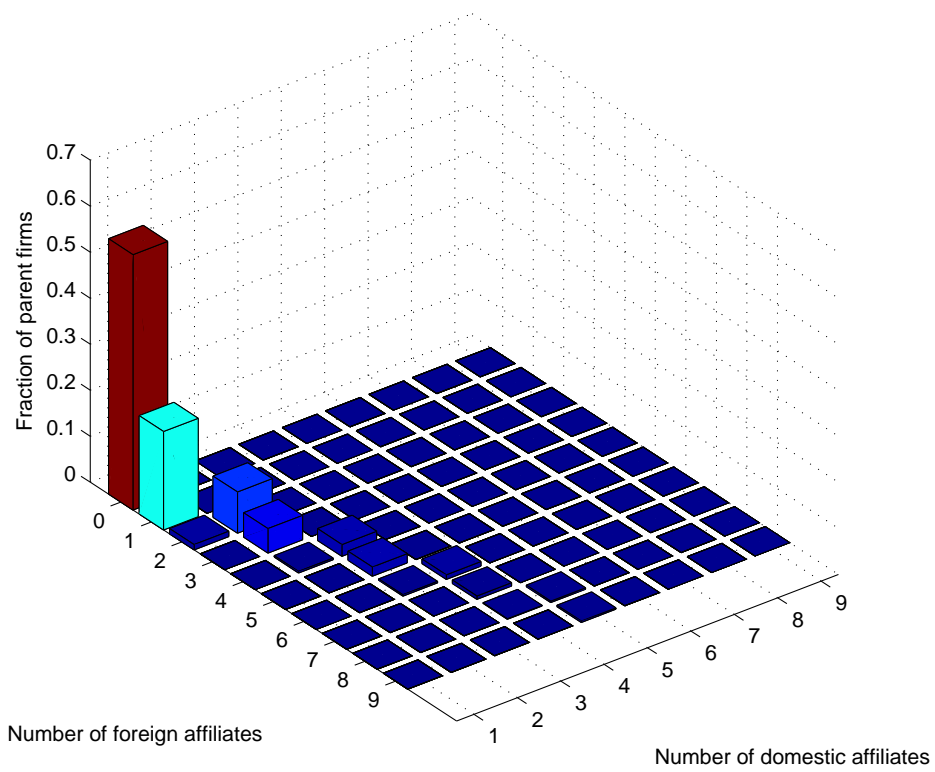


Figure 11: Distribution of firms with domestic and foreign affiliated firms.

5 The model with more than two countries

Extending the model to multiple (more than two) countries is straightforward in principal. As long as $\frac{w^*}{w} > \left(\frac{h}{h^*}\right)^\eta$ for all foreign countries, the entry productivity cutoff is determined only by the domestic entry condition in equation (20). Total profits are given by

$$\pi(\varphi) = \sum_j \int_{g_j=0}^{G_j} \pi_j(g_j) dg_j, \quad (32)$$

where j is a country index and the profits of firms in country j are given by equation (18). The scope of a firm is determined by

$$\text{Scope}(\varphi) = \left(\frac{\kappa}{f} \varphi^{\sigma-1}\right)^{\frac{1}{2}} \sum_j w_j^{\frac{1-\sigma}{2}} - \sum_j h_j \quad \text{if } \varphi \geq \hat{\varphi}_j, \quad (33)$$

where we order the countries by their entry cutoffs, such that $\varphi_j < \varphi_{j'}$ if $j < j'$.

6 Empirical analysis

In this section, we present some empirical results, using the same data as in Section 2. The above theoretical model suggests determinants of foreign market entry (the probability of an MNE to control any foreign affiliate in a market) and the number of foreign affiliates per host market. In particular, we emphasize the effect of cultural distance between the parent country and the host country of an MNE, since this should be specifically reflective of the costs of transferring intangible assets between markets.

6.1 Empirical model specification

A necessary condition for an MNE to enter a host country is that $G^* > 0$, given by (26):

$$\left(\frac{\kappa(P)}{f} \left(\frac{w^*}{\varphi}\right)^{1-\sigma}\right)^{\frac{1}{2}} - h^* > 0. \quad (34)$$

The latter is more likely, if transfer costs of intangible assets for a given parent firm to a specific host country, h^* , and unit labor costs of a given parent firm in the a specific country, $\frac{w^*}{\varphi}$, are low. The same equation suggests that the number of affiliates held of a given parent firm in that host country is likely higher if these costs are low.

Based on this insight, we may specify the following two models above considerations we estimate the following two equations for the probability for parent firm i which is based in parent country o about having at least one affiliate in host country d and for the number of

affiliates held by that parent, there:

$$\begin{aligned} Pr(\text{affiliate}_{iod} > 0) &= F(\alpha + \beta_1 \log(\frac{w_d}{\varphi_{io}}) + \beta_2 X_{od} + \beta_5 \log(\tau_{do}) + \gamma_d + \gamma_o + \gamma_l + \epsilon_{iod}), \\ \text{affilites}_{iod} &= P(\alpha + \beta_1 \log(\frac{w_d}{\varphi_{io}}) + \beta_2 X_{od} + \beta_5 \log(\tau_{do}) + \gamma_d + \gamma_o + \gamma_l + \epsilon_{iod}), \end{aligned}$$

where affiliate_{iod} is an integer-valued, non-negative variable reflecting the number of affiliates of parent i from country o in country d (excluding the case $o = d$), $L(\cdot)$ is the logit function operator, and $P(\cdot)$ is the Poisson function operator. The variable $\frac{w_d}{\varphi_{io}}$ captures the hypothetical unit-labor costs that firm i from country o would have in country d . We impute the latter variable by considering the parent's productivity level φ_{io} and adjust the average wage in host country d by it. X_{od} is a vector of country-pair-specific variables that determine the costs of transferring intangible assets from country o to country d . In the estimation, we use language difference and general cultural distance as elements of X_{od} . τ_{od} is the distance between country o and d , capturing trade costs. γ_d , γ_o , and γ_l represent parent-country-, host-country-, and industry-specific effects, respectively, which we estimate as fixed effects. Lastly, ϵ_{iod} is an error term.

6.2 Data

Akin to Helpman et al. (2004), we use the Amadeus Database provided by Bureau van Dijk to identify parent firms. The database covers 34 parent countries. We link all affiliates – in Europe and outside of Europe – to those parents, which leads to units in 164 host countries. We define parent firms as ones with a dispersed ownership, where no individual shareholder holds more than 25% of the firm's equity and firms where the sole owner is a known individual or family.²⁰ A firm is classified as an affiliate of a parent firm, if the parent firm has a (direct) controlling equity interest of more than 50%.

As stated in section 2.4 we determine parent-level productivity, φ_{io} , along the lines of Helpman et al. (2004) with sector-specific markups. We use the GDP per worker as a measure of the factor-unit-specific returns for the year 2007 based on version 8 of the Penn World Tables, Feenstra et al. (2013).

To proxy for cultural distance, we construct an index based on the World Values Survey (2014). For this, we calculate the average answers to the questions V4 to V9 of the survey per country. These questions relate to general attitude of the society towards the importance of family (V4), friends (V5), leisure time (V6), politics (V7), work (V8) and religion (V9). Then, we compute the euclidian distance between the average answers for each country

²⁰If an known individual or family owns more than one firm, we cannot determine which firm is the parent and which firm is the affiliated firm. In this case we treat all firms as separate independent entities.

pair. As an additional measure for cultural distance, we use the ethnological and the official language communality variables from the XXX data-set of the Centre d'Études Prospectives et d'Informations Internationales (CEPII), Mayer and Zignago (2011). The former variable is unity if a language is spoken by at least 9% of the population in both countries, and the latter variable is unity if two countries share a common official language. In order for the included measures to capture cultural distance, we construct non-common-language measures by subtracting the respective variables from unity.

To control for trade costs, we employ the (unweighted) distance between parent and host countries based on the aforementioned CEPII data-set.

Table 3 shows the descriptive statistics for the dependent and independent variables used in the estimation.

Table 3: Descriptive Statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Affiliates	11857426	0.00273	0.806	0	1377
Entry	11857426	0.00036	0.019	0	1
Unit costs	13204458	2879.266	3012.609	35.98624	373880.8
GDP per worker	162	29754.69	29533.33	655.4983	159577.1
Productivity	81509	10.63714	1.572439	0.426813	18.21525
Diff. language	7372	0.05331	0.224666	0	1
Diff. ethno	7372	0.952659	0.212382	0	1
Diff. cultural	1197	1.035297	0.480486	0	2.221329
Distance	7372	6283.11	3983.025	6.686169	19586.18

6.3 Estimation results

Table 4 summarizes the results from a fixed-effects logit regression for the probability of a parent firm to set up an affiliate in a given host country. In the table, we consider six alternative sets of results for that choice, depending on the specification of cultural distance. In all specifications, the unit-labor-cost measure induces a significant negative effect on the choice probability. Also the two language non-communality measures and the World-Values-Survey-based measure of cultural distance exert a negative impact on the choice of operating an affiliate in a host country.

In Table 5, we summarize the results for the same six sets of specifications of the right-hand side of the model when using Poisson (count-data) regressions with the number of foreign affiliates per parent and host country as the dependent variable. Again, the results involve fixed effects. In all estimations unit-labor costs induce a negative and highly significant effect on the number of affiliated units per parent firm and host country. This squares with the theoretical hypotheses and with the unconditional correlations shown in Figure 6.

Table 4: Fixed-effects logit regression.

	(1)	(2)	(3)	(4)	(5)	(6)
Unit costs	-5.832*** (0.725)	-5.835*** (0.723)	-5.834*** (0.724)	-6.152*** (0.597)	-6.154*** (0.597)	-6.154*** (0.597)
Diff. ethno		-0.194** (0.0871)			-0.297*** (0.0970)	
Diff. language			-0.141 (0.0889)			-0.292*** (0.0921)
Diff. cultural				-2.079*** (0.198)	-2.070*** (0.197)	-2.074*** (0.197)
Distance	-1.621*** (0.0802)	-1.615*** (0.0797)	-1.616*** (0.0793)	-1.089*** (0.0714)	-1.085*** (0.0709)	-1.083*** (0.0710)
Constant	39.35*** (4.589)	39.50*** (4.579)	39.45*** (4.581)	35.57*** (3.463)	35.81*** (3.457)	35.79*** (3.458)
Pseudo R^2	0.41	0.43	0.41	0.46	0.47	0.47
Observations	10,367,037	10,367,037	10,367,037	3,214,588	3,214,588	3,214,588

Logit regression, entry decision. Robust standard errors in parentheses.

Clustered at the country-pair level. Source and destination country fixed effects and industry fixed effects. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Cultural distance is particularly important determinant for this margin. The number of foreign plants decreases by about 0.297 if the parent and the host countries do not share a common ethnological language. Increasing the cultural distance by one standard deviation reduces the number of affiliates in the host country by about 0.44 on average. We may compare this with the role of parent-firm productivity by calculating the productivity increase that would be necessary to offset the negative cultural distance effect (given the average GDP per employer). For instance, an absence of the same ethnological distance, the productivity of an average parent firm would have to rise by 8.7899, and to offset the detrimental effects of a cultural distance that is higher by one standard deviation parent productivity would have to rise by 2.61. The latter means raising the productivity of the median firm to the 99% percentile for ethnological language and to the 95% percentile for cultural distance, respectively. Hence, this illustrates that only firms with a very high productivity are able to operate foreign affiliates in host countries that are culturally distant from their parent country.

7 Conclusion

In this paper we developed a tractable model of multi-plant firms and their location decision. The model stresses the importance of intangible assets in multi-product (multi-unit) firms. We develop a micro foundation for the commonly used assumption that marginal costs of

Table 5: Fixed-effects Poisson regression.

	(1)	(2)	(3)	(4)	(5)	(6)
Unit costs	-6.062*** (0.740)	-6.062*** (0.740)	-6.062*** (0.740)	-6.644*** (0.918)	-6.644*** (0.918)	-6.644*** (0.918)
Diff. ethno		-0.383** (0.162)			-0.416*** (0.151)	
Diff. language			-0.454*** (0.148)			-0.514*** (0.136)
Diff. cultural				-2.669*** (0.539)	-2.712*** (0.531)	-2.711*** (0.523)
Distance	-1.573*** (0.128)	-1.583*** (0.131)	-1.576*** (0.129)	-0.935*** (0.169)	-0.951*** (0.164)	-0.954*** (0.159)
Constant	68.50*** (6.344)	68.93*** (6.350)	68.95*** (6.338)	45.90*** (4.353)	46.67*** (4.367)	46.32*** (4.381)
R^2	0.149	0.173	0.166	0.168	0.189	0.194
Observations	10,262,097	10,262,097	10,262,097	3,037,262	3,037,262	3,037,262

Poisson regression, number of affiliated firms. Robust standard errors in parentheses. Clustered at the country-pair level. Source and destination country fixed effects and industry fixed effects. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

products increases with the number of products a firm has. In the model it becomes more costly for the firm to transfer intangible assets to an extending network of plants. As intangible assets are used as an input in the production, the marginal costs of "newer" plants increase. The costs of transferring intangible assets might differ between country-pairs, thus it might be more costly for a firm to open an affiliated firm in a country that is culturally distance from the source country. This limits the possibilities of firms to operate in foreign countries with the lower unit costs. These difference in the transfer costs of intangibles affect the entry decision of firms in foreign market as well as the number of plants a firm manages. Everything else equal, countries with lower transfer costs of intangibles have more foreign owned plants. We find that difference in the costs of transferring intangibles are a further comparative advantage of countries, besides classical wage differences and low trade costs. This implies that firms are more likely to operate affiliated firms in countries that have a similar language and culture.

We solve your model numerical and show that the model is consistent with many empirical facts. First, almost all firms in a country are single-unit firms, while domestic multi-unit firms and multinational firms represent only a tiny fraction of firms in a country, see Bernard et al. (2010) and Bernard et al. (2011). Second, the scope of multi-unit firms is very small, typically additionally unit. Third, within the model we find that more productive firms

produce more output, have more affiliates, higher sales, and earn higher profits. This is consistent with Helpman et al. (2004) who find that only the most productive firms operate units in foreign countries, are multinational firms. As in Caliendo and Rossi-Hansberg (2013) changes in exogenous variables such as entry costs, wages and the possibility to produce in foreign countries changes the allocation of intangible assets and the structure of firms in the economy. Entry costs for firm, setup costs of varieties and costs of accessing intangible assets, have strong effects on the entry decision as well as the firm-plant distribution. Allowing for foreign production increases number of firms in the market and increases competition as firms can introduce cheaper products produced in the foreign country. Having plants in foreign countries makes firms more profitable, which in turn makes entry more attractive. Last, we can decompose the domestic and foreign profits, as well as sales.

We qualitatively confirm your findings using stylized facts for (parent) firms in selected European countries as well as a simple empirical model. We find that the theoretical model squares in many ways with the derived results. If a parent firm enters a certain country with an affiliated firm depends greatly on the unit costs in the country as well as the cultural difference. The same holds for the number of affiliated firms a parent firm will have in a foreign country.

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A Vertical Production and FDI

In Figure 12 we plot a histogram of Herfindahl-Hirschman index (HHI) based on the Nace Rev. 2 4 digits classification of affiliated firms for each parent firm (conditional on having more than one affiliated firm). The HHI would be one if all affiliated firms have the same classification, which could indicate that the parent firm produces the same products in different countries in order to save transportation costs. This explanation would be in line with proximity-concentration hypothesis, see Brainard (1997). The HHI is very low for most parent firms indicating vertical outsourcing. Only 6.8% of the parent firms have all their affiliated in the same sector, i.e. pure horizontal outsourcing. Last note that most of pure horizontal outsourcing firms have only 2 affiliated firms, while most bigger parent firms have very low Herfindahl-Hirschman indices, i.e. are vertically outsourcers.

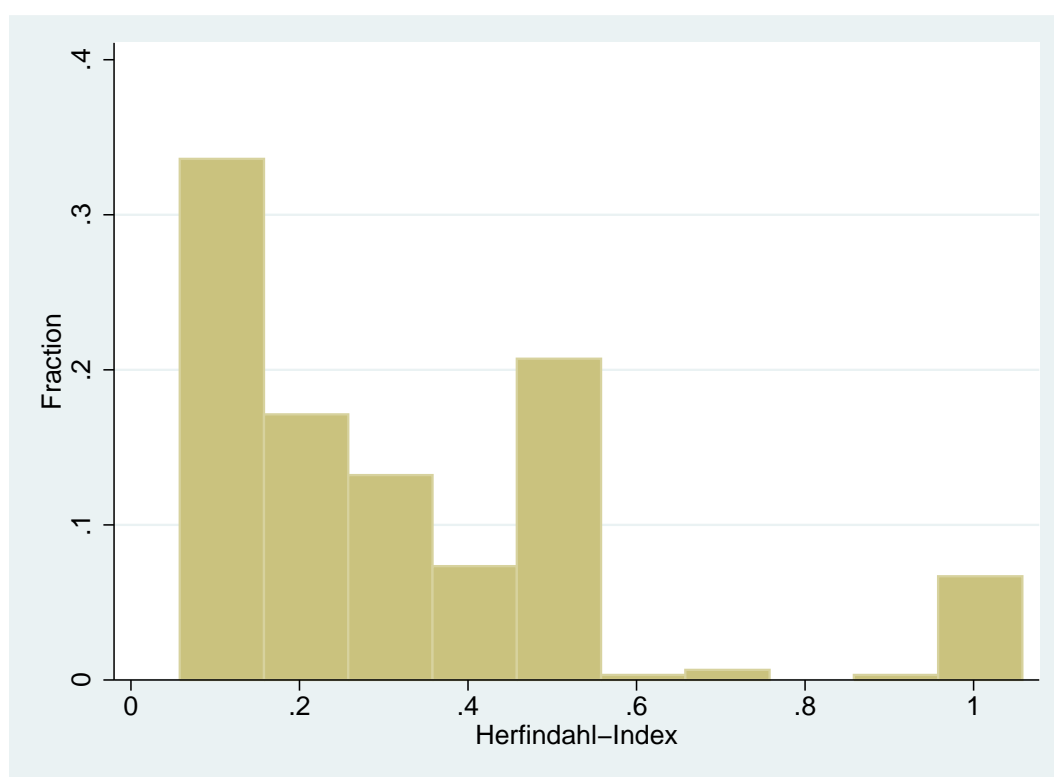


Figure 12: Histogram of Herfindahl-Hirschman index based on the Nace Rev. 2 4 digits classification of affiliated firms. Only manufacturing parent and affiliated firms more than 1 affiliated firm. 2007.