Essays in International Trade

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> "The world is like a ride in an amusement park, and when you choose to go on it you think it's real because that's how powerful our minds are. The ride goes up and down, around and around, it has thrills and chills, and it's very brightly colored, and it's very loud, and it's fun for a while. Many people have been on the ride a long time, and they begin to wonder, "Hey, is this real, or is this just a ride?" And other people have remembered, and they come back to us and say, "Hey, don't worry; don't be afraid, ever, because this is just a ride."
>
> *William Melvin "Bill" Hicks*

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1. Introduction

The importance of size and productivity in determining firm-level decisions and, consequently, in shaping the aggregate trade flows has been the subject of several studies in the literature starting from the workhorse model of Melitz (2003).

The crucial insight of this literature is that firms are different along several dimensions observable in the data (e.g. size and productivity). This difference necessarily reflects into their participation in the international markets; in particular, firms that are productive enough can select into exporting activity. Among those, only a narrow subset of them can afford the costs associated with the multinational activity (see Helpman, Melitz, and Yeaple (2004)).

Specifically, the bulk of the most productive firms is responsible for the large amount of employment and trade. According to Bernard, Jensen, and Schott (2009), firms that participate in the international trade, either as an exporter or importer, employ almost 50% of the workforce in the US. Moreover, multinational enterprises account for 90% of US trade.

Using an adapted version of Helpman et al. (2004), Yeaple (2009) finds supporting evidence in the data that more productive firms enter a larger number of countries. Furthermore, a firm can transfer its core productivity across the border as the affiliates generate relatively high revenues in their host countries. Additionally, countries becoming more attractive to less productive firms are able to magnetize a larger amount of foreign direct investment. However, this framework still does not capture several patterns observed in the data. For example, differently from what predicted by the model, large firms enter too few locations, whereas smaller firms enter too many locations. In addition, small firms enter less attractive locations more than predicted. Moreover, the last economic crisis showed how multinational firms reconsidered their location and production decisions in the different countries as a response to the negative economic downturn. In particular, countries that proved to be more resilient to the crisis became relatively attractive destinations for FDI flows. In addition, the share of sales of multinational firms increases relative to that of pure exporters.

The theory provided by Helpman et al. (2004) works reasonably well with manufacturing data, as shown in Yeaple (2009). However, it does not fit well the patterns relative to the the services industry because the ranking between selection into international activity of a firm and productivity is reversed in some circumstance.

The present dissertation, consisting of two self-contained chapters, builds upon the framework featuring heterogeneous firms and proposes two empirical contributions to this area of the literature. In particular, the second chapter, which is a joint work with Ekaterina Kazakova, provides empirical evidence that multinational firms conducting horizontal FDI operate as risk averse agents. The third chapter, also joint with Ekaterina Kazakova, analyzes the effects of the risk associated with quality perception in foreign markets on the entry mode selected by MNEs operating in the service sector. For both analyses, we rely on the development and estimation of structural models which allow us to run conterfactual analysis and evaluate the effects of policy changes.

Chapter 2. In Chapter 2, we build a structural model of firms that engage in horizontal FDI and are subject to demand risk, represented by the presence of aggregate and correlated across countries demand shocks. Firms decide where to locate their production plants, how much to produce in each of them, and where and how much to ship to the single destination market. The above decisions depend both on the expected demand for each market and the correlation structure of demand shocks across destination markets as the MNE manages the demand risk. The problem of the firms is analogous to that of an investor who holds a portfolio of risky activities: firms hold foreign risky sales whose magnitude can be correlated across foreign markets. In particular, we show that markets which offer better hedging opportunities to multinationals induce larger sales and are more attractive locations for establishing a production unit. Given that an MNE can use its foreign production facility as an export platform, the margin for diversification does not reduce only to the market in which the facility is physically present but involves also the surrounding markets served by the production facility itself. For the empirical analysis, we use firm-level data for German multinational enterprises to obtain firm-specific risk aversion coefficients. We pin down the level of firm's risk aversion by using MNE's sales in the foreign markets. Our main findings are the following: multinationals behave as risk averse agents, on average; the degree of risk aversion is heterogeneous across the firms; at the industry level, the degree of risk aversion correlates with the characteristics of demand rather than with the technological features of the sector; a subsequent counterfactual analysis suggests that the effect of a trade liberalization policy occurring in China spread to the other markets due to the presence of correlated demands. Our model is able to explain why large (small) firms tend to enter in fewer (more) locations than predicted by the framework of Helpman et al. (2004) and rationalizes the behavior of the multinational firms during the last financial crisis.

Chapter 3 In Chapter 3, we study the foreign-market entry patterns associated with the professional services industry. Among the service firms operating in foreign markets, the selection mechanism entails a reversal of the ranking with respect to manufacturing. In particular, the best firms select into exporting activity, whereas firms characterized by a lower level of quality establish foreign affiliates to serve the host market. We link this empirical finding to the imperfect transferability of technology and to the uncertainty regarding the perception of core quality in new markets. To analyze these mechanisms, we build a structural model of horizontal FDI with firms that are heterogeneous in terms of service quality. Firms can choose to serve foreign markets via exporting, cross-border mergers (M&A), or greenfield investment. The proximity-concentration tradeoff drives the choice between greenfield investment and exporting. In addition, reproducing high quality abroad potentially increases the fixed entry costs associated to greenfield investment, inducing high-quality service firms to export. Furthermore, both greenfield investment and exporting determine some uncertainty for the firm regarding the foreign perception of its core quality. Cross-border M&A can solve this uncertainty as it allows the multinational to access to the demand of the acquired firm. We structurally estimate the fundamental parameters of the model using firm-level FDI and trade data for a sample of German firms. Finally, we calibrate the model equilibrium for services industry to the data on multinational and trade flows among the EU, the US, and the rest of the world. Simulation of the service-trade liberalization between the EU and the US, as provided for in TTIP (Transatlantic Trade and Investment Partnership), shows that the reduction of non-tariff trade barriers and the introduction of quality standards reallocate quality across entry alternatives, making FDI a relatively more prominent entry type.

2. The Structure of Multinational Sales under Demand Risk

joint with Ekaterina Kazakova

2.1. Introduction

The activity of multinational enterprises (MNEs) comprises a set of complex location and sales decisions. First, MNEs decide in which countries to establish production facilities through foreign direct investment (FDI); in doing so, they typically weigh the benefit of proximity to customers against the cost of setting up a foreign plant. Second, MNEs decide how much to produce in each foreign plant; in particular, the output of a foreign plant can serve the local and the neighboring markets if MNEs use their production facilities as export platforms.[1]

Crucially, MNEs make the investment and production decisions *before* observing the realization of demand in each market. In addition, such realizations can be correlated across the foreign markets served by the MNEs. In other words, the MNEs' activity is subject to the risk of unfavorable demand fluctuations which can be correlated across foreign markets. This is what we define as demand risk. If MNEs are risk averse, then the location and sales decisions hinge both on the expected demand for each market and the correlation structure of demand realizations across destination markets.

Demand risk is an important determinant of multinational activity. For example, the UNCTAD World Investment Report 2010 describes how MNEs adjusted their investment flows and organization of production in response to the demand fluctuations following the outbreak of the financial crisis. Specifically, FDI flows favored, in relative terms, countries less affected by the economic downturn.[2]

[1] According to the World Investment Report 2017, foreign affiliates of MNEs exported approximately 20% of their total output abroad in 2016.

[2] Though global FDI flows decreased after 2008, the ratio of FDI inflows into developed compared to developing countries substantially changed. Specifically, FDI flows in developed countries contracted by 44% in 2009, whereas those in developing and transition economies fell by 27%. Thanks to their rapidly expanding local demand and resilience to the crisis, the developing regions accounted for the majority of worldwide FDI inflows for the first time.

This chapter addresses the question of how demand risk shapes investment and sales decisions of MNEs. For this purpose, we propose a structural model of horizontal FDI with firms that are heterogeneous in terms of productivity and risk aversion. MNEs decide about the locations of their production facilities, which countries to serve from each plant and the volume of production to sell in each market. They make all the above decisions under demand risk, i.e. before observing the realizations of demand in the destination markets. With risk averse MNEs and correlated demand realizations, investment and sales decisions are interdependent and similar to a complex portfolio choice problem. In particular, each market in which the MNE sells its output yields a risky return which imperfectly correlates with the returns offered by other foreign markets. Thus, the sales depend on the expected return, related to the expected demand realization in the market, and the diversification opportunities, related to how the market demand correlates with that of the other markets. *Ceteris paribus*, markets that offer better hedging opportunities to multinationals induce larger sales, and the more risk averse the firm is, the more beneficial the diversification is.

Foreign plants serve as export platforms since they can originate sales to local and third markets. Such export platforms reduce the effective distance between the MNE and a destination market. This results in an expected demand increase in the market itself. Moreover, establishing the plant eases MNE's access to markets, which may be possibly correlated in a favorable fashion to the ones the MNE already sells to. However, setting up a foreign plant comes at a fixed cost. Thus, MNEs have to trade off the described increase of the expected demand paired with the reduction in demand risk against the fixed set-up cost. Due to complementarities, the attractiveness of each foreign plant depends on the set of other plants owned by the MNE. Hence, the location entry choice of MNEs is a complex combinatorial discrete choice problem with complementarities. In particular, with N locations and a given host country of the MNE, there are 2^{N-1} eligible location sets.

Several theoretical implications related to the MNEs' activities result from our model.

First, our model rationalizes why expected sales in a given market are not a sufficient statistic for the entry decisions of multinationals in this market. Standard models of horizontal FDI (Helpman et al., 2004) have the counterfactual implication that distance-adjusted market size determines a monotone ranking in terms of entry: all firms sell to close and large markets as they are associated with large expected sales. However, only more productive firms afford to sell to smaller and more distant markets as they command lower expected sales. By contrast, in our model the described ranking does not necessarily obtain because the attractiveness of establishing a plant in a foreign country depends also on the diversification opportunities offered by this location, which depend, in turn, on the characteristics of other MNE's locations. As a consequence, if a low productive MNE opens up a foreign production facility, say, both in France and China, a highly productive one does not necessarily set up a plant in these two countries too as also demand risk matters.

These results hold when core productivity varies given the level of risk aversion and vice versa. Specifically, a larger degree of risk aversion does not automatically reduce the number of foreign locations a firm decides to enter.

Second, heterogeneity in risk aversion leads to country-firm-specific markups even when the elasticity of demand is constant. In fact, the firm chooses a quantity to ship in each country which reflects three factors: (i) country's demand variance and (ii) diversification potential, and (iii) the degree of risk aversion of the firm. As a result, the firm scales up or down the optimal quantity it would sell under no risk by a factor which reflects (i) – (iii), implying a different realized price in each of the markets.[3]

Third, demand risk diversification can impact on the outcomes of trade policies. A tariff reduction in a country which offers a good hedging potential can magnify the effect of a trade liberalization on trade flows compared to standard models.[4] Moreover, trade liberalization can give rise to third-country effects. In other words, sales flows may change also in countries which are not directly interested by the policy change, with the direction of the change depending on the sign of the correlation. To be specific, countries offering a demand hedge with respect to the market for which trade costs have been reduced experience an increase in imports, whereas markets whose demand is highly and positively correlated with the liberalized market are subject to negative spillovers.

The empirical analysis uses firm-level data on German multinationals operating in the manufacturing sector. The data represent the universe of German multinational firms holding an investment position in a foreign country and contain information about the balance sheet and location of the foreign affiliates. By exploiting the properties of the solution to the MNE's optimization problem described in the present chapter, we match the observed sales to the ones predicted by our model to obtain a measure of firm-specific absolute risk aversion. We find that the German multinational companies are risk averse. Moreover, the degree of risk aversion is heterogeneous across firms. The findings are consistent with our theoretical model which predicts that the level of correlation across foreign markets directly affects the composition of the sales portfolio of German multinationals. Compared to the risk neutral benchmark, firms tend to sell relatively more to the countries providing a better hedge. We estimate the risk aversion elasticity of aggregate sales to be 0.8 (in absolute value). We find that risk aversion varies across the different manufacturing sectors included in our analysis. Specifically, risk aversion correlates with the demand characteristics of the sector rather than with technological features. Furthermore, more risk averse firms operate in industries characterized by a relatively more disperse demand. In a

[3]In our framework, the price can be thought of as the residual equalizing the realized demand to the supply.

[4]On the contrary, a lower hedging potential or higher demand volatility may dampen the effect of a trade liberalization.

counterfactual analysis, we assess the effect of a tariff reduction on products exported to China. We find that the policy change increases the sales of German MNEs not only in China but also in the USA and Japan, whereas neighboring countries like Hong Kong and Singapore are negatively affected. Other, less correlated countries are less affected. We also demonstrate how a change in risk aversion of German companies (e.g. due to the entry of new firms or to the reduction of financial constraints) produces a larger variation in the sales toward those countries which are more correlated with Germany, whereas more distant regions are less influenced.

2.1.1. Related Literature

The present chapter relates to the literature studying firm's incentives to conduct horizontal FDI versus export (the so-called proximity-concentration tradeoff) in the presence of uncertainty. The closest contribution to the chapter is Tintelnot (2017) who proposes a structural model of firms engaging in multinational activities where they can use foreign affiliates as export platforms. His analysis assesses the costs involved in multinational production and the incentives of firms in designing their global operations under imperfect transferability of technology from the parent company to its subsidiaries. As Tintelnot (2017), we account for the importance of export platforms in shaping the multinational organization of production. However, we rather concentrate our attention on the role played by export platforms in affecting the sales structure of MNEs when the demand is risky and MNEs are risk averse. Indeed, the possibility of reaching markets different from the local one makes it possible for a firm to fully exploit the diversification opportunities offered by the foreign sales. The impact of technological and demand uncertainty on the choice between exporting and establishing a foreign production facility has been also addressed by Ramondo, Rappoport, and Ruhl (2013). In particular, they study the above tradeoff in the presence of country-specific shocks to the production costs and to the demand. The firm's dynamic choice between export and FDI hinges on the heterogeneous correlation existing between production costs across home and foreign countries. In particular, firms are more likely to select export over FDI in markets characterized by productivity shocks poorly correlated with those at home. In particular, as demand and costs are positively correlated, engaging in multinational activity entails high foreign production cost when the foreign demand is high and this partly offsets the benefits from FDI compared to exporting, which requires domestic inputs. With reference to the demand shocks, they find that firms are more likely to serve volatile locations by exporting activity. Differently from them, we focus on the demand side and highlight the importance of demand correlations across different markets in shaping entry and production choices. Other contributions investigating multinational activity under uncertainty are Rob and Vettas (2003), who discuss uncertain demand growth in foreign markets, and Chen and Moore (2010), who concentrate on idiosyncratic shocks to firm demand in the foreign market. With reference to the last paper, the authors find that more productive firms are more likely than less efficient ones to enter into tougher markets. Their result does not necessarily obtain in our framework since allowing for risk averse firms and demand interdependencies across countries break the monotonicity in the firms' entry choice with respect to productivity. Campa (1993), Goldberg and Kolstad (1995), and Russ (2007) introduce risk in the form of exchange rate fluctuations and find that firms take into account the exchange rate volatility when they solve the proximity-concentration tradeoff. Aizenman and Marion (2004) analyze the role of uncertainty on the choice between vertical and horizontal FDI, demonstrating how higher uncertainty should induce firms to favor horizontal over vertical FDI. This conclusion is in line with the idea that MNEs diversify their demand risk by using their production and sales structure. Ramondo and Rappoport (2010) explore the role of FDI flows both as an asset available to consumers for diversification and as a means for transferring technology across countries; the existence of multinational production affects the amount of goods available in each state of the world and reduces consumption risk as long as foreign affiliates are located in regions characterized by good hedging properties with respect to the world consumption risk.

The chapter also closely relates to the growing literature on the role of demand risk in international trade. Specifically, Di Giovanni and Levchenko (2012) analyze the risk content of exports and show that cross-country specialization patterns depend both on the comparative advantage and the riskiness of those sectors in which they have a comparative advantage. Kramarz, Martin, and Mejean (2016) quantify the contribution of idiosyncratic demand shocks and the structure of trade to the volatility of exports, and link the volatility of exporters to the low level of diversification in the client portfolio held by a firm. Conconi, Sapir, and Zanardi (2016) show that firms learn about their profitability in a foreign market by entering there as exporters before engaging in FDI activities. Our model implicitly assumes immediate learning; upon entering into a foreign market all uncertainty about the demand realization unravels.

We also contribute to the growing literature regarding the relation between firms' preferences toward risk and international trade. In particular, De Sousa, Disdier, and Gaigné (2017) and Esposito (2017) analyze risk averse exporters in the presence of demand shocks. The present chapter differs from these contributions along several dimensions. First, De Sousa et al. (2017) and Esposito (2017) focus on pure exporters.[5] MNEs typically face lower marginal costs compared

[5]In comparison with pure exporters, multinational enterprises typically have more opportunities of adjusting their sales across markets since they are present in several foreign countries. In this regard, the UNCTAD World Investment Report 2008 highlights how multinationals exhibited more stable sales than pure exporters during the crisis, in line with the idea that multinational firms benefit more extensively from diversification than other firms. Therefore, demand risk diversification plays a greater role for MNEs than for exporters. In addition, such a role can be assessed only in a framework which allows for the presence of export platforms. Not taking into account this possibility would lead to consider a (potentially) misspecified demand.

with exporters; as a consequence, it is more likely that for the latter the benefits of diversification outweigh the transportation costs. Second, we distinguish from De Sousa et al. (2017) since we allow for correlated expenditures across destination markets and abstract from the possible effects of skewed demand shocks; with regard to Esposito (2017), we focus on the risk affecting a firm both at the industry and macroeconomic levels, whereas he focuses on firm-specific demand shocks.[6] Riaño (2011) considers the investing and exporting decisions of risk averse managers in a framework where both productivity and demand are subject to firm-specific shocks. He proves that exporting increases the volatility of the firm's sales.

The present chapter also contributes to the literature on interdependent foreign markets. In Nguyen (2012a), firms learn the demand realization in potential foreign destinations by exporting given the positive correlation of demands across countries. Albornoz, Calvo Pardo, Corcos, and Ornelas (2012) consider a model of experimenting exporters who learn about their own profitability by entering into foreign markets. Under the assumption that profits exhibit the same positive correlation across different foreign destinations, risk regarding profits reduces over time not only in the markets the firm is present in, but also in the other unexplored markets. With respect to the above contributions, we relax the assumption that demand correlations are positive. Vannoorenberghe (2012) shows that foreign and domestic sales are negatively correlated at the firm level, which supports the hypothesis that firms diversify by selling abroad. Vannoorenberghe, Wang, and Yu (2016) shows that volatility of exports increase (decrease) with the level of diversification of destination countries reached by a small (large) firm. This result is justified with the presence of fixed costs and short-run demand shocks. Our analysis extends the above contribution by highlighting the role of heterogeneity in risk aversion and the importance of multinational activity.

Finally, this chapter is connected to the recent contributions on export platforms and multinational production. In particular, we model export platforms similarly to Tintelnot (2017) and Head and Mayer (2017).[7] Analogously to Ekholm, Forslid, and Markusen (2007) and Arkolakis, Ramondo, Rodríguez-Clare, and Yeaple (2018), we find the spillover effects of liberalization arising from the complexity of global value chains. Differently from their papers, we introduce demand-side spillovers affecting multinational production. However, to our knowledge, we are the first to highlight the importance of export platforms in enhancing sales diversification.

[6] In addition, in our framework, the firms are heterogeneous in terms of risk aversion. Cucculelli and Ermini (2013) provide evidence that managers differ in risk attitudes in a sample of Italian manufacturing firms. In particular, they find that about 76% of the managers display a risk averse attitude, 17% a risk neutral attitude and the rest a risk loving attitude. Hence, 93% of managers in their sample exhibit a (weak) risk aversion. This heterogeneity is also correlated with firm's characteristics like size, age, and innovativeness. Moreover, different financial conditions can result in differences in hedging opportunities by other means than sales.

[7] In our framework, the choice of serving a foreign market from an affiliate is deterministic.

The remainder of the chapter is structured as follows. Section 2.2 introduces the theoretical model and shows how risk aversion enters into firm's production and FDI decisions. Section 2.3 discusses the data used in the estimation. Section 2.4 describes the estimation procedure. Section 2.5 presents the main empirical results. Section 2.6 concludes.

2.2. Model

This section proposes a version of Chaney (2008) with N countries indexed by $d \in D \equiv \{1, \ldots, N\}$, and $I+1$ sectors indexed by $i = 0, \ldots, I$.

2.2.1. Demand

In each country d, there is a representative consumer whose total income equals Y_d. Her preferences are represented by the following quasi-linear utility function in the homogeneous good Q_{0d}

$$U_d = \sum_{i=1}^{I} \alpha_{id} \ln Q_{id} + Q_{0d}, \tag{2.1}$$

where $\alpha_{id} > 0$ is the absorption relative to the sector i and destination d, and Q_{id} denotes a Dixit-Stiglitz aggregate good i in country d, that is,

$$Q_{id} = \left[\int_{\omega \in \Omega_{id}} q_{id}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}. \tag{2.2}$$

The elasticity of substitution σ between any two varieties and ω' is larger than 1. The set Ω_{id} represents the varieties of Q_{id} sold in country d.

The absorption α_{id} is random. In particular, one can think of it as a shifter to consumer's preferences with respect to the aggregate good Q_{id}, describing fluctuations occurring at the industry and aggregate levels. For example, it can represent a change in the quality of the product produced in the industry i or an exogenous change in country d's total income or aggregate demand.

Realizations of absorptions in different countries can be correlated; they tend to move in the same (opposite) directions in countries either characterized by similar (opposite) tastes for a certain product or displaying more (less) integrated economies.

We assume that the vector of absorption $\boldsymbol{\alpha}_i = (\alpha_{i1}, \ldots, \alpha_{id}, \ldots, \alpha_{iN})$ has a bounded expected value, denoted by $\bar{\boldsymbol{\alpha}}_i = (\bar{\alpha}_{i1}, \ldots, \bar{\alpha}_{id}, \ldots, \bar{\alpha}_{iN})$, where $\bar{\alpha}_{id}$ is the expected absorption for the good Q_{id}. In addition, $\boldsymbol{\alpha}_i$ has a full-rank variance-covariance matrix Σ_i. The element in position (d, d')

of the matrix Σ_i represents the long-run covariance between the absorption in countries d and d' and is denoted by $\Sigma_i(d, d')$. We assume that, if $d \neq d'$, then it holds

$$-1 < \frac{\Sigma_i(d, d')}{\sqrt{\Sigma_i(d, d)\Sigma_i(d', d')}} < 1. \tag{2.3}$$

The above restriction on Σ_i excludes the possibility that the cross-correlations between the demand realizations in two destination countries are perfect.[8]

The representative consumer observes the realizations of the vector α_{id} for $i = 1, \ldots, N$ and makes any consumption decision accordingly.

The consumption bundle chosen by the consumer follows from the solution of the following utility maximization problem

$$\begin{aligned} &\max \sum_{i=1}^{I} \alpha_{id} \ln Q_{id} + Q_{0d} \\ &\text{s.t. } Q_{0d} + \sum_{i=1}^{I} \int_{\omega \in \Omega_{id}} p_{id}(\omega) q_{id}(\omega) d\omega = Y_d, \end{aligned} \tag{2.4}$$

from which we obtain $Q_{0d} = Y_d - \sum_{i=1}^{I} \alpha_{id}$ and $P_{id}Q_{id} = \alpha_{id}$, where P_{id} is the price index associated to Q_{id}.[9] In addition, the inverse demand for the variety is given by

$$p_{id}(\omega) = A_{id} q_{id}(\omega)^{-\frac{1}{\sigma}}, \text{ with } A_{id} \equiv \alpha_{id} Q_{id}^{-\frac{\sigma-1}{\sigma}} \text{ and } \Upsilon_{id} \equiv Q_{id}^{-\frac{\sigma-1}{\sigma}}, \tag{2.5}$$

where $p_{id}(\omega)$ is variety 's price in country d.

For the following discussion, we let $\boldsymbol{\Sigma}_{A_i} \equiv \Upsilon_i' \boldsymbol{\Sigma}_i \Upsilon_i$ denote the variance of $\boldsymbol{A}_i = (A_{i1}, \ldots, A_{Ni})$.

2.2.2. Firms

Each firm produces exclusively one variety of the differentiated good Q_{id}. We index this variety by ω. Since there exists a one-to-one relation between firms and varieties, we drop any industry-related subscript.

Firms also differ with respect to the level of productivities $\boldsymbol{\varphi}$, risk aversion r, fixed entry costs $\boldsymbol{f}$, and origin country o. Hence, a firm is fully characterized by the vector of variables $(\omega, \boldsymbol{\varphi}, r, \boldsymbol{f}, o)$.

In this section, we consider an arbitrary firm so we suppress also the index referring to the variety ω it produces.

[8] As the estimated industry variance-covariance matrix satisfies this requirement, the assumption is not stringent.
[9] We assume that Y_d is large enough to avoid the possibility of incurring in a corner solution.

A firm can observe the above variables at no cost before making any choice. Its profits are determined by three simultaneous decisions. First, a firm makes a *location decision*, i.e. it picks the set of locations in which to establish a foreign affiliate.[10] We denote a location set by L with $L \in \mathcal{L} = 2^{N-1}$ as we assume that the firm is always present in its home country. Second, a firm makes a *shipment decision*, i.e. it chooses the optimal location as origin for shipping the variety in a given destination market. Third, a firm makes a *production decision*, i.e. it selects the quantity of the variety to sell in each destination. Crucially, the three decisions are made before observing the actual realizations of demand in the destination markets. Hence, a firm decides under demand risk. In particular, the fact that the produced quantity cannot be adjusted following the realization of the demand implies that a firm is exposed to price fluctuations in the destination markets.[11]

In the following paragraphs, we closely describe firm's technology and each decision.

Technology and production costs. The firm has to pay a fixed entry cost f_l to set up a plant in the foreign location l. The fixed entry cost represents the firm-specific cost of building or acquiring a foreign plant in the country.[12]

In addition, the firm has a different level of productivity associated to each of its foreign plants. This assumption reflects two things. On the one hand, the firm can face productivity losses due to the imperfect transferability of technologies and production skills within its boundaries. On the other hand, the firm can possibly take advantage of the production infrastructure of its foreign affiliate.[13]

When firm produces in location l, it has to bear a variable production cost which is inversely proportional to the firm's location-specific productivity φ_l. The variable cost of producing q_l units in country l is, then, given by

$$C(q_l) = \frac{q_l}{\varphi_l}. \tag{2.6}$$

The firm can use its plant in location l to serve both the local and any other destination market. This means that the firm owns an export platform in country l. However, if the firm uses the production facility in country l to serve the foreign destination market d, then it has to pay an iceberg trade cost $\tau_{ld} > 1$.[14]

We denote the constant marginal cost of producing the variety in location l and shipping it to country d by $c_{ld} \equiv \tau_{ld}/\varphi_l$.

[10]Note that we assume that a parent company can maintain at most one foreign plant in each destination market.

[11]We discuss a relaxation of this assumption in Appendix G.

[12]In other words, we do not distinguish between greenfield and brownfield investments.

[13]More concretely, existing contracts with foreign counterparts, lower input prices, or the adoption of advanced techniques can make a foreign affiliate more productive than its parent. Need for learning, institutional differences between foreign countries and home, or technology adjustment cost can lead to productivity losses in a foreign market.

[14]If $l = d$, then $\tau_{ll} = 1$.

As in Tintelnot (2017), we abstract from the presence of any export fixed cost.[15] This restriction can be motivated by two considerations. First, MNEs tend to enter sequentially in foreign markets;[16] manufacturing firms generally start their activity abroad with exporting rather than operating a foreign production facility. When a firm sets up a foreign affiliate, the firm substitutes the origin of its trade flows for some of the foreign destination markets. This means that those destination markets, previously reached by the home production, can be served by the new production facility. Thus, the firm has already previously paid the fixed cost of exporting to the market. Second, one can think that part of the fixed export entry cost collapses into the fixed entry cost associated to the FDI.

Production decision. We assume that the firm does not observe the size of the aggregate demand in the destination markets before making any production decision. Hence, firm's profit is a random variable. As firm is risk averse, this implies that it does not only consider the (expected) profit in a prospective destination market but also its volatility and how it comoves with the profits in the other markets.

In line with this, sales across different destination markets can be seen as risky assets held as a sales portfolio by the firm, similarly to the standard setting of portfolio choice.[17] As the demand realizations are correlated across foreign markets, the sales of an affiliate not only depend on the local productivity, the size of the surrounding markets, and the cost of reaching them but also on the set of other locations where the firm is present, and the correlation structure in the destination markets. All these factors together affect the composition of the production portfolio chosen by the firm.

In the production decision, firm chooses how much to ship to each destination. We assume that firm's preferences are represented by a mean-variance utility function of profits in destination markets. This representation of preferences has been extensively used in the literature, and it can be also considered as a second-order Taylor approximation of a twice-differentiable increasing and concave utility function around the expected profits.[18]

[15]Estimating export entry costs would require us to observe data on multinational sales disaggregated by destination.

[16]See Conconi et al. (2016).

[17]The crucial difference with respect to the standard setting of portfolio choice relates to the presence of non-linear shares due to the CES preferences. As a consequence, the expected returns of the firm's portfolio vary with the size of share chosen by the firm.

[18]See Eeckhoudt, Gollier, and Schlesinger (2005). In particular, the second-order Taylor approximation is exact if (i) the Bernoulli utility function is CARA and (ii) the distribution of the random variable is fully characterized by the first two moments.

Throughout this section, we drop the location subscript l from the quantity q_{ld} under the assumption that the firm makes the optimal shipment choice (see successive paragraph). Given that, the realized profit of the firm selling to the destination countries $d = 1, \ldots, N$ is given by

$$\Pi(\boldsymbol{q}|L, \boldsymbol{\varphi}, r) = \sum_{d} (p_d q_d - c_d q_d) \tag{2.7}$$

$$= \sum_{d} \left(q_d^{\frac{\sigma-1}{\sigma}} \left(A_d - c_d q_d^{\frac{1}{\sigma}} \right) \right), \tag{2.8}$$

where $\boldsymbol{q} = (q_1, \ldots, q_d, \ldots, q_N)$ denotes the amount of the variety shipped to the destination markets given the optimal shipment choice. Hence, the expected profit is given by

$$\mathbb{E}[\Pi(\boldsymbol{q}|L, \boldsymbol{\varphi}, r)] = \sum_{d} \left(q_d^{\frac{\sigma-1}{\sigma}} \left(\mathbb{E}[A_d] - c_d q_d^{\frac{1}{\sigma}} \right) \right), \tag{2.9}$$

whereas the variance of profits is given by

$$\text{var}\left(\Pi\left(\boldsymbol{q}|L, \boldsymbol{\varphi}, r\right)\right) = \sum_{d} \sum_{d'} \text{cov}(A_d, A_{d'}) q_d^{\frac{\sigma-1}{\sigma}} q_{d'}^{\frac{\sigma-1}{\sigma}}. \tag{2.10}$$

Note that the variance does not depend directly on production costs, as risk only relates to the fluctuations of demand in the destination markets.[19]

Conditional on the choice of the location, the utility function of the firm is then given by

$$u(\Pi(\boldsymbol{q}|L, \boldsymbol{\varphi}), r) = \mathbb{E}\left[\Pi\left(\boldsymbol{q}|L, \boldsymbol{\varphi}, r\right)\right] - \frac{r}{2}\text{var}(\Pi(\boldsymbol{q}|L, \boldsymbol{\varphi}, r)) \tag{2.11}$$

where r is the firm's risk aversion. To find the optimal vector of quantities to ship to the foreign destination markets, the firm solves the following utility maximization problem

$$V(L) \equiv \max_{\boldsymbol{q} \in \mathbb{R}_+^N} \mathbb{E}\left[\Pi(\boldsymbol{q}|L, \boldsymbol{\varphi}, r)\right] - \frac{r}{2}\text{var}\left(\Pi\left(\boldsymbol{q}|L, \boldsymbol{\varphi}, r\right)\right), \tag{2.12}$$

where $V(L)$ denotes the indirect utility function associated to the location set L.

[19]Other sources of risk, like unexpected change to the production costs, are not taken into account in the present chapter.

For $d \in D$ such that $q_d > 0$, the first-order necessary[20] and sufficient conditions[21] with respect to q_d is given by

$$\frac{\partial u(\Pi(\boldsymbol{q}|L,\boldsymbol{\varphi},r))}{\partial q_d} = \frac{\partial \mathbb{E}\left[\Pi(\boldsymbol{q}|L,\boldsymbol{\varphi},r)\right]}{\partial q_d} \tag{2.13}$$

$$- \frac{r}{2}\frac{\partial \text{var}\left(\Pi\left(\boldsymbol{q}|L,\boldsymbol{\varphi},r\right)\right)}{\partial q_d} = 0, \tag{2.14}$$

where

$$\frac{\partial \mathbb{E}[\Pi(\boldsymbol{q}|L,\boldsymbol{\varphi},r)]}{\partial q_d} = \frac{\sigma-1}{\sigma}\mathbb{E}[A_d]q_d^{-\frac{1}{\sigma}} - c_d,$$

and

$$\frac{\partial \text{var}(\Pi(\boldsymbol{q}|L,\boldsymbol{\varphi},r))}{\partial q_d} = \frac{2(\sigma-1)}{\sigma}\left(q_d^{-\frac{1}{\sigma}}\sum_{d'}\text{cov}(A_d,A_{d'})q_{d'}^{\frac{\sigma-1}{\sigma}}\right).$$

Hence, for all d such that $q_d > 0$, it holds

$$q_d^{-\frac{1}{\sigma}}\frac{\sigma-1}{\sigma}\left(\mathbb{E}[A_d] - r\sum_{d'}\text{cov}(A_d,A_{d'})q_{d'}^{\frac{\sigma-1}{\sigma}}\right) = c_d. \tag{2.15}$$

Proposition 1. *(Existence and Uniqueness). If the matrix $\boldsymbol{\Sigma}$ has cross-correlations bounded away from -1 and 1, there exists a unique solution to the firm's utility maximization problem.*

Proof. See Appendix A. □

Proposition 1 implies that the optimal production portfolio of firm exists and is unique given the set of locations of foreign affiliates. Since firm's realized sales are a random variable due to the presence of aggregate demand fluctuations, the proposition also implies that their mean and variance are well-defined and unique. As we will show later, this guarantees that the measure of firm's risk aversion implied by our model is well-defined and theoretically identified.

For arbitrary values of σ, the above non-linear system of equations (2.15) does not have a closed-form solution. However, to provide some intuition on the optimal level of quantities sold in each destination, we show how the first order condition looks like for the case in which $\sigma = 2$. In particular, the first-order conditions for this case can be rewritten as

$$q_d = \left(\frac{\mathbb{E}[A_d]}{2c_d}\right)^2 \cdot \left(\frac{1 - r\frac{\sum_{d'\neq d}\text{cov}(A_d,A_{d'})q_{d'}^{\frac{1}{2}}}{\mathbb{E}A_d}}{1 + r\frac{\text{var}(A_d)}{2c_d}}\right)^2. \tag{2.16}$$

[20]We notice that the utility function is not differentiable when $q_d = 0$. However, as export fixed costs are set to zero, the firm always sells a positive amount to each destination markets.

[21]We defer the discussion about the concavity of the objective function to a later stage.

The first factor of the right hand side of equation (2.16) represents the quantity chosen by the firm if there is no risk aversion or uncertainty. If the expected market size in the market d is large relatively to the marginal cost of production inclusive of the trade costs, then the firm's sales to country d are large. The second part, instead, is the factor by which the firm optimally rescales the level of production shipped to country d due to the joint effect of risk aversion and demand risk. Specifically, this factor decreases with the specific risk associated to the destination d (captured by the variance $\text{var}(A_d)$ in the denominator), whereas it increases with the opportunities of diversification offered by the market d (captured by the covariances $\text{cov}(A_d, A'_d)$ in the numerator). Hence, countries characterized by larger variance or lower diversification potential attract smaller sales the more risk averse the MNE is.

Additionally, the first-order necessary and sufficient conditions in (2.15) can also be rearranged to obtain the risk aversion coefficient r implied by the solution to the firm's utility maximization problem.

Proposition 2. *(Risk aversion measure). The measure of risk aversion is a function of the optimal production portfolio, and is equal to*

$$r = \frac{\sum_d \left(\mathbb{E}p_d q_d - \tilde{p}_d q_d\right)}{\left(\boldsymbol{q}^{\frac{\sigma-1}{\sigma}}\right)' \boldsymbol{\Sigma}_A \boldsymbol{q}^{\frac{\sigma-1}{\sigma}}},$$

where $\mathbb{E}p_d$ *is the expected price in country* d*,* $\tilde{p}_d = \frac{\sigma}{\sigma-1}c_d$ *is the price under certainty in country* d*, and* $\boldsymbol{q}^{\frac{\sigma-1}{\sigma}}$ *is a vector whose* d *component is* $q_d^{\frac{\sigma-1}{\sigma}}$*, where* q_d *is the optimal quantity sold in country* d*.*

Proof. See Appendix B. □

In the representation of risk aversion offered in Proposition 2, the denominator is given by the variance of sales in the destination markets, whereas the numerator measures the risk premium a firm demands in terms of revenues as a compensation for the risk. Therefore, the risk aversion parameter shows the amount of extra markup a firm requires for a given level of riskiness of its sales portfolio. Given the heterogeneity in risk aversion, our model predicts that more risk averse firms charge higher markups, on average. Moreover, the adjustment of prices after the realization of demand shocks result in firm-destination-specific markups implied by the firm's choices. As the quantities shipped to each destination are different for similarly productive but differently risk averse firms, we can rationalize heterogeneous adjustment of prices to demand shocks.

Finally, the following results show the relation between the aggregate sales and the level of risk aversion.

Proposition 3. *(Risk Aversion and Aggregate Sales). The firm's aggregate sales are decreasing with risk aversion.*

Proof. See Appendix E. □

A more risk averse MNE tries to limit the demand risk it faces in its international activity by reducing the intensive margin of sales. It is worthwhile to notice that a change of risk aversion does not proportionately change the contribution of each destination to the MNE's sales portfolio. In particular, an increase of risk aversion induces the firm to substitute out relative risky destinations with safe ones (and vice versa).

Our framework assumes that a firm selects the optimal quantity rather than the optimal price to charge in each market. In Appendix F, we discuss how the results would differ when the firm sets the price instead.

As a reference point, it is useful to compare the case of risk aversion when (i) we remove the presence of export platforms, and (ii) we exclude risk.

No export platforms. Without export platforms, the system of equations (2.15) reads as

$$q_l^{-\frac{1}{\sigma}} \frac{\sigma - 1}{\sigma} \left(\mathbb{E}[A_l] - r \sum_{l'} \text{cov}(A_l, A_{l'}) q_{l'}^{\frac{\sigma-1}{\sigma}} \right) = c_l, \tag{2.17}$$

where l is a location in which the MNE holds a production facility. From equation (2.17), we notice that the diversification opportunities that the firm can achieve in this case are just a subset of those achievable in the model with export platforms, fixing the location set. In particular, only the covariances associated to the markets in which the firm has established a foreign affiliate appear in (2.17). As the firm sells the variety produced in l only to the local market, the marginal cost simply reduces to $1/\varphi_l$. For the special case of $\sigma = 2$, we obtain an expression similar to (2.16). In particular, we have

$$q_l = \left(\frac{\mathbb{E}[A_l]}{2c_l} \right)^2 \cdot \left(\frac{1 - r \frac{\sum_{l' \neq l} \text{cov}(A_l, A_{l'}) q_{l'}^{\frac{1}{2}}}{\mathbb{E}A_l}}{1 + r \frac{\text{var}(A_l)}{2c_l}} \right)^2. \tag{2.18}$$

If a firm uses the foreign plant l as an export platform, then the quantity predicted by the model sold to location l is not correct when we do not consider export platforms. In particular, the factor that scales up or down the quantity the firm wants to sell under no risk aversion or no uncertainty just considers the sales realized locally by the different foreign facilities without taking into account the possibility of demand risk diversification offered by the other markets in which the MNE is not physically present.

No risk aversion. In this case, the solution to the optimization problem has a closed form. In particular, it holds

$$q_d = \left(\frac{\sigma - 1}{\sigma}\frac{A_d}{c_d}\right)^{\sigma}. \tag{2.19}$$

Equation (2.19) shows how the quantity shipped to each destination increases with the realized size of the market, the productivity of the origin production facility, and decrease with trade costs. Assume that location l serves the subset of destinations $\tilde{D}$.[22] Using equation (2.19), we obtain that the revenues r_l realized in a given location l are given by

$$r_l = \sum_{d\in\tilde{D}} p_d q_d = \kappa\varphi_l^{\sigma-1}\sum_{d\in\tilde{D}}\frac{\alpha_d}{P_d^{1-\sigma}}\tau_{ld}^{1-\sigma}, \tag{2.20}$$

where $\kappa \equiv \left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}$. The expression for the revenues realized in a given location is similar to the one in Tintelnot (2017). In particular, if there is only one industry, then $\alpha_d = Y_d$. In the equation (2.19), it is easy to see that the revenues realized in some location increase with the productivity of the location whereas decrease with the distance between the foreign affiliate and the customers in the destination markets.[23]

Shipment decision. This paragraph describes how the firm selects the optimal location for shipping its variety to a given destination market.

The shipment decision hinges on the firm's productivity vector $\boldsymbol{\varphi}$ given the locations in which it is present, and on the trade costs associated to the possible location-destination pairs. As the shipment cost is independent of demand risk, the optimal decision exclusively relies on firm's productivity and iceberg trade costs. In particular, as returns to scale are constant, a standard cost minimization argument implies that the destination d is served from the location l if the unit cost c_{ld} is the lowest possible one. In other words, $q_{ld} > 0$ only if $c_{ld} = \min_{l'}\{c_{l'd} : l' \in L\}$.[24] It is worth to note that the optimal location-destination pair strictly depends on the location set L chosen by the firm.

Location decision. As stated, firm has to pay a fixed cost f_l for entering location l and setting up a plant there. This cost is observed by the firm before making its location choice. In our

[22]How the MNE makes this decision is the object of the next paragraph.

[23]If we also drop the assumption that firms can use a foreign location as an export platform, then equation (2.19) reduces to

$$r_l = \kappa\varphi_l\frac{\alpha_l}{P_l^{1-\sigma}}.$$

[24]This analysis abstracts from any possible indeterminacy arising when $c_{ld}, c_{l'd} \in \arg\min_{l'}\{c_{l'd} : l' \in L\}$ for $l \neq l'$. As productivities can be thought as draws from a continuous distribution, such event has probability equal to 0.

framework, the sum of fixed costs is considered as the price of holding a portfolio of risky assets associated to the locations from which it is possible to serve the local and foreign markets. The fixed costs enter as a constant in the utility of the firm. The observation implies that the sum of fixed costs associated to any location set can be separately subtracted from the value function obtained from the production and shipment decisions for that location set. As a consequence, in order to find the optimal location L^* for its multinational activity under demand risk, the firm solves the following discrete maximization problem

$$\max_{L \in 2^{N-1}} V(L) - \mathcal{F}(L), \quad \text{where } \mathcal{F}(L) = \sum_{l \in L} f_l. \tag{2.21}$$

2.2.3. Comparative Statics

In this section, we describe the effect of risk aversion on the MNE's production and location choices by means of some illustrative examples. First, fixing firm's productivity and chosen location set, we show how different demand correlation structures affect the firm's aggregate and relative sales across countries. Second, we conduct a trade liberalization exercise to show the existence of spillovers on trade flows to third countries when firms are risk averse. Finally, we consider how the location choice can be affected by the presence of risk aversion: in particular, to assess the effect of heterogeneous attitudes towards risk on the location decision, we analyze how firms with different levels of risk aversion and equal level of home productivity select different locations for establishing their foreign affiliates; we then conduct a similar exercise to show how differently productive firms, equally averse to risk, can select different location sets that do not necessarily nest.

The Role of Demand Correlations

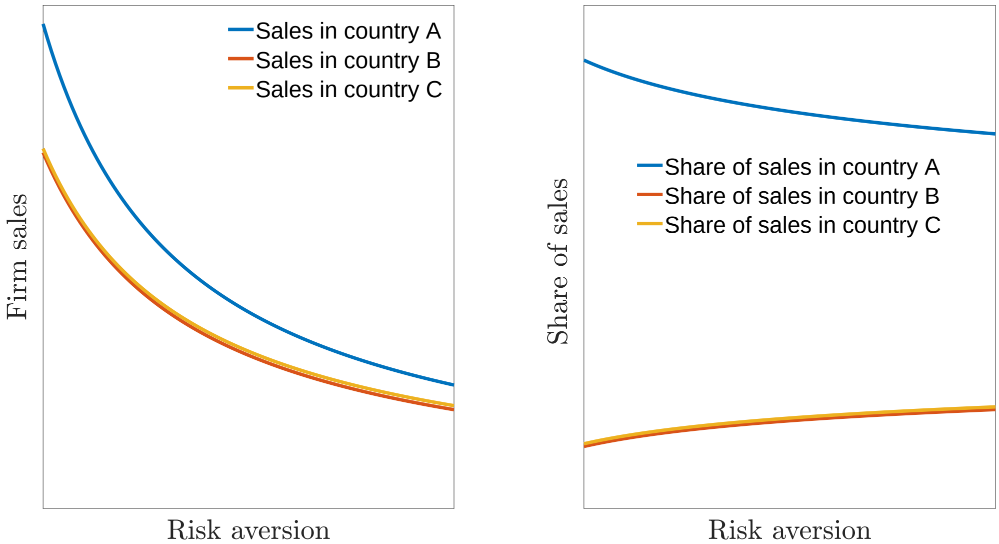
Throughout the subsection, we consider an economy consisting of three countries, A, B, and C. The variance of demand realizations, the (expected) market sizes, and the trade costs are equal for the three countries.[25] In addition, the firm holds its unique affiliate in country A. Given the above assumptions, we represent the absolute and relative sales of a firm to each country for a given level of risk aversion.

[25]We do not focus on the distinction among safer and riskier markets but rather concentrate our attention on isolating the pure effect of diverse correlation structures on the sales structure. Notice that the assumption that the expected size and variance are the same across the markets means the three countries exhibit the same coefficient of variation. Moreover, because the variances are the same, the covariances are a sufficient statistic for the degree of integration between the economies of any pair of countries.

Equally correlated economies. Assume that the demand correlations between A and B, B and C, and A and C are equal, positive but not perfect.[26] In the left panel of Figure 2.1, we notice how the absolute sales in country A are comparatively larger than those in countries B and C for any level of risk aversion. As the firm operates its affiliate in country A, it benefits from the proximity to the final customers. Hence, it ships a larger amount of the variety to the local market. Furthermore, given that the foreign countries B and C are symmetric, the firm sells the same amount to the two countries. In addition, a larger level of aversion to risk induces the firm to sell less to each country, as they are risky. The presence of risk aversion affects not only the absolute value of sales but also the relative shares among countries as it can be seen in the right panel of Figure 2.1. Indeed, a larger degree of risk aversion reduces the share of sales associated to country A and increases the shares of country B and C. The reason for that result is to be linked with the fact that a more risk averse firm exploits more extensively the diversification opportunities as they are more concerned with the demand risk.

Figure 2.1.: Case 1, Equally correlated economies

Risk aversion and firm sales – Only in highly correlated economies



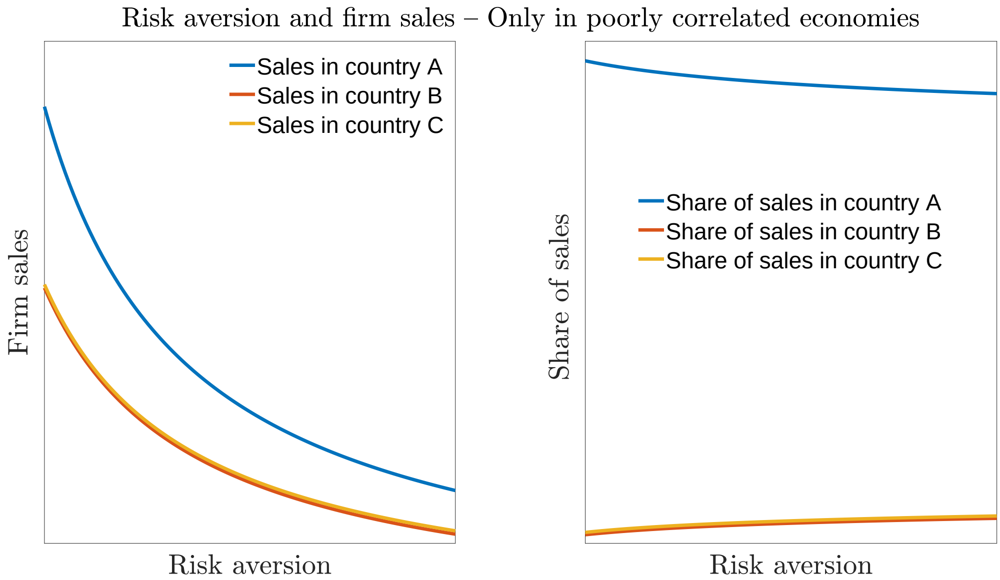
Differently correlated economies. Next, we consider the case in which the correlations of demand realizations between countries A and B, and A and C is lower than the correlation between countries B and C.[27] In this specification, the gap between sales in country A and

[26]This can be thought as the case of a German firm (affiliate in country A), producing only domestically and being able to serve additionally France (country B) and the UK (country C).

[27]This can be thought as the case of a German firm (affiliate in country A) producing only domestically and being able to serve additionally Japan (country B) and South Korea (country C).

countries B and C widens (see Figure 2.2). Though the structure of correlations has changed from the previous case, still countries B and C are symmetric so the firm ships the same amount to both countries. Additionally, we observe two things. First, country A displays a relatively poor demand correlation with both B and C; second, the demand correlation between countries B and C is now relatively large. The two observations together imply that, compared with the previous case, the firm wants to sell more to country A and reduces its exposure in countries B and C (see the left panel of Figure 2.2). Regarding the relative sales, a similar pattern to the previous case can be observed in the right panel of Figure 2.2. However, the adjustment of shares is now less remarkable than before as the countries B and C have a lower diversification potential.

Figure 2.2.: Case 2, Poorly correlated economies

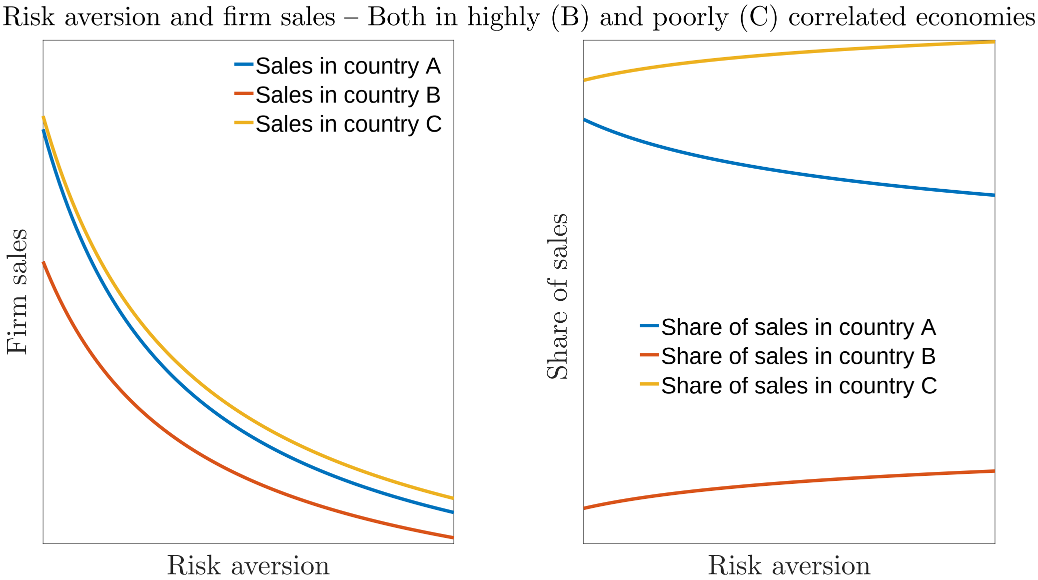


Mixed case. In the last case, we assume that the demand correlation between A and B is larger than the correlations between countries A and C, and B and C.[28] Given the structure of demand correlation, country C now provides the firm with a better hedge to negative fluctuations in country A's demand compared to country B. In the left panel of Figure 2.3, it is possible to note that, when risk aversion is large enough, the country with the largest diversification potential, that is country C, attracts the largest share of sales in absolute terms so that diversification benefits outweigh the marginal cost of selling in a foreign market. The right panel of Figure 2.3 shows

[28]This can be thought as the case of a German firm (affiliate in country A) producing only domestically and being able to serve additionally France (country B) and Japan (country C).

that, when risk aversion increases, the shares of sales in B and C increase, whereas the share of sales in A decreases.

Figure 2.3.: Case 3, Mixed case



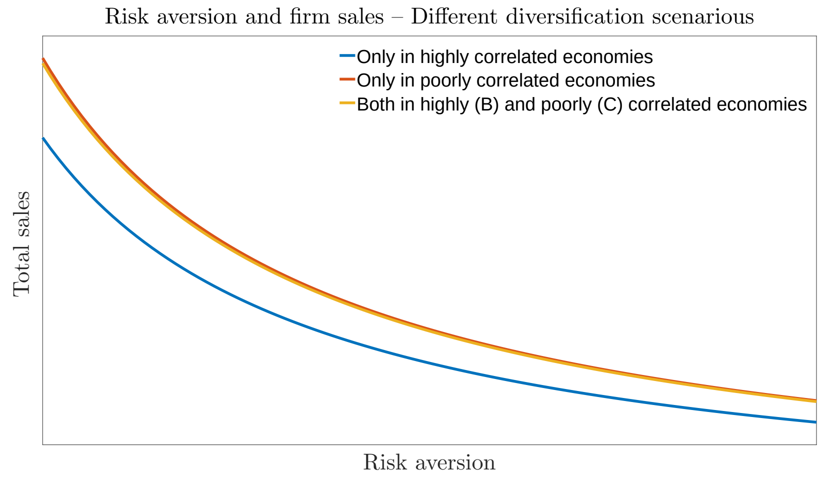
In the above examples, the diversification strategies of an MNE distort the sales distribution compared with the risk neutral model.[29] The distortion is particularly relevant either when risk aversion or diversification opportunities are large. Importantly, firms with different risk aversion value differently each destination market as each of them provides different hedging opportunities. The possibility of serving more conveniently a destination market can result into diverse location choices and reaction to trade policies as we will discuss later. Moreover, for a given level of risk aversion, the shares of sales in each location is not going to be affected by a change productivity. This finding plays an important role in separately identifying risk aversion and productivity separately.

Finally, it is interesting to see under which correlation structure firms sells more (Figure 2.4). Comparing aggregate sales across the above scenarios, a multinational firm sells more on average when the dispersion of correlations among the available countries is the largest, as a consequence of the largest diversification opportunities. Thus, we expect firms to sell more in industries characterized by a wider spread of demand correlations. This observation is also in line with the evidence that exporters' sales decrease more than MNEs' sales during the crisis; as MNEs can

[29] In the risk neutral model, the absolute sales are flat with respect to risk aversion. Moreover, the sales realized in country B and C represent a downward shift of the sales realized in country A, whose extent depends on the magnitude of the trade costs.

typically reach a larger number of countries, they access to a more favorable correlation structure than exporters do. Therefore, this mechanism can explain why the sales of MNEs were more stable than those of pure exporters during the last crisis.

Figure 2.4.: Diversification opportunities and aggregate firm sales



Liberalization Spillovers

Next, we evaluate the effect of a bilateral trade liberalization when demand realizations are correlated and firms are risk averse. Similarly to the previous part, we consider a scenario with three countries and look at the effect of a tariff reduction for the good imported into country B from A. Without risk averse firms, a tariff reduction in country B does not affect sales in A and C. However, when we introduce risk averse firms and correlated demand shocks, spillovers can emerge as a byproduct. In the case of three countries, the effect of the described policy change depends on the sign of the correlation of demands among the three countries. When sales in country B increase, the spillover effects in countries A and C depend on the possibility to hedge the larger exposure to risk due to the sales increase in country B.[30] In particular, if the demand in C, which is a third country, is positively correlated with the demand in country B, the sales to the destination C drop. On the contrary, a negative correlation between country B and C determines a sales increase in country C due to the fact that firms can reduce their exposure to demand risk. Table 2.1 shows the change in sales in the three countries for each combination of correlation signs.

[30]For a discussion on the effect of a trade liberalization see Appendix H.

Similar demand-side spillovers emerge for any country-specific change, e.g., an improvement of investment climate in one particular country results in the reshuffling of trade flows in all correlated foreign markets.[31]

Table 2.1.: Effects of trade liberalization

Reduction of τ_{AB}	Sales A	Sales B	Sales C
corr$(A, B) > 0$, corr$(B, C) > 0$	−	+	−
corr$(A, B) > 0$, corr$(B, C) < 0$	−	+	+
corr$(A, B) < 0$, corr$(B, C) > 0$	+	+	−
corr$(A, B) < 0$, corr$(B, C) < 0$	+	+	+

Risk Aversion and Entry

The above numerical exercises assume a fixed set of foreign affiliates in which the MNE operates. In what follows, we remove this restriction and consider the possibility that a firm self-selects into foreign locations. This exercise allows us to evaluate the impact of risk aversion and productivity on the entry choices.

In the trade literature studying the determinants of firm's entry in a foreign market (Helpman et al., 2004), the entry decision is typically described by a destination-specific productivity threshold. In particular, a firm engages in any foreign activity if and only if its level of productivity is large enough. Furthermore, a prediction of these models is that only sufficiently productive firms find it profitable to pay the fixed entry cost in a foreign location. In a multi-country environment where firms can establish a foreign plant in many locations, this prediction results in a hierarchical ordering of entry decisions. As a consequence, the location sets chosen by the firms constitute a sequence of nesting sets with respect to firm's productivity. In our model, since countries are no longer independent, firms decide on the set of foreign locations also accounting for the hedging opportunities the set provides. Therefore, we can rationalize the presence of non-hierarchical entry, as observed in the data (e.g. Yeaple (2009)).

To illustrate this point, we consider a world consisting of six countries. In all scenarios, country A is the origin country of the multinational firm.[32] First, we fix firm's productivity and look at the entry decisions for different values of risk aversion. In the numerical example, the sets of locations chosen by the firm are not nested as the upper panel of Table 2.2 shows. Moreover, a higher degree of risk aversion does not necessarily reduce the number of foreign locations the firm decides to be present in.

[31] Note that patterns in trade flows change are more complicated when more than three countries are involved as they depend on the entire structure of the variance correlations matrix.

[32] Costs of entry in the home country are set to zero.

Table 2.2.: Entry decision and risk aversion

Risk aversion	Country A	Country B	Country C	Country D	Country E	Country F
Low risk aversion	Yes	No	No	Yes	Yes	No
Medium risk aversion	Yes	Yes	No	No	Yes	No
High risk aversion	Yes	No	Yes	Yes	No	Yes
Very high risk aversion	Yes	No	No	No	No	Yes
Productivity	Country A	Country B	Country C	Country D	Country E	Country F
Low productivity	Yes	No	No	Yes	Yes	No
Medium productivity	Yes	No	No	No	Yes	No
High productivity	Yes	No	No	No	Yes	Yes
Very high productivity	Yes	No	No	No	Yes	No
indice						

Note: "Yes" stands for entry to the market, "No" stands for no entry.

For a firm with a medium level of risk aversion, it is profitable to enter two locations – country B and country E, while a more risk averse firm enters three locations – C, D and F (see Table 2.2).

Analogously, given the level of risk aversion, changing the productivity can affect not only the number of entered locations but also the compositions of the optimal location set. Specifically, a more productive firm does not need to enter more locations. Additionally, a more productive firm does not necessarily enter all locations a less productive firm is present in. The reason behind this outcome hinges on the different attractiveness as demand-risk hedge offered by each location. More productive firms are less concerned about the costs of serving foreign locations due to their advantage in terms of marginal costs. Hence, they can benefit from the presence of demand risk diversification even if they enter into fewer locations. Instead, firms with low productivity have to bear larger marginal costs; in order to exploit the diversification potential of sales, they has to select into more foreign locations in order to reduce the distance from the customers. Therefore, the model predicts that small (large) firms enter relatively more (less) locations than predicted by the standard proximity-concentration tradeoff literature. This rationalizes the finding of Yeaple (2009).

2.3. Data

For the empirical analysis, our main data source is the Microdatabase Direct investment[33] (MiDi), which contains firm-level information about foreign affiliates of German multinational companies.[34] More specifically, the data include balance sheet variables of foreign companies in which

[33]Deutsche Bundesbank (2016): Microdatabase Direct Investment 1999-2014. Version: 2.0. Deutsche Bundesbank. Dataset. http://doi.org/10.12757/Bbk.MiDi.9914.02.03

[34]The database is maintained by the Deutsche Bundesbank. For other research using the MiDi see Tintelnot (2017), who analyzes cost structure of vertical export platforms, Becker and Muendler (2008), who estimate responses of MNEs employment at the extensive and intensive margins.

German MNEs have directly (or indirectly) at least 10% (50%) of the shares or voting rights. In addition to the standard balance sheet variables (as capital stock, labor and turnover), we observe the locations of foreign affiliates and the industries[35] they operate in.

The empirical estimation relies on 952 German multinational firms operating in 19 different industries[36] and 45 foreign countries[37] with 3,232 affiliates[38] in 2007. We consider only those foreign affiliates in which a German multinational holds the control rights. Table 2.3 shows the total sales and the number of firms present in each of the top 10 destinations.[39] The United States, Spain and France are the three countries from which German affiliates sell the most. It is worth noting that the number of entrants in a country cannot be perfectly mapped to the productivity level (or size) of the median entrant. In addition, Appendix D shows that the average distance of the foreign affiliates from Germany does not monotonically increase in the number of affiliates itself. These observations gives us room for discussing the importance of demand factors in affecting the choice of foreign locations. Moreover, the relevance of foreign countries with respect to the aggregate sales differs for small-medium and large multinationals (see Appendix C for descriptive statistics). We note that the top countries in generating aggregate sales are Brazil and Japan for large MNEs, whereas they are Poland, Austria, Italy and Switzerland for small and medium MNEs. With respect to the entry pattern, the top locations are China and France for large MNEs, the US and Poland for small MNEs.

Since our model focuses on the contribution of the demand components to explaining the global production structure, we restrict our sample to those MNEs that conduct horizontal FDI. MiDi does not provide any information about the type of FDI chosen by a firm. In order to control

[35]Industries are classified on 2-digit level NACE Rev. 1.1.

[36]We aggregate the industries 1500 (manufacture of food products and beverages) and 1600 (manufacture of textiles). This consolidation is in line with NACE Rev. 1.1, which aggregates these two industries at the upper level DA (manufacture of food products, beverages and tobacco). Moreover, in order to fulfill the confidentiality requirements for the usage of the dataset, we exclude the industry 2300 (manufacture of other non-metallic mineral products).

[37]The set of countries consists of 26 European countries (Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Greece, Hungary, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom), 9 Asian countries (China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Singapore, Turkey), 5 South American countries (Brazil, Chile, Colombia, Mexico, Peru), two African countries (South Africa, Tunisia), Canada and the United States in North America, and Australia in Oceania. These are the countries where at least three different German MNEs operate an affiliate. Given this set of countries, we account for 96% of the total affiliates of MNEs operating in 2007 and performing horizontal FDI. Furthermore, the share of the affiliates we consider generates 99% of the total affiliate sales.

[38]We aggregate the capital, labor and sales for the affiliates of one MNE operating within the same country. As production fragmentation does not provide us with any information about the effect of country characteristics on the incentive to diversify, our main results do not change.

[39]The ranking is built with respect to the total amount of sales.

Table 2.3.: Descriptive Statistics on Foreign Affiliates and Parents by Country

Countries	Total sales	Sales affiliate		Sales MNE		Employment MNE		Average productivity	N
		Average	SD	Average	SD	Average	Median		
United States	47.5	257	1340	1758	89960	4497	883	3.38	185
Spain	22.2	239	995	4201	15665	11419	1809	3.38	93
France	16.9	105	225	2522	11709	6673	1210	3.53	161
Brazil	16.6	238	1060	4685	809	13290	3255	3.71	70
United Kingdom	15.5	135	442	4151	15042	10772	1434	4.18	115
Czech Republic	13.9	104	694	2279	12622	6621	909	3.58	134
China	10.8	60	178	2002	8733	6290	1453	3.64	181
Poland	9.9	75	301	1705	9417	4495	778	3.91	132
Hungary	9.6	117	646	1838	5760	6324	1252	4.09	82
Mexico	9.2	196	877	7207	21378	18309	2644	3.49	47
Germany	577.2	594	3620	873	5522	2557	676	3.90	971

Note: Total sales are expressed in billion Euro. Sales of affiliate and MNE are expressed in million Euro.
Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

for the presence of vertical FDI, we use the standard proxy considering an investment relation as horizontal if both parent and affiliate firms operate within the same industry.[40]

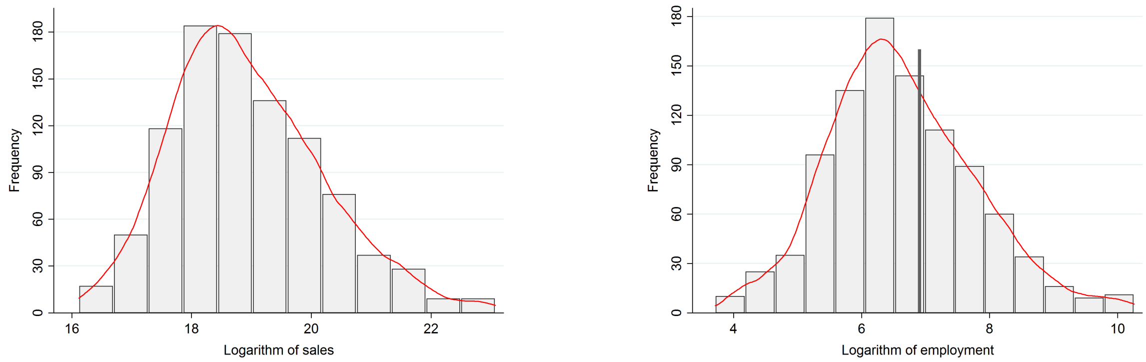
We integrate the information in AMADEUS database to complement the balance sheet data on the home plants of German multinational firms. In particular, we observe the level of home sales, the number of employees, and the capital of the parent companies.

Figure 2.5 shows the variation in MNE sales and employment. We notice that the set of firms in our analysis is not solely restricted to the largest German firms; the variability in the firm sales is particularly evident.

Table 2.4 shows some descriptive statistics about foreign affiliates operating in each industry. First, we can notice that the average and median sales of firms vary across industries, being particularly high in the manufacturing of auto, electrical machinery and basic metals. Moreover, these three industries are characterized by a large range of firm sales and sizes. With regard to foreign entry, producers operating in the chemical and transport sectors hold more affiliates on average (in the other industries, the average MNE is present only in one foreign country). Industries are quite dispersed in terms of share of multinational production. On average foreign affiliate sales generate 27.6% of the total sales of a German MNE. In some industries, the sales produced by affiliates are larger (auto, minerals, printing) whereas in other sectors most of the production is carried out by the parent firm in Germany (wood, machinery and basic metals). At the same time, foreign market participation cannot be perfectly mapped to the concentration of

[40]This assumption leaves us with 86% of the initial sample. Literature proposed also to proxy for horizontal FDI using the data on intrafirm trade. Unfortunately, MiDi does not contain this information explicitly. Nonetheless, intrafirm trade can be proxied by the share of affiliate current assets of which claims on the affiliated enterprises. This measure is less restrictive and includes our subsample. See Overesch and Wamser (2009), who use current assets claim to proxy for horizontal FDI in MiDi.

Figure 2.5.: Distribution of German MNEs' sales and employment in 2007 in manufacturing



(a) Sales (b) Employment

Note: Firms with employment level to the right of the bold vertical line are considered to be large firms (more than 1000 employees). Sales are expressed in the logarithm of million euros. Employment is expressed in the logarithm of the number of employees.
Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

sales across affiliates. The largest level of sales concentration occurs in basic metals and textile, while this measure is lower in other transport and paper manufacturing. One of the hypothesis that can explain this result is that industry characteristics can affect the way an MNE spreads its sales across affiliates.

To estimate non-firm-specific parameters, such as trade costs, production indexes, and the co-variance matrix of country demands, we use data from UN databases and CEPII.[41]

2.4. Estimation

In this section, we describe the estimation procedure we follow to obtain estimates of the risk aversion coefficient of the MNEs. Given the location set L in which the affiliates of firm operate and the aggregate sales $\sum_d p_d q_d$ of the multinational group, we determine the firm-specific risk aversion parameter r. Our model yields uniqueness of the risk aversion measure for a given choice of the location set. The estimation of risk aversion requires additional parametrization and estimation of firm- and country-industry-specific parameters $(\boldsymbol{\varphi}, \boldsymbol{\tau}, \boldsymbol{\sigma}, \bar{\boldsymbol{\alpha}}, \Sigma, \boldsymbol{Q})$. First, we discuss the estimation of productivities, trade costs, and quantity indexes, and parametrize the

[41]Trade flows and home production data are from the COMTRADE, INDSTAT and IDSB. Gravity dummies and distances are from CEPII. COMTRADE concordance tables provide industry-country trade flows in NACE Rev. 1.1 classification.

Table 2.4.: Descriptive Statistics on Affiliates by Industries

Industry	Sales		Employment		Number of affiliates	Concentration measure	Foreign share (%)	N
	Average	SD	Average	SD				
Food and tobacco	185	589	356	469	1.6	0.36	29.7	116
Textile	38	49	240	287	1.5	0.42	28.8	50
Wearing and leather	70	84	440	435	1.5	0.48	26.4	33
Wood	69	115	363	321	1.0	0.40	19.8	14
Paper	120	182	351	395	1.2	0.35	23.2	40
Printing	88	210	342	634	2.4	0.37	32.6	94
Chemicals	271	1118	640	1939	3.7	0.43	29.9	433
Plastic	69	175	312	529	2.1	0.36	30.5	290
Minerals	95	130	488	755	2.2	0.38	33.4	136
Basic metals	376	1112	924	2496	1.3	0.49	22.6	79
Metal products	73	129	380	575	1.8	0.42	25.4	262
Machinery n.e.c.	135	377	516	1321	2.0	0.47	22.2	598
Electrical	377	2227	1644	8026	2.1	0.41	26.8	235
Communication	360	954	957	1437	1.9	0.39	30.4	90
Medical	65	101	308	444	2.0	0.46	27.7	207
Auto	1180	5950	2648	11347	3.3	0.38	34.8	319
Other transport	226	460	826	1670	2.6	0.46	25.4	65
Furniture	46	47	289	274	1.2	0.33	31.3	31

Note: Sales are expressed in million Euro.
Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

other country-industry-specific parameters. Second, we show the procedure to derive the risk aversion coefficients.

2.4.1. Productivities and Industry Parameters

Productivities

German companies operating in different countries exhibit different productivity levels across affiliates. This observation can stem from the non-perfect cross-border transferability of technologies and different quality of inputs across countries. Hence, as to disentangle the role of demand from that of technology, we need to control for the heterogeneity in productivities across affiliates of one firm.

Since the estimates of productivities enter the risk aversion measure, we discuss the identification of the latter. Productivities and risk aversion affect firms' sales at a different levels. In our framework, productivities are affiliate-specific, whereas risk aversion coefficients are group-specific. In particular, for a risk neutral firm higher productivity in one affiliate makes it cheaper to serve all destination markets associated with this location. Therefore, without risk aversion, we expect higher sales to each destination market from the more productive affiliate. At the same time, risk aversion shapes sales flows due to the presence of demand correlations. When risk aversion is positive, an increase in the affiliate productivity results in a reshuffling of the sales portfolio and changes the sales shares in each destination market served from the affiliate in a way that is proportional to the hedging opportunities offered by the location. Moreover, a risk averse firm adjusts the sales realized in all other affiliates. Since we observe the affiliate sales of firms with different productivities, we can disentangle the effect of productivity on sales from that of diversification. We use the variation of sales at the affiliate level to capture the supply-side parameters, whereas we use the aggregate sales to determine the firm's risk attitude.

In the estimation of productivity, we control for firm- and market-specific demand parameters to obtain productivity estimates in the presence of a positive risk aversion. The equation we estimate at the affiliate level by industry reads as

$$\begin{aligned}\ln(\textit{sales}_{jl\omega}) = \beta_1 &+ \beta_k \ln(\textit{capital}_{jl\omega}) + \beta_\ell \ln(\textit{labor}_{jl\omega}) + \beta_a \ln(\textit{age}_{jl\omega}) \\ &+ \beta_c \textit{concentration measure}_\omega + \beta_v \textit{coefficient of variation}_l \\ &+ \beta_p \textit{premium}_l + \xi_{jl\omega},\end{aligned} \tag{2.22}$$

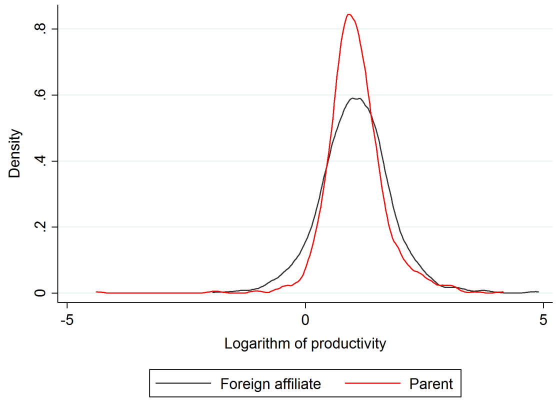
where j denotes the affiliate, l the location of affiliate j, and $\xi_{jl\omega}$ the affiliate-multinational-specific productivity shock. From the previous specification, we obtain the productivity estimate $\hat{\varphi}_{jl\omega}$ according to $\hat{\varphi}_{jl\omega} = \exp(\hat{\xi}_{jl\omega} + \hat{\beta}_1)$.

We include a measure of sales concentration to capture the diversification incentives of a firm to take into account different degrees of risk aversion across firms.[42] Moreover, we include the coefficient of variation of the demand associated to the location where the affiliate operates in. We find a significant negative relation between aggregate sales and the volatility of destination market demand. Another problem can potentially arise from the fact that we estimate productivity using realized sales rather than expected sales (i.e. sales before the realization of the shocks). Indeed, higher sales to a destination can be just due to a higher realization of the market demand rather than to the level of productivity of the firm in the given market. Therefore, to proxy for the effect of the realized market size, we include the difference between the realized and expected market size.[43] We show in Section 2.5 that the productivity estimates are not correlated with the estimated risk aversion coefficients when controlling for other firm characteristics. Moreover, we find that German MNEs are, on average, more productive at home than in the host countries (see Figure 2.7).

[42]The construction of the concentration measure of sales is discussed in the Appendix D.

[43]For the estimation of expected market size, see subsection 2.4.1.

Figure 2.7.: Distribution of productivities of foreign affiliates and parents (in logs)



Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

Industry Parameters

A set of parameters is common to all firms operating within an industry. For convenience, we distinguish between supply side parameters, i.e. trade costs, and demand side parameters, i.e. the elasticity of substitution, quantity indexes, variance-covariance matrix of market sizes, and expected market sizes.

The estimation of trade costs and quantity indexes is based on the methodology proposed by Anderson and van Wincoop (2003) for cross-sectional data. In particular, a partial equilibrium model for import flows at the industry level delivers the following equation:

$$\log\left(\frac{m_{d'd}}{M_d}\right) = (1-\sigma)\log\left(\tau_{d'd}\right) + (\sigma-1)\log(P_d) \;\; \text{for } d, d' \in 1, ..., N, \tag{2.23}$$

where $m_{d'd}$ is import from d' to d, and M_d is the sum of total import and consumption in country d. Therefore, the share of country d' in total consumption in country d is described by trade costs between countries, the level of prices in country d, and the elasticity of substitution.

Similar to Anderson and van Wincoop (2003), we can estimate trade costs and price indexes only conditional on the elasticity of substitutions σ. As we do not estimate industry-specific elasticity of substitution, we assume $\sigma = 6$.[44]

[44]This value is in line with Head and Mayer (2004) and Chen and Novy (2011). Note that this value implies a markup equal to 17% in a risk neutral framework. Importantly, estimates of risk aversion parameters exhibits a low sensitivity to the choice of the elasticity of substitution. This is linked to the fact that risk aversion represents a ratio between the sales premium and variance, which are scaled by the same sigma. See Proposition 2.

We model trade costs as a function of the distance between the two countries, contiguity, and common language. More precisely, we have

$$\log(\tau_{d'd}) = \beta_1 \log(\text{dist}_{d'd}) + \beta_2 \text{contig}_{d'd} + \beta_3 \text{lang}_{d'd} \text{ for } d, d' \in 1, ..., N. \tag{2.24}$$

To estimate industry-specific price indexes, we introduce dummies as in Baldwin and Taglioni (2006). The final equation we are estimating is

$$\log\left(\frac{m_{d'd}}{M_d}\right) = \tilde{\beta}_1 \log(\text{dist}_{d'd}) + \tilde{\beta}_2 \text{contig}_{d'd} + \tilde{\beta}_3 \text{lang}_{d'd} + \gamma_d + \epsilon_{d'd}, \tag{2.25}$$

where $\tilde{\beta}_b = (\sigma - 1)\beta_b$ for $b = 1, 2, 3$, $\gamma_d = (\sigma - 1)\log(P_d)$, is a country dummy.

We assume that trade costs and price indexes are 2-digit industry-specific, and correspondingly use import flows at the 2-digit disaggregation level. Country-industry-specific quantity indexes are obtained from the industry i equilibrium condition in country d: $P_{id}Q_{id} = \alpha_{id}$.

Finally, we proxy the total expenditure parameter α_{id} using data on the industry-level consumption from the IDSB dataset. This dataset contains information about country's values of production, export and import at a 2-digit level. We obtain co-variance matrices from time-series data on total expenditure for the 46 countries in our sample from 2002 to 2006.

We assume that α_{id} depends on its first lagged value. In particular, we assume that

$$\alpha_{id,t} = \alpha_{id,t-1}^{\beta} \exp^{IND_i + COUNTRY_d + \epsilon_{id,t}}, \tag{2.26}$$

where $\epsilon_{id,t}$ is an innovation term[45] with mean 1, and β captures the persistence in the evolution of α. We then estimate the following equation in logs

$$\log \alpha_{id,t} = \beta \log \alpha_{id,t-1} + IND_i + COUNTRY_d + \epsilon_{id,t}, \tag{2.27}$$

where we include control dummies for industry and country. From this equation we obtain a prediction for $\alpha_{id,t}$ given the value of $\alpha_{id,t-1}$. Hence, we compute the entry (d, d') of the variance-covariance matrix Σ_i in the following way

$$\Sigma_i(d, d') = \sum_{t=1}^{T} \frac{(\alpha_{id,t} - \bar{\alpha}_{id,t})(\alpha_{id',t} - \bar{\alpha}_{id',t})}{T - 1}, \tag{2.28}$$

where $\bar{\alpha}_{id,t}$ and $\bar{\alpha}_{id',t}$ denote the expectations of $\alpha_{id,t}$ and $\alpha_{id',t}$ given the level of $\alpha_{id,t-1}$ and $\alpha_{id',t-1}$, respectively, and T is the number of years we are using for our estimation.

[45] We do not restrict this shock term to be uncorrelated across countries and industries.

2.4.2. Risk Aversion

Uniqueness of the solution of the firm's problem ensures that aggregate sales across affiliates are a well-defined function of risk aversion. Therefore, we match theoretical sales, predicted by our structural model, with aggregate MNE sales, observed in the data.[46] We do not restrict risk aversion to be positive. For each firm, the matching proceeds as follows:

1. Guess the risk aversion parameter r.
2. Given the location set L observed in the data, solve the firm's utility maximization problem.
3. Obtain $\boldsymbol{q}$, and compute the implied aggregate theoretical sales $\sum_{d \in D} p_d q_d$.
4. Update r if the distance between theoretical and empirical sales is larger than the tolerance level.[47]

It is important to note that the updating of r is based on the characteristics of the solution to the utility maximization problem. Everything else equal, the firm's aggregate sales are strictly decreasing in risk aversion as shown in the Proposition 3.

2.5. Results

We perform the estimation of risk aversion coefficients for 952 MNEs in the sample in 2007.

Figure 2.8 shows the distribution of the estimates of the risk aversion coefficients. We observe that estimated risk aversion coefficients are positive for all firms in the sample. The majority of MNEs display risk aversion coefficients ranging between 0 and 1. In particular, the average risk aversion coefficient in the sample is 0.34 (s.d. equal to 1.16).

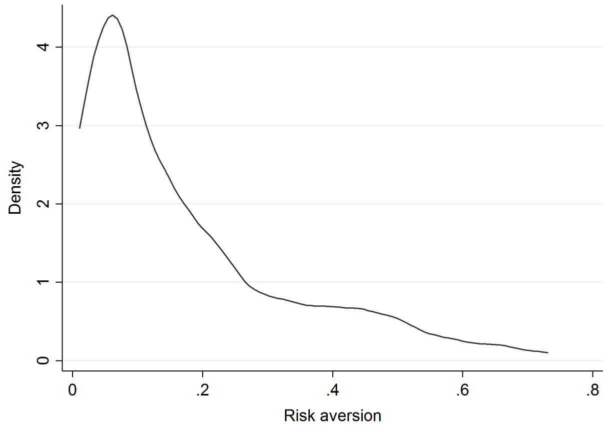
Table 2.5 shows that coefficients of risk aversion greatly differ across industries. The average risk aversion ranges from 0.10 in paper manufacturing sector to 1.39 in the manufacturing of basic metals sector.

The heterogeneity in risk aversion can be explained by several factors related to industry characteristics. In particular, the volatility of demand in the industry seems to play an important role. Figure 2.9 displays the spread in the coefficient of variation in each industry given countries in our sample. On average, larger risk aversion coefficients occur in industries with larger median coefficient of variation (basic metals, medical, electrical). In highly volatile industries, firms are

[46]Note that we do not observe expected sales in the data. However, sales to each destination are decreasing with the level of risk aversion. This together with uniqueness of the solution allows us to match empirical sales.

[47]We assume convergence when the absolute difference between empirical and theoretical sales is less than 0.001%.

Figure 2.8.: Estimated Density of Risk Aversion



	Mean	SD	p10	p25	p50	p75	p90	N
Risk aversion	0.34	1.16	0.01	0.04	0.11	0.31	0.72	952

Note: Outliers on the right tail are removed.
Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

indeed more exposed to demand shocks. Therefore, for these industries, firms consider the demand risk as a more relevant factor. In terms of our model, this implies a larger level of risk aversion. Interestingly, risk aversion is poorly correlated with average industry size and sales of affiliates. In addition, estimated risk aversions is mainly connected to industry-specific demand characteristics rather than to technological variables.

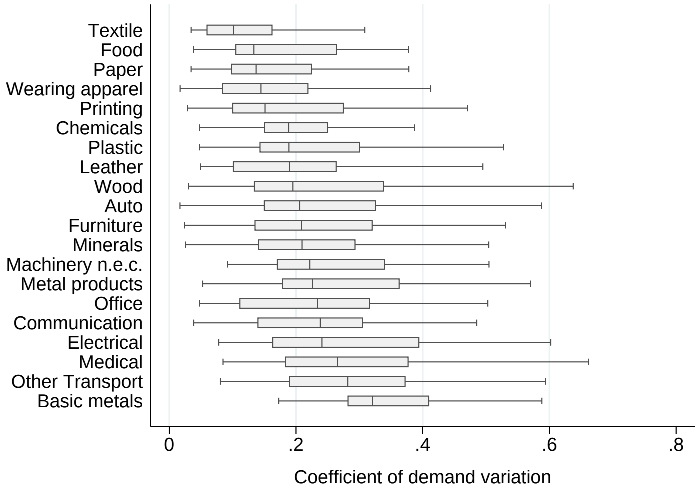
Next, we evaluate the relation between risk aversion and firm-specific characteristics to assess how the risk attitude correlates with the other sources of firm heterogeneity. In Table 2.6, we present the results of the regression of the estimated risk aversion coefficients on a set of firm's characteristics. First, we find no significant correlation between risk aversion and productivity. This observation is important, as we regard the estimated productivities as an observable. Therefore, the coefficient of risk aversions obtained from our estimation do not reflect the effect of firm's productivity on sales. Second, we find that risk aversion negatively correlates with firm size. Third, we find a negative correlation between firm's age and risk aversion. Our interpretation is that larger or more experienced firms are better at dealing with market risk. Finally, a more risk averse firm tends to display a more diversified structure of sales. This finding suggests that firms take advantage of possible diversification opportunities more extensively when they are more concerned about the market turmoil. Moreover, the negative correlation between the

Table 2.5.: Risk Aversion Across Industries

More risk averse industries	Risk aversion			Less risk averse industries	Risk aversion		
	Average	SD	N		Average	SD	N
Basic metals	1.39	4.98	34	Textile	0.20	0.19	20
Medical	0.79	0.93	68	Printing	0.18	0.30	26
Metal products	0.55	0.66	91	Machinery n.e.c.	0.18	0.92	196
Furniture	0.54	0.71	14	Wearing and leather	0.17	0.16	13
Electrical	0.35	0.49	75	Chemicals	0.14	0.42	90
Food and tobacco	0.34	0.70	44	Other transport	0.14	0.18	18
Plastic	0.31	0.33	93	Wood	0.13	0.14	7
Auto	0.25	0.78	73	Minerals	0.13	0.15	41
Communication	0.24	0.25	31	Paper	0.10	0.09	18

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

Figure 2.9.: Distribution of coefficient of variation of demand, product level



Source: UNIDO INDSTAT2 2016, authors' calculations.

concentration measure and risk aversion[48] is suggestive that the estimated risk aversion captures firm's attitude toward demand risk.

In addition, we find a positive correlation between the share of debt in the firm's capital and the level of risk aversion.[49] The intuition for this finding relates to the fact that financially constrained firms are more risk averse when they compose their sales portfolio.

To assess the goodness of fit of our model to the real data, we compare the predicted trade flows with real data across different regions. Table 2.7 shows that the model predicts accurately

[48]Note that this result is still valid when we consider other measure of concentration, like the Herfindal index.
[49]See Table J.2 in Appendix J.

Table 2.6.: Risk Aversion and Firm Characteristics

	I	II	III
productivity	-0.0658	0.0223	-0.0829
	(0.0583)	(0.1368)	(0.0589)
size	-2.0699^{***}	-1.9597^{***}	-1.9176^{***}
	(0.0795)	(0.0801)	(0.0796)
age		-0.0819^{**}	-0.1330^{***}
		(0.0399)	(0.0206)
*productivity*age*		-0.0364	
		(0.0281)	
concentration			-0.6905^{***}
			(0.1429)
constant	-1.3460^{***}	0.9009^{***}	-0.5058^{**}
	(0.1922)	(0.2697)	(0.2181)
industry fixed effects	Yes	Yes	Yes
N	952	952	952

Note: We consider productivity of parent German firm. Risk aversion and productivity are taken in logs. Size is equal to 1 for MNEs with more than 1000 employees. Concentration measure is measured by Herfindal Index. Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

trade flows in most regions. The underprediction of sales in North America and overprediction of sales in Asia and Oceania can be partly explained by the fact that trade costs are estimated outside the model. We believe that an estimation procedure able to match the characteristics of multinational trade flows across countries would provide more accurate results.[50]

Table 2.7.: Regional Trade Flows of German Multinationals (Percentage Shares)

Regions	Data	Model	N
Africa	1.1%	1.8%	47
Asia & Oceania	3.4%	10.9%	241
Europe	86.2%	82.2%	896
North America	7.3%	3.1%	205
South America	2.1%	1.9%	69

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

[50]In particular, estimating jointly productivities and firm's risk aversion may improve the ability of the model to match the empirical data.

Next, we estimate a proxy for the elasticity of MNE sales to the level of risk aversion.[51]

We find that a change of 1% in risk aversion produces a change of sales approximately equal to -0.8%.

Table 2.8.: Sales Response to Exogenous Change in Risk Aversion

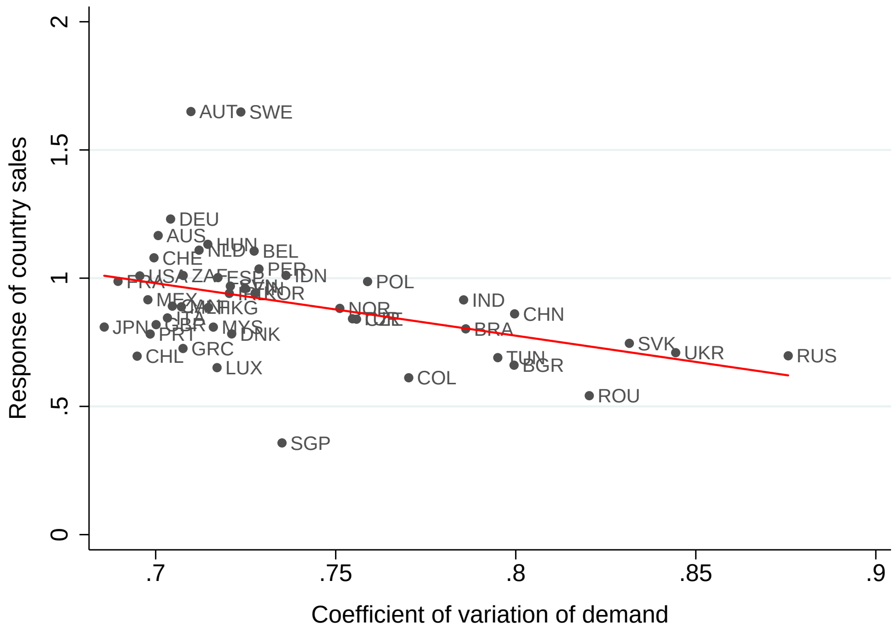
Change in risk aversion	Mean	p25	p50	p75
5% increase	-4.13%	-4.40%	-4.08%	-3.79%
1% increase	-0.85%	-0.92%	-0.85%	-0.78%
1% decrease	0.85%	0.79%	0.87%	0.93%
5% decrease	4.46%	4.12%	4.51%	4.82%

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

We conduct an analogous exercise to measure the sensitivity of countries' trade flows to changes in risk aversion. Figure 2.10 depicts the increase in sales of German multinationals to countries in response to a 1% decrease of risk aversion in the sample. Trade flows to all countries increase in absolute terms, which is in line with the result obtained in simplified setting in Section 2.2.3. Moreover, the magnitude of response is negatively correlated with the riskiness of the country. Safer markets gain more from the decrease in risk aversion, while more volatile economies still attract relatively lower trade flows. At the same time, changes in risk aversion affect to a larger extent countries whose economies are strongly co-moving with German economy. We observe that many developing economies are less sensitive to changes in risk aversion, which is again in line with the intuition provided in the comparative statics exercise: as risk aversion increases, multinationals are less prone to concentrate sales in similar countries and increase relative sales shares in less correlated countries.

[51]Changes of the degree of firm's risk aversion in the market can take place as a consequence of the entrance of a different population of firms in the market. Alternatively, changes in the level of financial constraints can also affect the attitude towards risk of the firms.

Figure 2.10.: Sales response to exogenous increase in risk aversion, country level



Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

Counterfactual: Trade Liberalization in China. In this section, we consider the effect of a trade liberalization occurring in China. In particular, we assume that the trade costs for the goods imported to this country decrease by 10%. The results are reported in Table 2.9.

Table 2.9 shows how the trade flows to China from German MNEs would increase by approximately 23%. A trade cost decrease has a first order effect on the import to China related to the fact that selling products to this destination market becomes cheaper. However, not only trade flows to China are affected but also those to other correlated countries. In particular, imports to the USA and Japan from German MNEs greatly increase. As the exposure to demand risk in China increased following the trade liberalization, German MNEs optimally reallocate their production favoring those countries that offer better hedge to the increased risk in China. On the contrary, countries like Hong Kong and Singapore are negatively affected by the policy change; though their demand sizes are significantly smaller than the Chinese one, the change is noticeable. We also evidence that the trade flows to the other EU countries would slightly decrease. Overall, the direction and magnitude of the change of imports depend on (i) how good a country is at providing hedging for the increase in the demand risk, (ii) the correlation structure among the

Table 2.9.: Response of Trade Flows to a Tariff Decrease in China by 10%

Country	Change (in %)	Country	Change (in %)
China	22.94	EU	−0.73
USA	11.20	Ukraine	−0.95
Japan	6.05	Indonesia	−0.96
Australia	−0.01	Colombia	−1.27
South Africa	−0.04	Russia	−1.32
South Korea	−0.05	Mexico	−1.76
India	−0.16	Norway	−2.04
Brazil	−0.21	Singapore	−2.45
Turkey	−0.36	Peru	−2.90
Chile	−0.53	Hong Kong	−5.93

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

countries in which the MNEs are present in, as predicted by our model.[52] In general, the structure of correlation makes prediction hard. Indeed, the reallocation patterns are rather complex as spillovers to one country can propagate to other correlated countries. If countries are relatively highly positively correlated countries, then a liberalization policy taking place in one of them negatively affects the others. Indeed, firms need to reduce their exposure to demand risk due to the increase in sales in one the countries.[53]

2.6. Conclusions

In this chapter, we develop a model of risk averse multinational firms conducting horizontal FDI and serving foreign markets through export platforms under demand risk.

Our theoretical model predicts that MNEs exploit the presence of demand correlations across foreign markets to hedge against the risk of unfavorable aggregate demand fluctuations. The quantity sold in a destination market differs from the one the firm would sell under no risk and, in particular, depends on the riskiness of the country, on its diversification potential, and the degree of risk aversion of the firm itself besides market size, distance, and production cost. As firms are heterogeneously risk averse, this implies that they set firm-country-specific markups even within a standard CES framework. We also find that third-country effects can follow a trade

[52] On May 11 2017, China and US signed a trade agreement to remove some of the existing barriers in the trade across the two countries. The agreement could be mutually beneficial not only because firms operating in both countries can take advantage of the lower trade costs but also because of the favorable correlation structure.

[53] This might have also implications for Brexit. Countries in the EU might benefits in the case of an increase in tariffs for the goods imported in the UK.

liberalization episode. In particular, countries that are not directly involved in the policy change can suffer or gain from a change in tariffs, depending on the structure of the correlation across demand realizations. Due to the interdependence across foreign markets and the presence of risk aversion, a nonstandard firm's entry policy obtains. Specifically, the size of the location sets in which a firm establishes its foreign production facilities does not necessarily vary monotonically both with risk aversion and home productivity.

The empirical analysis relies on the data on German multinational enterprises. Our main findings are consistent with the existence of diversification patterns in the sales structure of multinational enterprises. In particular, firms display strictly positive and heterogeneous degrees of risk aversion. This heterogeneity can be related to firm's characteristics, like size and age, and to the demand characteristics of the sector in which the firm operates in. In particular, firms in the relatively more volatile industries display a larger aversion toward risk. In two counterfactuals, we show (i) how a tariff reduction for goods imported into China would increase sales in less correlated economies and harm, instead, those countries whose demand are more correlated with the Chinese one, and (ii) how a reduction in risk aversion would result in a larger increase of sales in countries that are either less risky or whose economies are more correlated with Germany.

A. Existence and Uniqueness

Proposition 1. *(Existence and Uniqueness). If the matrix Σ has cross-correlations bounded away from -1 and 1, there exists a unique solution to the firm's utility maximization problem.*

Proof. Before delving into the proof of Proposition 1, we show an auxiliary lemma which turns out to be useful for the following discussion.

Lemma 1. *Let $(P1)$ denote the following problem*

$$\begin{aligned}\max_{\mathbf{q}\in\mathbb{R}^N_+} u(\Pi(\mathbf{q}|L,\boldsymbol{\varphi},r)) = &\sum_d \left(q_d^{\frac{\sigma-1}{\sigma}}\left(\mathbb{E}[A_d]-c_d q_d^{\frac{1}{\sigma}}\right)\right)\\ &-\frac{r}{2}\sum_d\sum_{d'}\operatorname{cov}(A_d,A'_d)q_d^{\frac{\sigma-1}{\sigma}}q_{d'}^{\frac{\sigma'-1}{\sigma'}}\end{aligned}$$

Define $s_d = f(q_d;\sigma)\equiv q_d^{\frac{\sigma-1}{\sigma}}$. Then, the problem $(P2)$ defined as

$$\begin{aligned}\max_{\mathbf{s}\in\mathbb{R}^N_+} u(\Pi(\mathbf{s}|L,\boldsymbol{\varphi},r)) = &\sum_d \left(s_d\left(\mathbb{E}[A_d]-c_d s_d^{\frac{1}{\sigma-1}}\right)\right)\\ &-\frac{r}{2}\sum_d\sum_{d'}\operatorname{cov}(A_d,A'_d)s_d s_{d'}.\end{aligned}$$

is equivalent to $(P1)$, i.e. $\boldsymbol{q}^*$ is a solution to $(P1)$ if and only if $\boldsymbol{s}^*$ is a solution to $(P2)$.

Proof. First, note that for $q_d \geq 0$ the function $f(\cdot)$ is a bijection. Consider the problems $(P1)$ and $(P2)$. If $s_d = q_d = 0$ for all d, then the statement follows. Assume that $q_d, s_d > 0$ for some d. Then, for such d, the first order conditions for $(P1)$ and $(P2)$ are respectively given by

$$\frac{\partial u(\cdot)}{\partial q_d} = \frac{\sigma-1}{\sigma}\mathbb{E}[A_d]q_d^{-\frac{1}{\sigma}} - r\left(\frac{\sigma-1}{\sigma}q_d^{-\frac{1}{\sigma}}\sum_{d'}\operatorname{cov}(A_d,A'_d)q_{d'}^{\frac{\sigma-1}{\sigma}}\right) - c_d = 0, \tag{A.1}$$

and

$$\frac{\partial u(\cdot)}{\partial s_d} = \mathbb{E}[A_d] - r\sum_{d'}\operatorname{cov}(A_d,A'_d)s_{d'} - \frac{\sigma}{\sigma-1}c_d s_d^{\frac{1}{\sigma-1}} = 0 \tag{A.2}$$

respectively. Then, using the definition of s_d, we can write (A.2) as

$$\frac{\partial u(\cdot)}{\partial s_d} = \mathbb{E}[A_d] - r\sum_{d'} \text{cov}(A_d, A'_d)s_{d'} - \frac{\sigma}{\sigma-1}c_d s_d^{\frac{1}{\sigma-1}} = 0 \tag{A.3}$$

$$\Leftrightarrow \frac{\partial u(\cdot)}{\partial s_d} = \mathbb{E}[A_d] - r\sum_{d'} \text{cov}(A_d, A'_d)q_{d'}^{\frac{\sigma-1}{\sigma}} - \frac{\sigma}{\sigma-1}c_d q_d^{\frac{1}{\sigma}} = 0 \tag{A.4}$$

$$\Leftrightarrow \frac{\partial u(\cdot)}{\partial s_d} = \mathbb{E}[A_d]q_d^{-\frac{1}{\sigma}} - r\left(q_d^{-\frac{1}{\sigma}}\sum_{d'} \text{cov}(A_d, A'_d)q_{d'}^{\frac{\sigma-1}{\sigma}}\right) - \frac{\sigma}{\sigma-1}c_d = 0, \tag{A.5}$$

where the last equivalence follows from the fact that $q_d > 0$. So, if q_d solves (A.1), then s_d solves (A.2), and vice versa. This shows that problems $(P1)$ and $(P2)$ are equivalent given the definition of s_d, and admit the same solution, provided this solution exists. □

Next, we consider the problem $(P2)$. We show that the solution exists and is unique. Then, using Lemma 1, we can extend this result to the original problem $(P1)$.

Existence. To show the existence of a solution, we use the notion of coercive function. Recall that a continuous function f is coercive if and only if

$$\lim_{\|\boldsymbol{s}\|\to\infty} f(\boldsymbol{s}) = +\infty.$$

Note that $u(\cdot)$ can be written as the sum of the expected profits and the variance of profits multiplied by a scalar r. These functions, taken with negative sign, are both coercive.[1] Moreover, the sum of coercive functions is coercive. We can then apply Proposition 2.1.1 in Bertsekas, Ozdaglar, and Nedić (2003) to conclude the existence of a solution to the utility maximization problem.[2]

Uniqueness. To show the uniqueness of a solution, it is enough to show that the utility function u is strictly concave in $\boldsymbol{s}$.

Let $\mathbf{H}_u$ denote the Hessian matrix associated to the firm's utility.

Note that any element of the main diagonal is given by

$$\mathbf{H}_u(d,d) = \frac{\partial^2 u(\Pi(\boldsymbol{s}|L,\varphi,r))}{\partial s_d^2} = -\frac{\sigma}{(\sigma-1)^2}c_d s_d^{\frac{2-\sigma}{\sigma-1}} - r\text{var}(A_d) < 0. \tag{A.6}$$

[1]Note that the expected profit function is the sum of the profit realized in each destination d, which is a continuous and concave function of s_d admitting a unique global maximizer, i.e. the solution under no risk aversion or uncertainty. Hence, the expected profit function is coercive when taken with the negative sign. Recall that cross-correlations are bounded away from 1. Hence, the variance of profits is coercive, as it is non-negative and goes to infinity when the norm of $\boldsymbol{s}$ goes to infinity.

[2]Indeed, maximizing a function is equivalent to minimizing its opposite.

Moreover, the element outside the main diagonal can be written as

$$\mathbf{H}_u(d, d') = \frac{\partial^2 u(\Pi(\boldsymbol{s}|L, \varphi, r))}{\partial s_d^2} = -r\text{cov}(A_d, A_{d'}). \tag{A.7}$$

Let

$$\mathbf{D}_u \equiv \text{diag}\left(\left\{\frac{\sigma}{(\sigma-1)^2} c_d s_d^{\frac{2-\sigma}{\sigma-1}}\right\}_d\right). \tag{A.8}$$

Thus, the Hessian $\mathbf{H}_u$ can be written as

$$\mathbf{H}_u = -(\mathbf{D}_u + r\mathbf{\Sigma}_A). \tag{A.9}$$

Then, we note that matrix $\mathbf{D}_u$ is positive definite being a diagonal matrix with all diagonal elements positive. Moreover, $r\mathbf{\Sigma}_A$ is positive definite being the product of a positive scalar with a positive definite matrix. Hence, $\mathbf{D} + r\mathbf{\Sigma}_A$ is positive definite being the sum of two positive definite matrices[3] implying that $\mathbf{H}_u$ is negative definite.

□

[3]See Horn and Johnson (2012).

B. Risk Aversion Measure

Proposition 2. *(Risk aversion measure). The measure of risk aversion is a function of the optimal production portfolio, and is equal to*

$$r = \frac{\sum_d \left(\mathbb{E}p_d q_d - \tilde{p}_d q_d\right)}{\left(\boldsymbol{q}^{\frac{\sigma-1}{\sigma}}\right)' \boldsymbol{\Sigma}_A \boldsymbol{q}^{\frac{\sigma-1}{\sigma}}},$$

where $\mathbb{E}p_d$ is the expected price in country d, $\tilde{p}_d = \frac{\sigma}{\sigma-1}c_d$ is the price under certainty in country d, and $\boldsymbol{q}^{\frac{\sigma-1}{\sigma}}$ is a vector whose d component is $q_d^{\frac{\sigma-1}{\sigma}}$, where q_d is the optimal quantity sold in country d.

Proof. Let $s_d = q_d^{\frac{\sigma-1}{\sigma}}$.

The first order optimality condition with respect to s_d is given by

$$\begin{aligned} \frac{\partial u(\Pi(\boldsymbol{s}|L,\varphi))}{\partial s_d} &= \frac{\partial \mathbb{E}(\Pi(\boldsymbol{s}|L,\varphi))}{\partial s_d} - \frac{r}{2}\frac{\partial \text{var}(\Pi(\boldsymbol{s}|L,\varphi))}{\partial s_d} \\ &= \mathbb{E}A_d - \frac{\sigma}{\sigma-1}c_d s_d^{\frac{1}{\sigma-1}} - r\text{var}(A_d)s_d \\ &- r\sum_{d'\in D}\text{cov}(A_d, A_{d'})s_{d'} = 0 \\ &= \mathbb{E}A_d - \frac{\sigma}{\sigma-1}c_d s_d^{\frac{1}{\sigma-1}} - r\sum_d \text{cov}(A_d, A_{d'})s_d = 0. \end{aligned} \tag{B.1}$$

Hence, multiplying both sides of equation (B.1) by s_d, and summing over d the risk aversion coefficient r can be expressed as follows

$$r = \frac{\sum_d \left[\mathbb{E}A_d s_d - \frac{\sigma}{\sigma-1}c_d s_d^{\frac{\sigma}{\sigma-1}}\right]}{\sum_d\sum_{d'}\text{cov}(A_d, A_{d'})s_d s_{d'}} = \frac{(\mathbb{E}p_d q_d - \tilde{p}_d q_d)}{\left(\boldsymbol{q}^{\frac{\sigma-1}{\sigma}}\right)' \Sigma \boldsymbol{q}^{\frac{\sigma-1}{\sigma}}} \equiv \frac{SP}{SV}, \tag{B.2}$$

where $\tilde{p}_d = \frac{\sigma}{\sigma-1}c_d$ is the price firm would set under certainty, SP is the *sales premium*, and SV is the *sales variance.* □

C. Small-Medium and Large Multinationals

Table C.1.: Descriptive statistics on foreign affiliates and parents of small-medium MNEs by country

Countries	Total sales	Sales affiliate		Sales MNE		Employment		N
		Average	Median	Average	Median	Average	Median	
United States	2.4	24	14	121	86	428	388	100
France	1.6	23	17	116	86	410	372	69
Poland	1.3	18	14	111	81	468	474	76
Austria	1.3	30	16	124	103	462	411	43
Belgium	1.3	84	32	371	148	563	559	15
Czech Republic	1.1	16	13	107	83	523	491	70
China	1.0	15	9	118	85	538	527	71
United Kingdom	1.0	20	13	151	115	501	460	49
Italy	0.9	34	20	179	116	420	447	27
Switzerland	0.7	19	13	103	84	366	352	37
Germany	55.0	90	60	118	83	445	417	612

Note: Total sales are expressed in billion Euro. Sales of affiliate and MNE are expressed in million Euro. In this table we consider subsample of multinationals with less then 1000 employees.
Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

Table C.2.: Descriptive statistics on foreign affiliates and parents of large MNEs by country

Countries	Total sales	Sales affiliate		Sales MNE		Employment		N
		Average	Median	Average	Median	Average	Median	
United States	45.1	531	73	3683	716	9286	2905	85
Spain	21.7	362	43	6438	848	17396	3117	60
Brazil	16.5	275	41	5443	982	15390	4010	60
France	15.3	167	63	4328	822	11370	2954	92
United Kingdom	14.5	219	48	7120	1310	18397	3840	66
Chezh Republic	12.8	199	40	4654	508	13290	2670	64
China	9.7	89	23	3218	685	10002	2809	110
Hungary	9.0	196	46	3204	718	10861	2755	46
Mexico	8.9	255	30	9602	912	24363	4081	35
Japan	8.6	346	109	7653	824	17767	3891	25
Germany	522.1	1454	344	2161	474	6158	2152	359

Note: Total sales are expressed in billion Euro. Sales of affiliate and MNE are expressed in million Euro. In this table we consider subsample of multinationals with more then 1000 employees.
Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

D. Firm Risk Aversion

This section discusses some evidence in the data and other contributions in the literature related to the assumption that firms might exhibit risk averse behavior.

Firms Diversification Strategies. In this paragraph, we discuss some patterns in the data which are in line with the idea that firms adopt diversification strategies on both the intensive and extensive margins of sales when carrying out their multinational activity.

The diversification of sales by firms operating in international markets has been widely discussed in the literature. Hirsch and Lev (1971) show that firms holding a more diversified foreign sales portfolio display also more stable sales. Vannoorenberghe (2012) provides evidence that foreign and domestic sales are negatively correlated at the firm level, which supports the hypothesis that firms hedge against demand risk in the home country by selling abroad. This finding contradicts the theoretical prediction provided by models considering only productivity, which imply a positive correlation of sales across destination markets. Fillat, Garetto, and Oldenski (2015) show that multinational profits benefits from geographical diversification of sales.

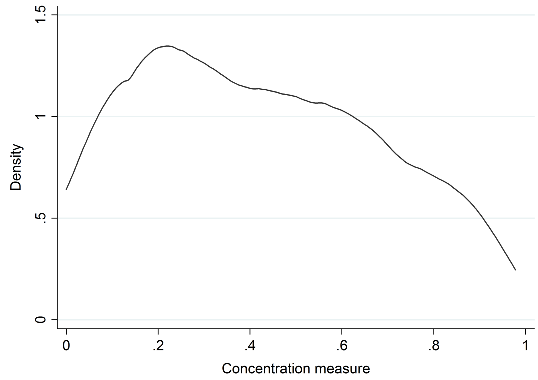
Using data on German multinationals, we find evidence in favor of sales diversification. In particular, for a firm present in at least two locations (home included), we compute the following measure of sales concentration as

$$\mathcal{C} = \frac{\sum_{j=1}^{J} \left(share_j - \frac{1}{J} \right)^2}{\frac{J-1}{J}}, \tag{D.1}$$

where J is the number of firm's locations and $share_j$ represents the ratio of firm sales in location j to total firm sales. Note that $\mathcal{C}$ equals 0 if sales evenly distribute across different locations (minimum level of concentration), and equals 1, if sales concentrate in one and only one location (maximum level of concentration). Moreover, the proposed measure takes into account the number of foreign locations a MNE is present in, as J differs across firms.

Figure D.1 shows that firms tend to spread their sales across locations rather than concentrate their activities. We can notice that the mode of the concentration measure in the data is slightly above 0.2.

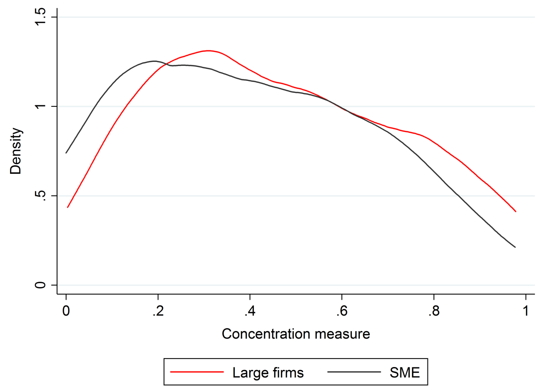
Figure D.1.: Distribution of concentration measure of sales, firm level



Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

Moreover, as Figure D.2 shows, the degree of sales concentration is directly related to firm size; smaller firms are typically more financially constrained so that holding a portfolio of well diversified financial assets is harder for this class of enterprises.[1] As a response to this, they diversify their sales across locations to reduce the degree of riskiness related to their activity.

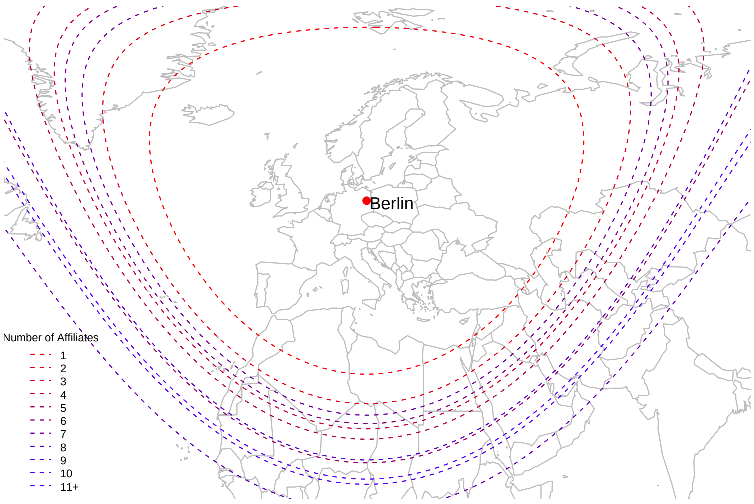
Figure D.2.: Distribution of concentration measure of sales by size of MNEs, firm level



Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

[1]In our data, the median liquidity ratio for a small (large) firm equals 1.33 (1.47). The median solvency ratio for a small (large) firm equals 35.85 (39.15). The median current ratio for a small (large) firm equals 1.19 (2.16). This shows that the small median firm is more financially constrained than the (large) median firm.

Figure D.3.: Average distance of foreign affiliates from Germany



Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

We also relate the total sales to the average correlation of the given location with all other markets present in our sample.[2] Table D.1 shows that the sales are lower in those locations characterized by a larger average correlation, as expected.

Table D.1.: Location sales and average correlation

Dependent variable: log(sales)	Coefficient	SE
average correlation	-0.3865^{***}	0.1076
constant	17.8212^{***}	0.0348
N	1611	
R^2	0.0080	

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

In addition, diversification patterns cannot be explained by heterogeneity in firm efficiency as we find no correlation between the proposed measure of sales portfolio diversification and firm efficiency.[3]

[2] For country d, the average correlation in the sector i is given by $\sum_{d' \in D} \text{corr}(\alpha_{id}, \alpha_{id'})/|D|$.
[3] Firm's productivity estimation is described in Section 2.4.1.

On the extensive margin, figure D.3 shows that the average distance from Germany of the affiliates does not monotonically increase with the number of countries the firm operates in. Hence, firms that can afford to pay several times the fixed costs of entry are not establishing themselves necessarily in more distant markets as predicted by the standard theory of proximity-concentration tradeoff.

Table D.2.: Average distance from Germany per number of affiliates hold by an MNE

Number of affiliates	Sample mean	SD	N
1	2795.74	3272.13	593
2	3271.36	2693.60	173
3	3676.50	2361.76	69
4	3843.34	2077.86	38
5	4223.96	2577.52	24
6	3593.86	2310.64	15
7	3455.94	1445.43	15
8	5006.77	1998.38	6
9	4177.81	1899.63	11
10	4569.92	1076.58	9
11+	4486.80	1186.02	18
Average Distance	3119.01	2994.77	971

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

Managers of Multinational Firms are Risk Averse. There are several papers showing that firms are run by risk averse agents. Cucculelli and Ermini (2013) elicit CEOs' risk attitude in a sample of 178 manufacturing firms of different sizes. They find that most respondents exhibit an averse attitude toward risk.[4] Moreover, their measure of risk aversion varies with different firm characteristics like size and age.[5] In particular, managers of larger or older firms tend to be less risk averse. Other empirical papers like Esposito (2017), De Sousa et al. (2017), Herranz, Krasa, and Villamil (2015) analyze risk aversion in managerial behavior. In particular, the first two contributions provide empirical evidence of risk averse attitude of exporters.

In addition, several recent surveys show that managers are concerned about the volatility of demand in international markets and have a negative attitude toward risk. In particular, according to the Capgemini Survey 2011, demand volatility is the most relevant business challenge (40%

[4] 76.4% (93.2%) of respondents are (weakly) risk averse.

[5] The average sales, number of employees, and range of supplied products are significantly larger for those firms run by risk loving managers than for those run by (weakly) risk averse managers.

of responses) in the agenda of managers of global companies.[6] These results are in line with the Capgemini Survey 2012, in which the fraction of responses indicating demand volatility as the most relevant concern topped 52%.[7] An analogous study conducted by McKinsey in 2010 shows that increasing volatility of customer demand is the most frequently mentioned challenge for companies operating in a global environment (37% of responses).[8] These surveys also point out that firms react to demand risk by adjusting their production and sales plans.

The outcomes of these surveys are also relatable to the consideration that managers can hardly perfectly diversify their endowment of human and physical capital across different firms.[9] Indeed, in most cases, the relation between a multinational company and a CEO tends to be exclusive. Moreover, the theoretical contribution of Nocke and Thanassoulis (2014) finds that risk aversion can be the outcome of credit constraints and diminishing marginal returns to scale of an investment in a pledgeable asset.

Managers' risk aversion can be also due to the fact that a part of managerial compensation schemes is linked to company performance. In particular, the value of bonuses and company's shares depends crucially on the market performance realized by the firm. In this regard, Perrino, Poteshman, and S. (2002) highlight that risk-reducing projects attract managers as they become more risk averse. Relatedly, Abdel-Khalik (2007) shows that managers want to reduce the volatility of firms they manage to avoid the reduction of company's market value, as this would reflect in a decrease of the value of their assets.

Demands are Imperfectly Correlated across Destination Markets. Both the World Trade Report 2008 and the World Investment Report 2008 highlight the importance of imperfectly correlated demands across countries during the 2007 crisis. While the Trade Report claims that exporters did not hedge during the crisis, the Investment Report states the opposite for multinational firms. In particular, at the aggregate level multinational firms moved their export and production toward those markets considered as more resilient to demand shocks. During the crisis, transition and developing economies worked as a good hedge for the declining demand in developed regions. In line with this observation, we find that German multinationals operating in both the OECD and non-OECD countries hold more diversified portfolios (in terms of sales) than those with production plants only in one type of the country. In particular, the median concentration for firms operating only in the non-OECD countries is 0.65, whereas the median concentration of firms operating only in the OECD countries is 0.38. Firms operating in both

[6]Based on responses from 300 leading companies managers in Europe, North and Latin America, Asia. Demand risk result more important than other factors, like increasing material costs, meeting changing customer requirements, sustainability, etc.

[7]Based on responses from 350 leading companies managers in Europe, North and Latin America, Asia.

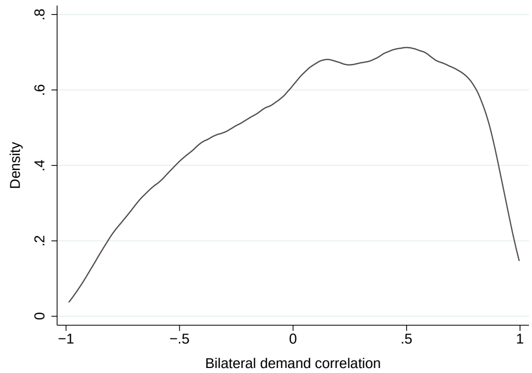
[8]Survey based on responses from 639 leading companies managers worldwide.

[9]This form of idiosyncratic risk cannot be diversified since markets are incomplete.

types of countries display a median sales concentration equal to 0.32. Moreover, the extent of sales diversification may be explained not only by the characteristics of the firms but also by the features of the countries, with particular emphasis on market volatility.

Additionally, we compute the variance-covariance matrix at the 2-digit industry-level of the consumption expenditure,[10] using production and trade data of the top 45 German export-destination countries for the period 2002 − 2006. Figure D.4 shows the distribution of bilateral correlations at the industry level. As it can be noticed, the correlation of demands across countries is imperfect for all industries, with the median correlation of demand being below 0.5.

Figure D.4.: Distribution of demand correlations, product level



Source: UNIDO INDSTAT2 2016, authors' calculations.

Therefore, the structure of demand correlations suggests that markets offer hedging opportunities to multinational firms.

[10]For a given industry, the consumption expenditure is given by the difference between total production and net exports.

E. Risk Aversion and Aggregate Sales

Proposition 3. *(Risk Aversion and Aggregate Sales). The firm's aggregate sales are decreasing with risk aversion.*

Proof. The system of first-order necessary and sufficient conditions reads as

$$\mathbb{E}A_d - \frac{\sigma}{\sigma-1} c_d s_d^{\frac{1}{\sigma-1}} - r \sum_{d'} \text{cov}(A_d, A_{d'}) s_{d'} = 0, \quad \forall d \in D. \tag{E.1}$$

Differentiating both sides with respect to r we obtain

$$-\frac{\sigma}{(\sigma-1)^2} c_d s_d^{\frac{1}{\sigma-1}-1} \dot{s}_d - \sum_{d'} \text{cov}(A_d, A_{d'}) s_{d'} - r \sum_{d'} \text{cov}(A_d, A_{d'}) \dot{s}_{d'} = 0, \quad \forall d \in D, \tag{E.2}$$

where $\dot{s}_d \equiv \frac{\partial s_d}{\partial r}$ for all $d \in D$. Hence, $\forall d \in D$

$$\frac{\sigma}{\sigma-1} c_d s_d^{\frac{1}{\sigma-1}-1} \dot{s}_d = -(\sigma-1) \left(\sum_{d'} \text{cov}(A_d, A_{d'}) s_{d'} + r \sum_{d'} \text{cov}(A_d, A_{d'}) \dot{s}_{d'} \right). \tag{E.3}$$

Again, using FOC we observe that

$$\frac{\sigma}{\sigma-1} c_d s_d^{\frac{1}{\sigma-1}} = \mathbb{E}A_d - r \sum_{d'} \text{cov}(A_d, A_{d'}) s_{d'}, \quad \forall d \in D. \tag{E.4}$$

Combining equations (E.3) and (E.4) we obtain

$$\begin{aligned} &\left(\mathbb{E}A_d - r \sum_{d'} \text{cov}(A_d, A_{d'}) s_{d'} \right) \dot{s}_d \\ &= -(\sigma-1) \left(\sum_{d'} \text{cov}(A_d, A_{d'}) s_{d'} + r \sum_{d'} \text{cov}(A_d, A_{d'}) \dot{s}_{d'} \right) \end{aligned} \tag{E.5}$$

for all d, which implies

$$\mathbb{E}A_d\dot{s}_d = -(\sigma-1)\left(\sum_{d'}\text{cov}(A_d, A_{d'})s_{d'} + r\sum_{d'}\text{cov}(A_d, A_{d'})\dot{s}_{d'}\right) + r\sum_{d'}\text{cov}(A_d, A_{d'})s_{d'}\dot{s}_d. \tag{E.6}$$

Summing both sides over d we obtain

$$\sum_d \mathbb{E}A_d\dot{s}_d = -(\sigma-1)\left(\sum_d\sum_{d'}\text{cov}(A_d, A_{d'})s_{d'} + r\sum_d\sum_{d'}\text{cov}(A_d, A_{d'})\dot{s}_{d'}\right) + r\sum_d\sum_{d'}\text{cov}(A_d, A_{d'})s_{d'}\dot{s}_d. \tag{E.7}$$

where the left hand side is the derivative of the aggregate sales with respect to r. We want to show that this derivative is negative.

Let's consider the term in brackets of equation (E.7). Recall that

$$-\frac{\sigma}{\sigma-1}c_d s_d^{\frac{1}{\sigma-1}-1}\dot{s}_d = \sum_{d'}\text{cov}(A_d, A_{d'})s_{d'} + r\sum_{d'}\text{cov}(A_d, A_{d'})\dot{s}_{d'}. \tag{E.8}$$

Multiplying both sides of equation (E.8) by $\dot{s}_d$, we obtain

$$-\frac{\sigma}{\sigma-1}c_d s_d^{\frac{1}{\sigma-1}-1}(\dot{s}_d)^2 = \sum_{d'}\text{cov}(A_d, A_{d'})s_{d'}\dot{s}_d + r\sum_{d'}\text{cov}(A_d, A_{d'})\dot{s}_{d'}\dot{s}_d. \tag{E.9}$$

Summing both sides of equation (E.9) over d and re-arranging, we obtain

$$\sum_d\sum_{d'}\text{cov}(A_d, A_{d'})s_{d'}\dot{s}_d = -r\sum_d\sum_{d'}\text{cov}(A_d, A_{d'})\dot{s}_{d'}\dot{s}_d - \sum_d\frac{\sigma}{\sigma-1}c_d s_d^{\frac{1}{\sigma-1}-1}(\dot{s}_d)^2. \tag{E.10}$$

We note that the left hand side of the above expression has to be negative since the right hand side is the sum of two negative terms, i.e.

$$\sum_d\sum_{d'}\text{cov}(A_d, A_{d'})s_{d'}\dot{s}_d < 0. \tag{E.11}$$

Incidentally we also notice that

$$r\sum_{d}\sum_{d'}\text{cov}(A_d, A_{d'})\dot{s}_d\dot{s}_{d'} + \sum_{d}\sum_{d'}\text{cov}(A_d, A_{d'})s_{d'}\dot{s}_d < 0. \tag{E.12}$$

Finally, note that $\text{var}(\boldsymbol{A}'\boldsymbol{s} + r\boldsymbol{A}'\dot{\boldsymbol{s}})$ can be written as

$$\begin{aligned}
\sum_{d}\sum_{d'}\text{cov}(A_d, A_{d'})s_d s_{d'} + 2r\sum_{d}\sum_{d'}\text{cov}(A_d, A_{d'})s_{d'}\dot{s}_d \\
+r^2\sum_{d}\sum_{d'}\text{cov}(A_d, A_{d'})\dot{s}_{d'}\dot{s}_d = \\
\sum_{d}\sum_{d'}\text{cov}(A_d, A_{d'})s_d s_{d'} + r\sum_{d}\sum_{d'}\text{cov}(A_d, A_{d'})s_{d'}\dot{s}_d \\
+r\left(r\sum_{d}\sum_{d'}\text{cov}(A_d, A_{d'})\dot{s}_{d'}\dot{s}_d + \sum_{d}\sum_{d'}\text{cov}(A_d, A_{d'})s_{d'}\dot{s}_d\right) > 0.
\end{aligned} \tag{E.13}$$

From equation (E.12) we notice that the term in the brackets is negative. Hence, the sum outside the brackets has to be positive since the variance is a positive number, i.e.

$$\sum_{d}\sum_{d'}\text{cov}(A_d, A_{d'})s_d s_{d'} + r\sum_{d}\sum_{d'}\text{cov}(A_d, A_{d'})s_{d'}\dot{s}_d > 0. \tag{E.14}$$

Hence, considering equations (E.7), (E.10) and (E.13), we conclude that aggregate sales are decreasing in r. □

F. Price Setting

In this section, we assume that the firm maximizes its expected-utility function of profits realized in the destination market with respect to the price rather than quantity.

Recall that consumer utility is

$$U_d = \sum_{i=1}^{I} \alpha_{id} \ln Q_{id} + Q_{0d}, \tag{F.1}$$

with

$$Q_{id} = \left[\int_{\omega \in \Omega_{id}} q_{id}(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}. \tag{F.2}$$

Utility maximization implies the following direct demand function for the variety

$$q_{id}(\omega) = \alpha_{id} p_{id}(\omega)^{-\sigma} P_{id}^{\sigma-1}, \tag{F.3}$$

where

$$P_{id} = \left[\int_{\omega \in \Omega_{id}} p_{id}(\omega)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}. \tag{F.4}$$

Firm's profits as a function of the price $\boldsymbol{p} = (p_1, p_2, \ldots, p_d, \ldots, p_N)$ are given by

$$\begin{aligned} \Pi(\boldsymbol{p}|L, \boldsymbol{\varphi}, r) &= \sum_d p_d q_d - c_d q_d \\ &= \sum_d \alpha_d p_d^{1-\sigma} P_{id}^{\sigma-1} - c_d \alpha_d p_d^{-\sigma} P_d^{\sigma-1} \\ &= \sum_d \alpha_d P_d^{\sigma-1} p_d^{-\sigma} \left(p_d - c_d \right). \end{aligned} \tag{F.5}$$

From equation (F.5), expected profits $\mathbb{E}[\Pi(\boldsymbol{p}|L, \boldsymbol{\varphi}, r)]$ are given by

$$\mathbb{E}\Pi[(\Pi(\boldsymbol{p}|L, \boldsymbol{\varphi}, r))] = \sum_d \bar{\alpha}_d P_d^{\sigma-1} p_d^{-\sigma} \left(p_d - c_d \right), \tag{F.6}$$

whereas the variance $\text{var}(\Pi(\boldsymbol{p}|L,\boldsymbol{\varphi},r))$ is given by

$$\text{var}(\Pi(\boldsymbol{p}|L,\boldsymbol{\varphi},r)) = \sum_d \sum_{d'} \text{cov}(\alpha_d,\alpha_{d'}) P_d^{\sigma-1} P_{d'}^{\sigma-1} p_d^{-\sigma} p_{d'}^{-\sigma} \left(p_d - c_d\right)\left(p_{d'} - c_{d'}\right). \tag{F.7}$$

Recall that the objective function of the firm is given by

$$u(\Pi(\boldsymbol{p}|L,\boldsymbol{\varphi},r)) = \mathbb{E}[(\Pi(\boldsymbol{p}|L,\boldsymbol{\varphi},r))] - \frac{r}{2}\text{var}((\Pi(\boldsymbol{p}|L,\boldsymbol{\varphi},r)). \tag{F.8}$$

The first order derivative of $\mathbb{E}[(\Pi(\boldsymbol{p}|L,\boldsymbol{\varphi},r))]$ with respect to p_d is given by

$$\begin{aligned}\frac{\partial \mathbb{E}[(\Pi(\boldsymbol{p}|L,\boldsymbol{\varphi},r))]}{\partial p_d} &= \bar{\alpha}_d P_d^{\sigma-1} p_d^{-\sigma}(1-\sigma) + c_d \bar{\alpha}_d \sigma p_d^{-\sigma-1} P_d^{\sigma-1} \\ &= \bar{\alpha}_d P_d^{\sigma-1}\left(p_d^{-\sigma}(1-\sigma) + c_d \sigma p_d^{-\sigma-1}\right).\end{aligned} \tag{F.9}$$

The expected profits have one critical point which corresponds to the standard constant markup over cost pricing. In particular, a firm maximizes the expected profits if $p_d = \frac{\sigma}{\sigma-1}c_d$ for all destination markets. This corresponds to the problem when a firm is not risk averse or there is no risk.

The first order derivative of $\text{var}(\Pi(\boldsymbol{p}|L,\boldsymbol{\varphi},r))$ with respect to p_d is given by

$$\frac{\partial \text{var}(\Pi(\boldsymbol{p}|L,\boldsymbol{\varphi},r))}{\partial p_d} = 2\left(p_d^{-\sigma}(1-\sigma) + c_d \sigma p_d^{-\sigma-1}\right)\sum_{d'} \text{cov}(\alpha_d,\alpha_{d'}) P_d^{\sigma-1} P_{d'}^{\sigma-1} p_{d'}^{-\sigma}(p_{d'} - c_d). \tag{F.10}$$

Hence, the variance has two salient critical points: (i) $p_d = c_d$ for all destination markets, and (ii) $p_d = \frac{\sigma}{\sigma-1}c_d$ for all destination markets. The second critical point is irrelevant as it is a local maximum of the variance. Instead, the first critical point is a global minimum of the variance function. In particular, the firm can make the variance of profits equal to 0 if $p_d = c_d$ for all destination markets.

From the above analysis, we can draw the following conclusion. On the one hand a firm wants to maximize its expected profits by setting the standard constant markup over marginal cost implied by the CES preferences. On the other hand, the firm wants to minimize the variance by pricing at the marginal cost in each destination market.

Let $\zeta(p_d) \equiv \left(p_d^{-\sigma}(1-\sigma) + c_d\sigma p_d^{-\sigma-1}\right)$. Then, the optimality condition $\partial u(\Pi(\boldsymbol{p}|L,\boldsymbol{\varphi},r))/\partial p_d$ can be written as

$$\frac{\partial u(\Pi(\boldsymbol{p}|L,\boldsymbol{\varphi},r))}{\partial p_d} = \bar{\alpha}_d P_d^{\sigma-1}\zeta(p_d) - r\zeta(p_d)\sum_{d'} \text{cov}(\alpha_d,\alpha_{d'}) P_d^{\sigma-1} P_{d'}^{\sigma-1} p_{d'}^{-\sigma}\left(p_{d'} - c_{d'}\right) = 0. \tag{F.11}$$

Equation (F.11) can be also arranged in the following way

$$p_d = \frac{\sigma}{\sigma - 1}c_d + r\frac{\left(p_d - \frac{\sigma}{\sigma-1}c_d\right)}{\bar{\alpha}_d}\sum_{d'}\text{cov}(\alpha_d, \alpha_{d'})P_{d'}^{\sigma-1}\frac{p_{d'} - c_{d'}}{p_{d'}^{\sigma}}, \tag{F.12}$$

which shows that the optimal price can be shifted upward or downward depending on the diversification potential of market d.

We focus on two cases: (i) the case in which $p_d = \frac{\sigma}{\sigma-1}c_d$ for all markets d, and (ii) the case in which $p_d \neq \frac{\sigma}{\sigma-1}$ for some market d.

Consider the case (i). The element (d, d') in the Hessian matrix associated to the utility function in (F.8) is given by

$$\mathbf{H}_u(d, d') = \left(\frac{\partial^2 u(\Pi(\boldsymbol{p}|L, \boldsymbol{\varphi}, r))}{\partial p_d \partial p_{d'}}\right). \tag{F.13}$$

Then, if $d \neq d'$, the element of

$$\mathbf{H}_u(d, d') = 0, \tag{F.14}$$

when evaluated at $p_d = \frac{\sigma}{\sigma-1}c_d$ for all d.

Instead, if $d = d'$, the element of $\mathbf{H}_u(d, d)$, evaluated at $p_d = \frac{\sigma}{\sigma-1}c_d$ for all d, is given by

$$\frac{\partial^2 u(\Pi(\boldsymbol{p}|L, \boldsymbol{\varphi}, r))}{\partial p_d^2} = \zeta'\left(c_d\frac{1}{\sigma - 1}\right)P_d^{\sigma-1}\left(\bar{\alpha}_d - r\sigma^{-\sigma}(\sigma - 1)^{\sigma-1}\sum_{d'}\text{cov}(\alpha_d, \alpha_d')P_{d'}^{\sigma-1}c_{d'}^{1-\sigma}\right), \tag{F.15}$$

as $\zeta\left(\frac{\sigma}{\sigma-1}c_d\right) = 0$. Moreover, $\zeta'(p_d) < 0$ for $p_d = \frac{\sigma}{\sigma-1}c_d$.

Hence, the a constant-markup over marginal cost is a local maximum if and only if $\mathbf{H}_u(d, d) < 0$ or, equivalently, if and only if

$$r < \min_{d\in\{1,\ldots,N\}} \frac{\bar{\alpha}_d}{\sigma^{-\sigma}(\sigma - 1)^{\sigma-1}\sum_{d'}\text{cov}(\alpha_d, \alpha_{d'})P_{d'}^{\sigma-1}c_{d'}^{1-\sigma}}$$

for all $d \in D$.

Consider now case (ii). For some destination d, the firm charges a price different from the constant markup over marginal cost. Then, we can rearrange equation (F.11) in the following way.

$$\begin{aligned}\frac{p_d - c_d}{p_d^{\sigma}} &= \frac{\bar{\alpha}_d}{r\text{var}(\alpha_d)P_d^{\sigma-1}} - \sum_{d'\neq d}P_{d'}^{\sigma-1}\frac{\text{cov}(\alpha_d, \alpha_{d'})}{\text{var}(\alpha_d)}\frac{p_{d'} - c_{d'}}{p_d^{\sigma}} \\ &= \frac{\bar{\alpha}_d}{r\text{var}(\alpha_d)P_d^{\sigma-1}} - \sum_{d'\neq d}P_{d'}^{\sigma-1}\beta_{d,d'}\frac{p_{d'} - c_{d'}}{p_{d'}^{\sigma}}\end{aligned} \tag{F.16}$$

where $\beta_{d,d'} \equiv \frac{\text{cov}(\alpha_d,\alpha_{d'})}{\text{var}(\alpha_d)}$. The left hand side of the above expression measures firm's market power.

A closed form solution for p_d cannot be obtained in this case. However, to get some intuition, let $\text{cov}(\alpha_d, \alpha'_d) = 0$ for all d, d' with $d \neq d'$. Then, the above expression reads as

$$\frac{p_d - c_d}{p_d^\sigma} = \frac{\bar{\alpha}_d}{r\text{var}(\alpha_d)P_d^{\sigma-1}}. \tag{F.17}$$

Hence, larger and stabler markets allow the firm to increase the price for that market. A more risk averse firm tends to charge a lower price.

Assume also that $\sigma = 2$ similarly to De Sousa et al. (2017). Then, the solution[1] implied by equation (F.17) when $\sigma = 2$ is given by

$$p_d = \frac{rP_d\text{var}(\alpha_d) + \bar{\alpha}_d\sqrt{\frac{rP_d\text{var}(\alpha_d)(P_d r\text{var}(\alpha_d)-4\bar{\alpha}_d c_d)}{\bar{\alpha}^2}}}{2\alpha_d} \geq 2c_d. \tag{F.19}$$

As the Hessian is negative definite, the first order conditions expressed by (F.11) are sufficient. From (F.19), We can observe that the firm charges a price which exceeds the standard constant markup over marginal cost price.

Moreover, when $\sigma = 2$ and all covariances are equal to 0, we are able to compare the price implied by the solution to the utility maximization problem under price choice with the price selected by the firm in equation (F.19). To see this, consider (2.16). In this case, we obtain

$$q_d = \left(\frac{\mathbb{E}[A_d]}{2c_d}\right)^2 \cdot \left(\frac{1}{1 + r\frac{\text{var}(A_d)}{2c_d}}\right)^2. \tag{F.20}$$

Recall that $\mathbb{E}A_d = \bar{\alpha}_d Q_d^{-\frac{\sigma-1}{\sigma}}$. Hence, rearranging we obtain

$$q_d = \frac{\bar{\alpha}_d^2 Q_d}{(2c_d Q_d + r\text{var}(\alpha_d))^2}. \tag{F.21}$$

Plugging into the equation (F.3), we obtain an expression for the expected price $\mathbb{E}p_d$

$$\mathbb{E}p_d = 2c_d + r\frac{P_d\text{var}(\alpha_d)}{\bar{\alpha}_d} \tag{F.22}$$

[1]When $\sigma = 2$ and all covariances are zero, the Hessian of the utility function is a diagonal matrix whose d element on the main diagonal is given by

$$\mathcal{H}_{d,d} = -\frac{64\bar{\alpha}_d^6 c_d^2 P_d^2 r\text{var}(\alpha_d)}{\left(P_d r\text{var}(\alpha_d) + \bar{\alpha}_d\sqrt{\frac{P_d r\text{var}(\alpha_d)(-4\bar{\alpha}_d c_d + P_d r\text{var}(\alpha_d))}{\bar{\alpha}^2}}\right)^6} < 0. \tag{F.18}$$

which does not solve the first order conditions (F.11) with respect to price. Hence, the expected price implied under quantity choice differs from that chosen by the profit maximizing firm under price choice. Moreover, the expected price under quantity choice exceeds the risk-neutral price by an amount which represents the per-unit risk-premium the firm asks for selling the product in the destination market d.

Comparing the price expression from equation (F.22) with that of equation (F.19), we obtain

$$\mathbb{E}p_d \geq p_d \Leftrightarrow \text{var}(\alpha_d) \geq \frac{4\bar{\alpha}_d c_d}{P_d r} \tag{F.23}$$

provided $\bar{\alpha}_d \geq 1$.

Hence, when uncertainty is a relatively large concern for the firm (either high risk aversion or high variance), the risk-premium in terms of extra markup required by the firm is larger in the quantity setting case. This hints at the fact that with large variance the firm is shipping a smaller amount of the good to the destination market than those expected under price choice. Under quantity choice the firm needs to plan in advance and pay the production costs upfront. Hence, the firm would be prefer to produce a relatively small quantity to reduce its exposure to adversarial demand fluctuations in the foreign markets.

G. Different Timing

Recall that firm's problem consists of three decisions, as discussed in Section 2.2. Specifically, one of the assumptions of the model is that the firm decides on how much to sell in each destination market before observing the actual realizations of the demand. In this section, we relax this assumption in the following way.[1] We assume that the firm decides the level of production in each of its foreign affiliate before observing the demand shocks. However, the firm can optimally readjust its sales according to the demand realizations in the different markets in which it is operating, given the chosen level of production. As a preliminary, we notice that this different specification of the timing does not affect location and shipment decisions as presented in Section 2.2.

Assume that the firm has chosen a level of production q_l for $l \in L$. As discussed, the level of production in each plant reflects the plant productivity, the benefits (in terms of trade cost savings and market sizes of the destination markets) associated to the export platform, and the degree of firm's risk aversion.

Suppose that the firm has to decide on how much to sell in each destination market after having observed the demand realizations A_d in each market d. Then, the firm needs to solve

$$\begin{aligned} \max_{\boldsymbol{q} \in \mathbb{R}_+^{L+N}} & \sum_d \sum_l (p_d - \tau_{ld}) q_{ld} \\ \text{s. t. } & \sum_d q_{ld} \leq q_l \quad \forall l \in L, \\ & \sum_l q_{ld} = q_d \quad \forall d. \end{aligned} \tag{G.1}$$

The first set of constraints expresses the fact that the output sold in the different markets from the plant in country l cannot exceed the output therein produced. The second set of constraints states that the quantity sold in d equals the sum of outputs produced in the different locations and meant to be sold in the destination market d itself.

[1] Notice that also other specifications are possible. For example, demand realizations might be observed by the firms after the entry has taken place. However, this would imply that risk aversion only affects entry choices, which is inconsistent with what we observe in the data.

After the shocks have realized, the production costs are sunk. Hence, the firm only wants to maximize the difference between the price in each destination market and the trade costs associated to that market, given the capacity constraints set in the previous stage. As the firm considers the realized demand, we observe that $p_d = A_d q_d^{-\frac{1}{\sigma}}$. Notice that this specification of the problem complicates the analysis. When the firm makes the production and shipment decisions at the same time, then each destination market is served by one and only one location, as trade costs and marginal production costs are constant. However, when these decisions are separated, the amount of production carried out in one plant, which operates as a capacity constraint, can be insufficient to accommodate the total demand in a given destination market. In other words, the firm serves a destination market from the optimal origin as long as the built-up capacity suffices. Then, it has to resort to some stored capacity available in other plants. Moreover, the original location-destination paths that firm accounts for when selecting the optimal level of production can be no longer relevant, as the production costs are sunk. In particular, when maximizing its profits, the firm only considers the trade costs associated to each plant together with its capacity, and this fact potentially determines different location-destination paths from the original one.

Using $p_d = A_d q_d^{-\frac{1}{\sigma}}$ and the constraint $\sum_l q_{ld} = q_d$, firm's problem (G.1) can be written as

$$\begin{aligned} \max_{\boldsymbol{q}\in\mathbb{R}_+^{L+N}} & \sum_d A_d \left(\sum_l q_{ld}\right)^{\frac{\sigma-1}{\sigma}} - \sum_d \sum_l \tau_{ld} q_{ld} \\ \text{s. t.} & \sum_d q_{ld} \leq q_l \quad \forall l \in L. \end{aligned} \tag{G.2}$$

Then, the optimality conditions for the problem (G.2) are given by

$$\text{(i)} \quad \frac{\sigma-1}{\sigma} A_d \left(\sum_l q_{ld}\right)^{-\frac{1}{\sigma}} - \tau_{ld} - \lambda_l + \mu_{ld} = 0 \quad \forall l, d \tag{G.3}$$

$$\text{(ii)} \quad \lambda_l \left(-q_l + \sum_d q_{ld}\right) = 0 \quad \forall l \tag{G.4}$$

$$\text{(iii)} \quad \sum_d q_{ld} \leq q_l \quad \text{and} \quad \lambda_l \geq 0 \; \forall l \tag{G.5}$$

$$\text{(iv)} \quad \mu_{ld} q_{ld} = 0 \quad \forall l, d \tag{G.6}$$

$$\text{(v)} \quad \mu_{ld} \geq 0 \quad \wedge \; q_{ld} \geq 0, \tag{G.7}$$

where μ_{ld} is the multiplier associated to the non-negativity constraint for q_{ld} and λ_l is the multiplier associated to the capacity constraint in location l. Notice that the existence of a solution to the problem (G.1) derives from Weierstrass theorem whereas uniqueness follows from concavity of the objective function and linearity of the constraint functions. This timing does not affect qualitatively our major findings concerning the structure of multinational sales. The realized price in each market for the optimal $(q_{ld})_{l\in L,d\in D}$ differs from the standard markup over marginal cost and that they are heterogeneous with respect to firm and destination. To note this point, we write the set of conditions (G.3) in terms of q_d as a function of the parameters

$$q_d = \left(\frac{\sigma-1}{\sigma}\frac{A_d}{\tau_{ld}-\mu_{ld}+\lambda_l}\right)^{\sigma} \quad \forall l, d. \tag{G.8}$$

Then, it follows from the conditions in (G.8) that

$$\tau_{l'd}-\tau_{ld} = (\lambda_l-\lambda_{l'})+(\mu_{l'd}-\mu_{ld}) \quad \forall l, l', d. \tag{G.9}$$

Hence, if the difference between the trade costs of serving market d from locations l and l' is large, then the value of relaxing the capacity constraint associated to the plant l compared with that associated to plant l' has to be large as well. In addition, notice that if $\tau_{ld} = \min_{l'} \tau_{l'd}$, then for any $l' \neq l$, then

$$\lambda_l - \lambda_{l'} + \mu_{l'd} - \mu_{ld} \geq 0. \tag{G.10}$$

This means that when a firm sells its product to a country in which it has a production facility, either it does from the location itself, in which case $\mu_{ld} = 0$, or it needs to be the case that the difference between λ_l and $\lambda_{l'}$ has to be relatively large. This might be the consequence of the fact that the firm has built a low level of capacity in the plant l itself in the previous stage.

In addition, we note that the quantity q_d depends negatively on the level of trade costs to serve the market d, positively on the market size and the capacity built-up in the previous period. Moreover, the quantity sold in a market under demand risk is not larger than the quantity sold under no risk if firm's capacity in l associated to the first scenario is lower than the one in the second one.

Finally, from equation (G.8), we can obtain an expression for the realized price. In particular,

$$p_d = \frac{\sigma}{\sigma-1}(\tau_{ld}-\mu_{ld}+\lambda_l) \quad \forall d. \tag{G.11}$$

From the expression (G.11), though high marginal costs of production induce large prices, we observe that the price in this setting is potentially different from that emerging in the parallel model where we set the demand risk equal to zero.

H. Liberalization

Proposition 4. *Suppose a firm sells its variety in the destination market $\tilde{d}$ from its foreign affiliate located in l. Then, a reduction in the trade cost $\tau_{l\tilde{d}}$ increases firm's sales to the destination market $\tilde{d}$.*

Proof. As discussed in the chapter, for each firm there is a unique location-destination path which is optimal. For this reason, we suppress the subscript of the origin location l, assuming that the firm serves the foreign market $\tilde{d}$ in the optimal way.

Consider the first order condition (A.2) given by

$$\mathbb{E}[A_d] - r\sum_{d'} \text{cov}(A_d, A'_d)s_{d'} - \frac{\sigma}{\sigma-1}c_d s_{\tilde{d}}^{\frac{1}{\sigma-1}} = 0. \tag{H.1}$$

Then, for any d, we can differentiate both sides of the above equation with respect to $\tau_{\tilde{d}}$. We distinguish two cases. If $d = \tilde{d}$, then

$$-\frac{\sigma}{(\sigma-1)^2}c_{\tilde{d}} s_{\tilde{d}}^{\frac{2-\sigma}{\sigma-1}} \dot{s}_{\tilde{d}} - r\sum_{d'} \text{cov}(A_{\tilde{d}}, A_{d'})\dot{s}_{d'} = \frac{\sigma}{\sigma-1} s_{\tilde{d}}^{\frac{1}{\sigma-1}} \dot{c}_{\tilde{d}}. \tag{H.2}$$

If $d \neq \tilde{d}$, then

$$-\frac{\sigma}{(\sigma-1)^2}c_d s_d^{\frac{2-\sigma}{\sigma-1}} \dot{s}_d - r\sum_{d'} \text{cov}(A_{\tilde{d}}, A_{d'})\dot{s}_{d'} = 0. \tag{H.3}$$

By multiplying both sides of the above equations by $\dot{s}_d$ and adding them up side by side over destinations, we obtain

$$\sum_{\tilde{d}} \frac{\sigma}{(\sigma-1)^2}c_{d'} s_d^{\frac{2-\sigma}{\sigma-1}} \dot{s}_d^2 + r\sum_{\tilde{d}}\sum_{d'} \text{cov}(A_{\tilde{d}}, A_{d'})\dot{s}_d\dot{s}_{\tilde{d}} = -\frac{\sigma}{\sigma-1} s_{\tilde{d}}^{\frac{1}{\sigma-1}} \dot{s}_{\tilde{d}}. \tag{H.4}$$

Note that $\sum_{\tilde{d}}\sum_{d'} \text{cov}(A_{\tilde{d}}, A_{d'})\dot{s}_d\dot{s}_{\tilde{d}} > 0$ which is a positive quadratic form, being Σ_A positive definite. Hence, the left-hand side of equation (H.4) is positive, as it is the sum of positive numbers. Therefore, $\dot{s}_d < 0$. □

I. Fixed Cost Estimation

Estimation of fixed costs can be carried out adapting the approach discussed in Tintelnot (2017). Consider the problem of a firm with risk aversion equal to r, core productivity φ, and fixed entry costs $\boldsymbol{f}$. Firm productivity in each foreign country l is $\gamma_l \varphi$ where γ_l is a country-specific shifter common to all firms. Hence, if a firm establishes a foreign affiliate in country l, its marginal cost equals $1/(\gamma_l \varphi)$. The firm selects the set $L \in 2^{N-1}$ if for all $L' \in 2^{N-1}$

$$V(L) - \mathcal{F}(L) \geq V(L') - \mathcal{F}(L'), \tag{I.1}$$

where $V(L)$ is the indirect utility function associated to the set L and $\mathcal{F}(L) = \sum_{l \in L} f_l$.

Hence, the probability that the firm selects the set L over all other location sets is given by

$$\begin{split} \Pr(L|\varphi, r, \boldsymbol{\tau}, \boldsymbol{\gamma}, \mathbb{E}\boldsymbol{A}, \Sigma_A, \boldsymbol{\theta}_f) = \\ \int\limits_{\boldsymbol{f}} \mathbb{1}\left(V(L) - \mathcal{F}(L) \geq V(L') - \mathcal{F}(L') \;\; \forall L \in 2^{N-1}\right) dG_f(\boldsymbol{f}; \boldsymbol{\theta}_f), \end{split} \tag{I.2}$$

where G_f is the (differentiable) cdf of the fixed costs parametrized by the vector $\boldsymbol{\theta}_f$.

Once firm enters the chosen locations, productivity, risk aversion and the market characteristics (expected and realized sizes and variance of demand realizations, trade costs and shifters) determine the level of sales associated to each location. The theoretical revenues realized by the firm depend on r and all the above variables.

We assume that the risk aversion and core productivities are respectively distributed according to continuous parametric cdfs $G_r(r; \boldsymbol{\theta}_r)$ and $G_\varphi(\varphi; \boldsymbol{\theta}_\varphi)$, where $\boldsymbol{\theta}_r$ includes the parameters associated to the distribution of risk aversion, whereas $\boldsymbol{\theta}_\varphi$ includes those associated to the distribution of core productivities.

Hence, the contribution of firm i to the likelihood is given by the product of observing the chosen location sets multiplied by the densities of firm's revenues s_i in the different plants, i.e.

$$l_i(\boldsymbol{\theta}|L_i, s_i) = \int\limits_{\varphi} \int\limits_{r} \Pr(L_i|\varphi, r, \boldsymbol{\tau}, \boldsymbol{\gamma}, \mathbb{E}\boldsymbol{A}, \Sigma_A, \boldsymbol{\theta}_f) dG_s(s_i|L_i, \varphi, r) dG_r(r; \boldsymbol{\theta}_r) dG_\varphi(\varphi; \boldsymbol{\theta}_\varphi), \tag{I.3}$$

where $\boldsymbol{\theta} = (\boldsymbol{\theta}_f, \boldsymbol{\theta}_r, \boldsymbol{\theta}_\varphi)$ and G_s is the cdf of the revenues. As our model does not yield a closed-form solution for the revenues, the density of sales needs to be non-parametrically estimated.

The likelihood function implied by our model is then given by

$$l\left(\boldsymbol{\theta}|\{L_i\}_{i=1,\ldots,I}, \{s_i\}_{i=1,\ldots,I}\right) = \prod_{i=1}^{I} l_i(\boldsymbol{\theta}|L_i, s_i), \tag{I.4}$$

where I equals to total number of firms in our sample. In order to obtain estimates of $\boldsymbol{\theta}$, we can maximize function in (I.4) subject to the constraint that the theoretical sales for each firm implied by our model match those observed in the data.

J. Firm Characteristics and Risk Aversion

Table J.1.: Aggregate sales and risk aversion

Dependent variable: total group sales	Coefficient	SE
risk aversion	-0.5835^{***}	0.0133
productivity	0.6740^{***}	0.0283
number of affiliates	0.1478^{***}	0.0083
constant	2.7747^{***}	0.0954
industry fixed effects	Yes	Yes
N	952	

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

Table J.2.: Gearing and risk aversion

Dependent variable: gearing	Coefficient	SE
risk aversion	17.5022^{**}	8.5526
size	-21.2136	31.0504
*size*risk aversion*	-13.0365	10.4800
age	-4.4616	3.8717
constant	248.1135	37.3606
industry fixed effects	Yes	Yes
N	393	

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, authors' calculations.

3. Serving Abroad: Export, M&A, and Greenfield Investment

joint with Ekaterina Kazakova

3.1. Introduction

Going abroad, firms select between opening a foreign branch, which allows them to be close to their consumers, and exporting, which is associated with variable trade costs but avoids duplication costs. This so-called proximity-concentration tradeoff is extensively discussed in the trade literature. In line with the empirical evidence for the manufacturing sector, a seminal paper by Helpman et al. (2004) finds that only the most productive firms conduct foreign direct investment (FDI), while less productive firms serve foreign markets via exports.[1] However, the entry patterns for service exporters and multinationals do not correspond to the ones predicted by the classical proximity-concentration literature. Specifically, in the German professional services industry,[2] only the most productive firms export their services, while less productive firms opt for FDI.[3] In particular, the average exporter is 3.0 times larger and sells 2.1 times more domestically than an average multinational firm.[4] When breaking down service FDI by entry mode, 73% of FDI occurs via cross-border mergers and acquisitions (M&A), and only 27% via the opening of new

[1]For the manufacturing sector in Germany, Ottaviano and Mayer (2007) find that relative to exporters, multinationals are substantially larger, more productive, pay higher wages and generate higher value added. In particular, exporters are 3.0 times larger than domestic producers, while multinational firms are 13.2 times larger. Same difference holds true for other countries.

[2]Professional services can be described as a broad consulting industry, including legal and accounting activities, management consultancy activities, architectural and engineering activities, technical testing and analysis, scientific research and development, advertising and market research, veterinary activities and other professional, scientific and technical activities. In our analysis, we also consider IT consulting and administrative and support service activities.

[3]According to the General Agreement in Trade in Services, there are four possible modes to trade services abroad. A transaction can occur without a physical movement of a consumer or a service provider to a location of the other (mode 1); a consumer can receive the service in the country of a service supplier, which would be specified under the mode 2; finally, a service provider can temporarily move to the location of its foreign buyer (mode 4) or establish a branch there (mode 3). The statistical data on services trade for German firms further aggregate these modes and classify modes 1, 2 and 4 as export.

[4]Similar evidence was found by Bhattacharya, Patnaik, and Shah (2012) for the Indian software industry and by Oldenski (2012) for the US services industry.

establishments abroad (greenfield investment).[5] Moreover, M&A generates larger affiliate sales than greenfield investment.

In this chapter, we rationalize the differences in foreign-market entry patterns across industries and analyze their implications for trade-liberalization outcomes. The study of the last question is particularly relevant for understanding the effects of service-trade liberalization and potential differences in the outcomes compared to manufacturing due to the specific features of this sector.[6] This chapter contributes to the area of the literature concerned with the structural estimation of the proximity-concentration tradeoff by taking into account the distinction between M&A and greenfield investment, as well as by introducing industry- and country-specific returns to exporting and FDI. Due to the potential differences in the sorting patterns into FDI and exporting, the liberalization can have different effect in the services sector compared to manufacturing, so that the main change in the intensive and extensive margins would come from FDI rather than exporting.

We build a structural model of horizontal FDI with firms that are heterogeneous in terms of their service quality. Firms can choose to serve foreign markets via exporting, cross-border mergers (M&A), or greenfield investment. Since foreign consumers can have a different perceiption of the service quality, entry into a new foreign market is associated with uncertainty about demand. Therefore, firms face the tradeoff between trying to transmit their core quality to a prospective market without *ex ante* observing the tastes of foreign consumers (via greenfield investment and exporting), and "buying demand" of a preexisting foreign firm in order to get access to its network of consumers and its expertise (via M&A).[7] Moreover, as replicating a quality abroad is potentially subject to larger costs for firms with initially higher quality, these firms may decide to export in order to avoid larger entry costs associated with high-quality greenfield investment. In our model, the M&A process features "cherry-picking," meaning that better targets are more likely to be acquired. Finally, acquisitions provide a higher return to core quality when the magnitude of synergies between the acquirer and the targets is larger.

The model generates a completely flexible relationship between quality and entry types[8] for each market. Entry patterns depend on the industry- and country-specific parameters, which

[5]The statistics is reported for the average parameters over the period 2005 – 2014 in Germany. For comparison, in the manufacturing sector, 62.6% of FDI entries in during this period occur via M&A.

[6]Analyzing the Transatlantic Trade and Investment Partnership (TTIP), Francois, Manchin, Norberg, Pindyuk, and Tomberger (2013) find that reduction in non-tariff barriers has larger impact for the manufacturing sector than for the services.

[7]The Baker & McKenzie (2014) survey names "the acquisition of customers or distribution networks" as the main incentive for cross-border mergers and acquisitions. According to their survey, the chief financial officer of a South African MNE in the professional-services sector say about the M&A in Mauritius: "The customer base was very attractive and we were confident of extracting the value by targeting the customer base of the target company."

[8]Hereafter entry alternatives are called "entry types" in order to avoid any confusion with the GATS specification of entry modes in the services sector.

determine the return to firm's core quality for each entry type in a given market. For example, high-quality services are more likely to be provided via greenfield investment if expected perceived quality is high and FDI entry costs do not increase much in quality. Alternatively, one will observe high-quality services to be exported if variable trade costs are low and expected perceived quality is high. Finally, high-quality services will be provided via M&A if targets are on average of high quality and synergies between acquirers and targets are substantial. Thus, depending on the characteristics of the industry, the model is able to deliver different outcomes regarding entry patterns and foreign sales for each entry type.

We then structurally estimate the fundamental parameters of the model for each market. We base our empirical analysis on firm-level data for German multinationals and exporters operating in the professional services sector. In particular, we consider the cross-section of the first entries of German multinationals into the EU, the US and the rest of the world markets during the period 2005 – 2014. In the structural estimation, we use information on the affiliate and domestic sales, as well as the entry types selected by firms in each market. The unique feature of the data is that it distinguishes between greenfield investment and M&A entries for each new FDI case. The structural estimation delivers the fundamental parameters which determine returns associated to each activity (change in the perception of quality across markets, synergies magnitude, trade costs, quality of M&A targets, and the cost of quality transmission with greenfield investment), as well as institutional entry costs specific to the foreign market and the entry type.

We find that the resulting equilibrium thresholds reverse the standard outcome for the manufacturing sector, where high-quality (or high-productivity) firms tend to engage in FDI. In contrast, firms with lower service quality prefer FDI to exporting. This result partly comes from the fact that the costs of replicating quality in a new market increase in core service quality, so that high-quality firms try to avoid these costs by serving foreign markets from their home location via exporting. Moreover, we find that the market differences in the distribution of foreign quality perception, as well as differences in the quality of M&A targets result in market-specific relations between the average service quality and FDI entry modes. While greenfield investors in the US exhibit a higher service quality than firms engaging in M&As, this relation is reversed for the EU and the rest of the world.

In the final part of our analysis, we aim to use the estimated model to examine the potential impact of a service-trade liberalization episode between the EU and the US, as planned for TTIP (Transatlantic Trade and Investment Partnership). We consider the impact on average service quality for each entry type and the average level of service quality provided in each market: the EU, the US, and the rest of the world. The model can be used to simulate two main features of TTIP for the services sector. First, we look at a reduction of institutional entry barriers, including facilitation of cross-border M&As and easier market access through reductions in costs associated to licensing and approvals of businesses. We consider a moderate scenario with a 10%-reduction in non-tariff barriers, as well as a more ambitious scenario of a 25%-reduction of barriers. Accordingly, this policy mainly impacts on the threshold quality that makes each entry alternative profitable, while the relative ranking between quality and entry modes remains unchanged. Second, we look at the introduction of quality standards, which reduces the costs of transferring core quality overseas. The corresponding reallocation effects can result in changes of relative qualities exported and provided via greenfield investment. Moreover, given the predictions on the ordering of entry alternatives in our model, we can expect that facilitating quality transmission abroad leads to higher quality of M&A targets, so that mergers become less frequent but of a better quality.

3.1.1. Related Literature

This chapter contributes to the literature on the proximity-concentration tradeoff with heterogeneous firms. We depart from Helpman et al. (2004), who describe the selection of firms into exporting and greenfield investment, by (i) allowing firms to acquire foreign targets in order to resolve uncertainty regarding the quality perception and to exploit the potential merger synergies; (ii) introducing the flexibility in the returns each entry activity provides to firm's revenue productivity. These novelties make our model empirically tractable and allow us to explain differences in the entry patterns across industries and countries.[9] This chapter relates to a small set of papers that structurally estimate a model of the Helpman et al. (2004) type. The recent contributions by Irarrazabal, Moxnes, and Opromolla (2013), Ramondo and Rodríguez-Clare (2013), Ramondo (2014), Tintelnot (2017) propose frameworks suitable for the empirical analysis of multinational production and trade. In contrast to the model described in this chapter, these models predetermines the relation between productivities of firms selecting into exporting and FDI, since the return from exports is always smaller due to the presence of iceberg trade costs. Moreover, these papers do not consider M&A, which are conceptually different from the greenfield investment in terms of the technology transfer and, therefore, are driven by different incentives and provide different outcomes from greenfield investment.

This chapter also relates to the literature analyzing the determinants of cross-border mergers, among those the papers by Nocke and Yeaple (2007, 2008) are the closest to the present chapter. Analogously to Nocke and Yeaple (2007), we regard M&A as a vehicle for obtaining the network and service quality of an existing firm in the prospective market. Similar to their model, we regard quality as a non-transferable capacity. For example, a high-quality firm in the services sector may have an exceptional consultant, so that the costs of finding a new worker with the same set of skills are larger than those of sending the worker herself to the foreign country. Unlike Nocke and

[9] Geishecker, Schröder, and Sørensen (2017) show that the exporter productivity and size premia vary across countries and industries.

Yeaple (2007), we do not restrict the realization of perceived quality in the foreign market to be lower than at home. Moreover, in our framework, the ordering of cutoffs for greenfield investment and M&A is not determined by the source of firm heterogeneity but instead by the country-specific distribution of perceived quality shocks and the structure of entry costs. Additionally, we find that firms conducting greenfield FDI in the professional services sector have lower quality than exporters, so that we have a different ordering of cutoffs for these two entry types. Similarly to Nocke and Yeaple (2008), the incentives of engaging in cross-border acquisition and greenfield FDI differ across countries. As the distribution of target quality in the EU and the US is characterized by larger expectations of the targets' quality, the acceptance rate of M&A offers is higher, too.

This chapter extends the trade literature on the services sector. Bhattacharya et al. (2012) model the choice between FDI and export in IT-oriented services. They find that firms with high service quality prefer exporting over FDI. Differently from our work, the choice between entry types is driven by the differences in the overseas transferability of quality via export and greenfield investment. By contrast, we do not assume that the physical presence in the country reduces demand uncertainty. Given that services export involves personal contact between a supplier and a consumer, it seems hard to justify an assumption about the differences in perception of service quality between export and FDI. Moreover, perception of quality in our model reflects country-specific tastes, so that consumer preferences are independent of the supply mode. Oldenski (2012) also emphasizes the importance of personal presence in the country for providers of commercial services, which can affect the entry choice. In our model, the choice for M&A and greenfield investment is endogenous and not amplified by any restriction on the need for commercial presence for the personal contact with a consumer.

One of the key ingredients of our model is the uncertainty about foreign quality perception. Rob and Vettas (2003), Nguyen (2012b), Albornoz et al. (2012), and Conconi et al. (2016) highlight the importance of non-observability of demand in new destination markets, and learning about demand which occurs via entry in related foreign locations. For the services sector, we do not observe sequentiality of entry into foreign markets, and consider the first entry into a given market in order to avoid confusion between the mechanism of our interest and learning occurring via foreign activities. Aeberhardt, Buono, and Fadinger (2014) consider firms that can choose to serve a foreign market either directly, facing the costs of getting to know the foreign market, or indirectly, via a local partner who can potentially hold them up. Similar to their paper, we find that the characteristics of foreign markets can be crucial for determining the incentives to select one of the available alternatives.

Finally, this chapter also contributes to the literature highlighting the role of product quality in international trade. Analogously to Kugler and Verhoogen (2012), Johnson (2012), and Feenstra and Romalis (2014), we argue that service quality is one of the key factors explaining firm heterogeneity. Similar to Cagé and Rouzet (2015), we assume that perceived quality is not observed prior to entry into the foreign market, therefore firm's choice is based on the expected perceived quality. Since we allow for M&A as a way to avoid informational frictions, we observe relatively less efficient firms active via acquired affiliates in the foreign markets. Moreover, since the professional services sector is a long quality ladder industry, we use the results of Khandelwal (2010) to argue that the sales of a firm are a good proxy for firm's service quality.

The rest of the chapter is organized as follows. Section 3.4 describes the data used in the empirical analysis and presents the entry patterns observed in the services sector for German firms. Section 3.5 estimates the fundamental market-specific parameters for German multinational firms. Section 3.6 calibrates the industry equilibrium and describes the way to conduct counterfactual analysis for the services sector liberalization according to the TTIP proposal. Section 3.7 concludes.

3.2. Theoretical Framework

We build a structural model to explain the entry choice of a firm when it decides to go abroad. There are three entry types distinguished: direct export, cross-border mergers and acquisitions, and greenfield investment. The main aim of the model is to rationalize the differences in the entry patterns across industries and countries. We describe the model for a firm operating in the services sector, and therefore highlight the importance of quality and brand recognition in generating heterogeneity across firms. However, the model can be applied to other sectors, when equivalently describing firm heterogeneity in terms of the revenue productivity.

3.2.1. Demand

The economy consists of a set $I = \{1, \ldots, N\}$ of countries. Each country $i \in I$ admits a representative consumer whose preferences are given by the quasi-linear utility function in the homogeneous good A_i

$$U_i = \beta_{s,i} \ln \left[\int_{\omega \in \Omega_i} (\tilde{\varphi}_i(\omega) q_i(\omega))^{\frac{\sigma-1}{\sigma}} \, d\omega \right]^{\frac{\sigma}{\sigma-1}} + A_i, \tag{3.1}$$

where $\beta_{s,i}$ denotes the absorption of services sector in country i, $q_i(\omega)$ the amount of service ω, σ elasticity of substitution, Ω_i the endogenous set of varieties sold in country i, and $\tilde{\varphi}_i(\omega)$

the perceived quality of service ω in country i.[10] In order to reflect potential differences in the perception of the service quality across different foreign markets, the quality $\tilde{\varphi}_i(\omega)$ of the variety ω can vary across countries. Quality perception of the service ω reflects the differences in tastes of consumers, value of quality to them, as well as the awareness of the brand of variety ω. A representative consumer in country i can evaluate the quality of a given variety with certainty.[11]

Let Y_i and $p_i(\omega)$ denote the total expenditure per consumer and the price of service ω in country i, respectively. Then, the representative consumer i's budget constraint given the upper-tier of utility maximization reads as

$$\int_{\omega \in \Omega_i} p_i(\omega) q_i(\omega) d\omega + A_i \leq Y_i. \tag{3.2}$$

By solving the consumer i's utility maximization problem subject to the budget constraint (3.2), we obtain the direct demand function for variety ω in country i which is given by

$$q_i(\omega) = \frac{\tilde{\varphi}_i(\omega)^{\sigma-1} p_i^{-\sigma}}{P_i^{1-\sigma}} \beta_{s,i} = \tilde{\varphi}_i(\omega)^{\sigma-1} p_i(\omega)^{-\sigma} \Phi_i, \tag{3.3}$$

where $P_i \equiv \left(\int_{\omega \in \Omega_i} \tilde{\varphi}_i(\omega)^{\sigma-1} p_i(\omega)^{1-\sigma} d\omega \right)^{1/(1-\sigma)}$ is a country i's quality-adjusted price index, $\Phi_i \equiv P_i^{\sigma-1} \beta_{s,i}$ is a demand shifter. The expression (3.3) implies that the demand for variety ω increases with its perceived quality $\tilde{\varphi}_i(\omega)$ in country i.

3.2.2. Supply

A firm from country $o \in I$ provides the same service variety ω in all markets it decides to operate. Therefore, we identify the firm by the supplied service variety ω.

[10]The homogeneous good is chosen as the numeraire; it is produced with a linear technology requiring a unit input of labor and is freely traded. In equilibrium, all countries produce a positive amount of a homogeneous good, which results in the equalization of the factor prices across markets. Thus, for the rest of the analysis, we consider the equilibrium wages in an open economy. In particular, this means that the level of wages, and therefore all entry costs expressed in labor terms, stay unaffected by any policy changes, and wages can be set equal to 1.

[11]Since the aim of this chapter is to analyze the determinants of the entry choice by firms, we disregard the potential uncertainty on the side of consumers. Therefore, in our setting, we model uncertainty regarding the quality perception at the side of a service provider, while consumers know with certainty the value each service provides to them. Alternatively, one can think about learning from the side of consumers about the quality of a given variety (Bagwell and Staiger (1989), Chisik (2003), Cagé and Rouzet (2015)). We can accommodate this concept in our model by assuming that the perceived quality reflects the current belief of a representative consumer regarding the quality of the product, so that she consumes a service basing her consumption choice on this belief.

Each firm is a monopolist for the service it provides, and makes its entry and provision choice taken aggregate price and market size as given. Firms are heterogeneous in the quality of their services. In particular, each firm ω is endowed with a core level of quality φ.[12]

As consumers have different tastes towards quality and are differently aware of services' brands, same quality is differently perceived within and across countries. The country- and variety-specific perceived quality shock ϵ_i adjusts the core quality level of the firm to the perceived level in country i. In particular, the perceived quality of the service in country i is $\varphi_i = \varphi\epsilon_i$, which implies that services with initially higher core quality have on average better realizations of the perceived quality across markets. Since each firm operates a domestic unit, the perception of quality in the origin market is known by the firm.[13] At the same time, the firm cannot observe *ex ante* how its quality is perceived by foreign consumers if it was never present in the country.[14]

The problem of the firm can be separated into two stages. At the first stage, for each foreign market $i \in I_o^f \equiv I \setminus \{o\}$ the firm decides whether to enter, and if so, with which out of three alternatives: direct export or establishment of a cross-border greenfield investment or acquisition of a foreign target firm. Accordingly, the firm pays the entry costs associated with the selected foreign activities. Upon entry, the firm observes how its quality is perceived in each market it selected to operate in. At the second stage, the firm solves the profit maximization problem and sets the unit of service provision for each market.

A firm is defined by the variety of service it provides, ω, its country of origin, o, its core quality, φ, a vector of perceived quality shocks $\boldsymbol{\epsilon}$, a vector of quality of M&A offers, $\boldsymbol{\varphi^M}$, a vector of export entry costs, $\boldsymbol{f^E}$, and vector of institutional exntry costs with greenfield investment, $\boldsymbol{\bar{f}^G}$.

[12]A core level of quality is an adjusted level of quality by the physical productivity, and is represented as a product of quality itself and the physical productivity of a firm. Hereafter, we refer to the quality adjusted by the physical productivity, φ, as the main source of heterogeneity across firms. Since the physical productivity of services firms is difficult to measure, we explain the variation in adjusted quality (or revenue productivity) by differences in the quality component. In other words, one can consider all firms in the services sector to exhibit the same level of physical productivity, but different service quality.

[13]In the absence of firm-specific origin quality shifter, the model would imply zero likelihood. This is due to the fact that home sales would solely define firm's core quality which in turn would result in deterministic supply choices for foreign markets. In other words, this means that two firms with identical core quality would opt for the same foreign activity choices while selecting between exporting and greenfield investment, which is not observed in the data. For more details, we refer to the estimation section.

[14]Nguyen (2012b) introduces learning about demand in untested destination markets through the positive correlation of demand in them with markets firm is present in. In our model, we abstract from the learning aspect, defining markets to be large enough to capture specific tastes of consumers to the service. Moreover, the learning by operating abroad would imply sequentiality of entry, which is not observed in the data for the professional services industry.

3.3. Serving the Foreign Markets

Now we consider the choice of the firm to serve a foreign market i. In order to highlight the tradeoff among different entry types, we compute the payoffs associated with each alternative.[15]

Export and Greenfield Investment. Entering via exporting or greenfield investment, the firm transmits its quality abroad and does it under uncertainty about the perception of its quality by foreign consumers. This uncertainty can be mapped to the problem of incomplete transferability of quality (or technologies) overseas.[16] Therefore, a firm evaluates the benefits of entering via export or greenfield investment by considering the expected perceived quality in the prospective destination market. Accordingly, the more favorable is the expectation regarding the perceived quality shock in the foreign country, the higher the return to the core quality the firm expects from conducting greenfield FDI or exporting.

Although exporting and greenfield investment are similar to each other on the demand side, there are differences in the marginal and entry costs associated to these activities. In order to serve foreign market i via export, the firm pays an additional *ad valorem* trade cost $\tau_{i,o} > 1$. Therefore, the marginal costs of serving market i are larger for exporters. Entry costs of exporting, f_i^E, reflect non-tariff restrictions firms face by serving foreign market i via export, e.g. restriction to movement of people, licensing discrimination, or non-perfect regulatory transparency. In turn, as the replication of a higher level of quality and the establishment of a better brand can be more costly, we allow the entry costs of greenfield investment, $f_i^G(\varphi)$, to be dependent on the core quality φ of the firm. One can also rationalize this assumption by regarding these entry costs as related to advertisement expenses, which are proportional to the number of consumers a firm intends to reach in the new market.[17] In particular, we assume that the firm pays $f_i^G(\varphi) = \bar{f}_i^G + \alpha_i^G v_i(\varphi)$ when it establishes a foreign affiliate in country i, where v_i is the firm's value in market i under the assumption that it can fully transfer its core quality φ to the country i and there are no perceived quality frictions, i.e. $v_i \equiv (\sigma - 1)^{\sigma-1}\sigma^{-\sigma}\varphi^{\sigma-1}\Phi_i$.[18] Thus, we associate the variable part of the entry costs to the firm's value in country i provided that country i's consumers attach the evaluation φ to the service itself. The parameters of the entry costs function can be interpreted as

[15] For what follows, we maintain that the profit associated with no activity in country i is normalized to 0.

[16] In particular, imperfect foreign mobility of technologies and loss to productivity associated to foreign locations are discussed by Nocke and Yeaple (2007), Guadalupe, Kuzmina, and Thomas (2012), and Tintelnot (2017).

[17] See Arkolakis (2010) who models explicitly the choice of marketing investment of firms that are heterogeneous in revenue productivity.

[18] Similarly to Arkolakis (2010), the aggregate market shifter, Φ_i, captures the fact that entry costs can be larger for larger markets. Moreover, since this shifter contains information about the average perceived quality in the market, one can think about larger replication costs for quality when entering a market with higher average quality of services.

follows. The component $\bar{f}_i^G$ of the entry costs for greenfield investment represents the institutional entry barriers that the firm faces in country i. In particular, the level of institutional entry costs reflects the development of legal institutions, ease of getting the license, quality of capital markets, closeness of services regulations of a host country and the origin, and other regulatory and non-regulatory restrictions to entry. The quality cost for greenfield investment, α_i^G, is determined by the country characteristics which affect the ease of quality transmission, e.g. size of the labor markets, advertisement costs.

The expected profits associated to the two above suitable choices are given by

$$\begin{aligned} \mathbb{E}\pi_i^G &= \underbrace{\left[\mathbb{E}\epsilon_i^{\sigma-1} - \alpha_i^G\right] \tilde{\Phi}_i}_{\Delta_i^G} \varphi^{\sigma-1} - \bar{f}_i^G, \\ \mathbb{E}\pi_i^E &= \underbrace{\mathbb{E}\left(\frac{\epsilon_i}{\tau_{i,o}}\right)^{\sigma-1} \tilde{\Phi}_i}_{\Delta_i^E} \varphi^{\sigma-1} - f_i^E, \end{aligned} \tag{3.4}$$

where $\tilde{\Phi}_i \equiv (\sigma-1)^{\sigma-1}\sigma^{-\sigma}\Phi_i$, Δ_i^G denotes the greenfield investor's return to the core quality in country i, and Δ_i^E denotes the exporter's return to the core quality in country i. From the expressions above, we can see that the return to greenfield investment will be larger the more favorable is the expectation of perceived quality and the lower are the costs of replicating the brand's quality abroad. Similarly, the exporter's return is larger the higher is expected perceived quality and as lower is the increase in the marginal costs associated to this activity.

Mergers and Acquisitions. The uncertainty of quality perception can be eliminated via M&A. By acquiring a foreign firm, a multinational gets access to the target firm's local market and, as a consequence, to its already established group of consumers. One can see the acquisition of a foreign firm as a device to "buy the demand" of a preexisting local firm.[19] Therefore, before accepting the merger, a firm knows with certainty how its service is perceived by consumers in the foreign location, and, specifically, which volume of sales it can generate.

We model the M&A market as follows. The firm receives a take-it-or-leave-it offer from a target firm with perceived quality φ_i^M.[20] Since the foreign firm observes the realization of the perceived quality shock to its service in its origin market i, the quality level φ_i^M is represented

[19] An analogous interpretation of M&A can be found in Nocke and Yeaple (2007).

[20] To make our model more tractable, we assume that each firm gets offers for M&A in each market. Alternatively, we can introduce the probability of getting an offer from each market, which will not change the results of the model, but this variation is not empirically tractable as identifying the corresponding parameters require additional data on M&As. At the same time, we allow the offer to be such that no firm finds it profitable to accept. Therefore, the resulting distribution of the target offer can be seen as the combination of the actual distribution and the probability of an offer.

by a product of the core quality of the foreign target, φ', and the perceived quality shock, ϵ_i'. The acquisition price serves the role of the entry costs with M&A, $f_i^M\left(\varphi_i^M\right)$, and consists of the value of the foreign firm, $v_i^M \equiv \tilde{\Phi}_i \varphi_i^M$, and the institutional entry costs, $\bar{f}_i^M$. The institutional costs include not only the legal costs of M&A in a given country but also capture the level of entry barriers imposed for mergers and acquisitions.

Though the acquirer cannot perfectly transfer its quality abroad, some common practices or brand name can be used by an acquired affiliate. Therefore, the acquisition process generates synergies $\mathcal{S}_i(\varphi)$, the size of which increases in the core quality of an acquirer.[21] The perceived quality of the acquired affiliate is $\varphi_i = \mathcal{S}_i(\varphi)\varphi_i^M$, so that perceived quality is $\mathcal{S}_i(\varphi)$ times larger than prior acquisition. It is important to note that should the synergies be positive, the net profit from M&A (weakly) increases with target firm's quality. Therefore, if the firm faces several merger proposals from one country, it optimally select the one from the highest quality target firm.

There are several things worth noting. First, the offers for M&A are independently and identically drawn across firms and countries. This assumption eliminates any self-selection of acquired firms to more (or less) productive acquiring firms. We rationalize it by the fact that foreign firms do not observe the quality of the service of potential acquirers, so that all foreign firms are *ex ante* identical for them. Moreover, the acquisition price is solely determined by the quality of the target firm, so that the benefit of a foreign firm from M&A is independent of the acquirer identity.

Second, we parameterize synergies by a linear function, i.e. $\mathcal{S}_i(\varphi) = s_i\varphi$.[22] The profits from acquiring the foreign firm are given by

$$\pi_i^M = \underbrace{s_i^{\sigma-1}\left(\varphi_i^M\right)^{\sigma-1}\tilde{\Phi}_i}_{\Delta_i^M}\varphi^{\sigma-1} - \tilde{\Phi}_i\left(\varphi_i^M\right)^{\sigma-1} - \bar{f}_i^M, \tag{3.5}$$

where Δ_i^M denotes the acquirer's return to the core quality in country i. This return is higher as better is the target firm, and is higher the magnitude of synergies s_i. In particular, one would expect higher synergies in the markets where common practices are more applicable and the brand name of an acquirer has a better reputation.

Third, we do not model any competition for the target firms from the side of potential acquirers. Since this does not drive our main results regarding the entry type choice, we avoid any complication for the merger market to keep our model as parsimonious as possible.

[21]Here we note that if the function of synergies is constant, so that the size of synergies is independent of the core quality of an acquirer, the M&A will be regard as an outside option, so that the lowest quality served abroad will be supplied via M&A. Moreover, we assume that the magnitude of synergies is observed by an acquirer prior making an entry decision. Therefore, we take M&A as a *safe* option or normalize all levels of uncertainty with respect to the level of uncertainty of m M&A.

[22]The linear function is needed to insure the single-crossing of the profits associated to each entry alternative.

To sum up, the quality of potential targets varies across and within countries and this, together with country-specific entry barriers, results in the differences of M&A price and merger profitability across foreign locations.

3.3.1. Entry Decision

Having described the profits associated to each of the three activities, we are ready to consider the first stage of the firm's problem: which markets to enter and via which entry alternatives. Prior to deciding about the entry into foreign markets, the firm observes (i) its core quality level φ, (ii) perceived quality in the origin φ_o, (iii) country-specific M&A offers $\boldsymbol{\varphi^M}$, (iv) entry costs associated to each entry type. The entry choice, $\boldsymbol{e} \equiv \{e_i\}_{i \in I_o^f}$, combines the entry type the firm selects for each foreign market $i \in I_o^f$ (if any), such that

$$e_i = \arg \max_{e_i \in \{0,E,G,M\}} \{\mathbb{E}\Pi_i^{e_i}\} \quad \forall i \in I_o^f, \tag{3.6}$$

where $\mathbb{E}\Pi_i^{e_i}$ corresponds to the (expected) profit from not entering (0), exporting (E), conducting greenfield investment (G), and M&A (M).

In the next paragraphs, we discuss the tradeoffs existing among the three described entry alternatives when entering market i. First, we describe the traditional proximity-concentration tradeoff between greenfield investment and exporting. Second, we analyze the choice between two types of foreign direct investment.

Proximity-Concentration Tradeoff. Consider the tradeoff between exporting and greenfield investment. We observe that exporting is preferred to greenfield investment in market i if and only if

$$\mathbb{E}\pi_i^E \geq \mathbb{E}\pi_i^G \quad \Leftrightarrow \quad \varphi^{\sigma-1}\left[\alpha_i^G - (1-\tau_{i,o}^{1-\sigma})\mathbb{E}\epsilon_i^{\sigma-1}\right] \geq \frac{f_i^E - \bar{f}_i^G}{\tilde{\Phi}_i}. \tag{3.7}$$

We can separate into two groups the set of parameters affecting the value for the quality cutoff between exporting and greenfield investment. The first group includes those parameters that determine the relative quality of services provided via each of the two entry types. Accordingly, these are the parameters that change the return to the core quality for exporters and greenfield investors, i.e. quality cost for replicating brand abroad, α_i^G, trade costs, $\tau_{i,o}$, and the expectation of the perceived quality, $\mathbb{E}\epsilon_i^{\sigma-1}$. The second group of parameters affects the propensity of each entry type to be selected and include entry costs of export, f_i^E, and institutional entry costs for greenfield investment, $\bar{f}_i^G$.

If the replication of high quality abroad is harder, that is $\alpha_i^G \gg 0$ and replication costs outweigh the proximity benefits, then firms with higher quality will export in order to avoid large entry costs with greenfield FDI. Therefore, the average quality exported will be higher than the one provided via greenfield investment. Moreover, the lower the trade costs are and the less favorable the expectation of the perceived quality is, the more likely that high quality firms export their services to market i. The special case of this cutoff ordering arises if the institutional entry costs of greenfield are so large that all firms find it more profitable to export.

An inverse ordering of cutoffs in the core quality arises if greenfield entry costs are lower for firms with higher quality. This assumption would invert the condition for exporting and imply that high quality firms self-select into greenfield investment, while firms with relatively lower quality choose to export.[23] Moreover, the larger trade costs and the expectation of perceived quality are, the more likely it is that high-quality firms self-select into greenfield FDI, rather than exporting. In particular, if export entry costs are sufficiently large, all firms will conduct greenfield investment rather than export.

Two Types of Foreign Direct Investment. Now we turn to the choice between greenfield investment and M&A. The firm prefers greenfield investment over M&A in the market i if and only if

$$\mathbb{E}\pi_i^G \geq \pi_i^M \quad \Leftrightarrow \varphi^{\sigma-1}\left[\mathbb{E}\epsilon_i^{\sigma-1} - \alpha_i^G - s_i^{\sigma-1}\left(\varphi_i^M\right)^{\sigma-1}\right] \geq \frac{\bar{f}_i^G - \bar{f}_i^M}{\tilde{\Phi}_i} + \left(\varphi_i^M\right)^{\sigma-1}. \tag{3.8}$$

The selection of firms with higher or lower quality into greenfield investment rather than M&A depends on the firm-specific target draw and country-specific parameters. Therefore, we can talk about the ordering of cutoffs only subject to the clusters of firms defined by the quality of M&A offer firms receive in the foreign market i. Within a cluster, high quality is provided via greenfield investment rather M&A if (i) expected perceived quality is high, (ii) the increase in greenfield entry costs due to high core quality is low, (iii) synergies are low. Thus, the order of cutoffs is determined by the relation between the loss/gain in perceived quality and variable entry costs for greenfield FDI, as well as by the magnitude of synergies. In countries where the costs of finding abroad a consultant with an equal level of home skills are prohibitive, or the advertising expenditures are large, relatively more productive firms self-select into M&A rather than greenfield investment. If the institutional costs of mergers and acquisitions are too high, acquisition is not profitable for middle-quality firms, and only greenfield investment can be selected. We note that with the presence of uncertainty in quality perception, the set of accepted M&A is different from the case

[23] In the empirical analysis, we do not restrict the sign of α_i^G, thus we are not assuming any ordering of exporting and greenfield investment cutoffs. In particular, with $\alpha_i^G = 0$ we will obtain a standard proximity-concentration tradeoff, when entry costs for greenfield investment are equal across firms with different quality.

with perfect forecasting of foreign consumer tastes for a service; also there is no clear ordering of this activity with respect to others in terms of the core quality.[24]

3.3.2. Equilibrium

Now we aggregate the industry-level parameters, as market sizes and quality adjusted price indexes, and derive the general equilibrium for our model. Each country $i \in I$ is populated with mass n_i of firms heterogeneous in their service quality. We assume that all firm-specific parameters are independently drawn across countries and firms from corresponding distributions. The core quality φ is drawn from an arbitrary distribution $G(\varphi)$. The perceived quality shocks ϵ_i are drawn from an arbitrary country-i- and origin-o-specific distribution $H_{i,o}(\epsilon_i)$.[25] The M&A offers φ_i^M are drawn from an arbitrary country-i-specific distribution $M_i\left(\varphi_i^M\right)$. The entry costs of export to market i, f_i^E, and institutional costs for greenfield investment, $\bar{f}^G$ are drawn from the distribution $F_{i,o}^E\left(f_i^E\right)$ and $F_{i,o}^G\left(\bar{f}_i^G\right)$ with the positive supports, correspondingly.

Conditional on being active in market j, the share of firms from country $j \neq i$ with core quality level φ that enter market i with entry type e is

$$\zeta_{i,j}^e(\varphi) = \int\limits_{f_i^E}\int\limits_{\bar{f}_i^G}\int\limits_{\varphi_i^M} \mathbb{1}\left[e_i\left(j,\varphi,f_i^E,\bar{f}_i^G,\varphi_i^M\right) = e \mid e_i\left(j,\varphi,f_i^E,\bar{f}_i^G,\varphi_i^M\right) \neq 0\right] dM_i\left(\varphi_i^M\right) dF_{i,j}^G\left(\bar{f}_i^G\right) dF_{i,j}^E\left(f_i^E\right). \tag{3.9}$$

We note that different realizations of firm-specific entry costs of export, greenfield and quality of M&A targets would result in different profits associated to those entry types.

The total sales generated by firms from country $j \neq i$ with core quality φ in country i via entry type e are given by

$$X_{i,j}^e(\varphi) = n_j \int\limits_{f_i^E}\int\limits_{\bar{f}_i^G}\int\limits_{\varphi_i^M} \mathbb{1}\left[e_i\left(j,\varphi,f_i^E,\bar{f}_i^G,\varphi_i^M\right) = e\right] \cdot \int\limits_{\epsilon_i} r_i^e\left(j,\varphi,\epsilon_i,\varphi_i^M\right) dH_{i,j}(\epsilon_i) dM_i\left(\varphi_i^M\right) dF_{i,j}^G\left(\bar{f}_i^G\right) dF_{i,j}^E\left(f_i^E\right). \tag{3.10}$$

[24]Empirically, if M&A quality is observed, this can be reflected in the higher variance of domestic sales generated by acquirers relative to exporters and firms conducting greenfield FDI compared to the case when quality of M&A is unobservable.

[25]Similar to Schott (2008), this assumption reflects the presence of the origin-specific shifters to the perception of quality.

Different realizations of perceived quality shocks and quality of targets would result in different foreign revenues. Integrating over the core quality levels of foreign firms and summing over all entry types and foreign countries, the aggregate trade inflow of services to country i is

$$X_i^{foreign} = \sum_{j \in I_i^f} \sum_{e=\{E,G,M\}} \int_{\varphi} X_{i,j}^e(\varphi) dG(\varphi). \tag{3.11}$$

The home production in country i is given by

$$X_i^{domestic} = n_i \int_{\varphi} \int_{\epsilon_i} r_i(i, \varphi, \epsilon_i) dH_{i,i}(\epsilon_i) dG(\varphi). \tag{3.12}$$

Total labor income in country i consists of two components. The first component is the labor cost of services provision in country i, which includes the sum of wages paid for domestic services suppliers, exporters from country i, as well as FDI-makers in country i. The second component combines entry costs paid by FDI- and export-entrants from foreign markets. The third component constitutes labor income in the homogeneous good sector. Given that wages are equalized in the open economy when each country produces the homogeneous good, the labor market clearing condition reads as

$$\begin{aligned}
L_i = \frac{\sigma - 1}{\sigma} & \left[X_i^{domestic} + \sum_{j \in I_i^f} \left(n_i \int_{\varphi} X_{j,i}^E(\varphi) dG(\varphi) + \sum_{e=\{G,M\}} n_j \int_{\varphi} X_{i,j}^e(\varphi) dG(\varphi) \right) \right] \\
& + \sum_{j \in I_i^f} n_j \iiiint_{\varphi, f_j^E, \bar{f}_j^G, \varphi_j^M} \Big(\mathbb{1} \left[e_j \left(i, \varphi, f_j^E, \bar{f}_j^G, \varphi_j^M \right) = E \right] f_j^E \\
& \qquad + \mathbb{1} \left[e_j \left(i, \varphi, f_j^E, \bar{f}_j^G, \varphi_j^M \right) = G \right] f_j^G \left(\varphi, \bar{f}_j^G \right) \\
& \qquad + \mathbb{1} \left[e_j \left(i, \varphi, f_j^E, \bar{f}_j^G, \varphi_j^M \right) = M \right] f_j^M \left(\varphi_j^M \right) \Big) \\
& dF_{j,i}^E \left(f_j^E \right) dF_{j,i}^G \left(\bar{f}_j^G \right) dM_j(\varphi_j^M) dG(\varphi) + L_{A,i},
\end{aligned} \tag{3.13}$$

where $L_{A,i}$ denotes the labor in the homogeneous sector in country i.

The quality-adjusted price index in country i is formed by the contribution of foreign and domestic firms

$$P_i = \frac{\sigma-1}{\sigma}\Bigg[\sum_{j\in I_i^f} n_j \int_{\varphi} \sum_{e} \zeta_{i,j}^{e}(\varphi)\left(\frac{\varphi}{\tau_{i,j}^{\mathbb{1}[e=E]}}\right)^{\sigma-1} dG(\varphi) + n_i \int_{\varphi} \varphi^{\sigma-1} dG(\varphi)\Bigg]^{\frac{1}{1-\sigma}}. \tag{3.14}$$

Finally, we assume that a representative consumer in country i owns the domestic firms, so that the aggregate income is given by the sum of the labor income and the profits generated by firms with origin in country i

$$\begin{aligned} Y_i = L_i &+ \frac{1}{\sigma} X_i^{domestic} \\ &+ n_i \int_{\varphi} \sum_{\substack{j\in I_i^f \\ e\in\{E,G,M\}}}\sum \int_{f_j^E}\int_{\bar{f}_j^G}\int_{\varphi_j^M} \mathbb{1}\left[e_j\left(i,\varphi,f_j^E,\bar{f}^G,\varphi_j^M\right)=e\right] \\ &\cdot \int_{\epsilon_j}\left(\frac{r_j^e\left(j,\varphi,\epsilon_j,\varphi_j^M\right)}{\sigma} - f_j^e\left(\varphi,\bar{f}_j^G,\varphi_j^M\right)\right) \\ &dH_{j,i}(\epsilon_j) dF_{j,i}^E\left(f_j^E\right) dF_{j,i}^G\left(\bar{f}_j^G\right) dM_j\left(\varphi_j^M\right) dG(\varphi). \end{aligned} \tag{3.15}$$

The next definition describes the general equilibrium of the model.

Definition 1. *(General Equilibrium) Given parameters $\tau_{i,o}$, α_i^G, s_i, σ and distribution functions $G(\varphi)$, $H_{i,o}(\epsilon_i)$, $M_i\left(\varphi_i^M\right)$, $F_{i,o}^E(f_i^E)$, $F_{i,o}^G(\bar{f}_i^G)$ for all countries $o, i \in I$, the equilibrium constitutes a set of levels of service consumption, $q_i(\omega)$, and homogeneous good, A_i, prices, $p_i^e(o,\varphi,\epsilon_i,\varphi_i^M)$, entry choices, $\boldsymbol{e}(o,\varphi,\boldsymbol{f^E},\boldsymbol{\bar{f}^G},\boldsymbol{\varphi^M})$, price indexes, P_i, and income, Y_i, such that*

(i) *the optimal level of consumption of service variety ω and homogeneous good A_i is given by (3.2) and (3.3),*

(ii) *$\boldsymbol{e}(o,\varphi,\boldsymbol{f^E},\boldsymbol{\bar{f}^G},\boldsymbol{\varphi^M})$ solves the firm's entry problem (3.6),*

(iii) *$p_i^e(o,\varphi,\epsilon_i,\varphi_i^M)$ solves the firm's profit maximization problem,*

(iv) *P_i satisfies equation (3.14),*

(v) *the labor market clears (3.13),*

(vi) *Y_i satisfies equation (3.15).*

3.3.3. Discussion

Our model is agnostic about the ordering of cutoffs between different entry types. Depending on the return parameters $\mathbb{E}\epsilon_i^{\sigma-1}$, $\tau_{i,o}$, α_i^G and s_i, as well as the distribution of target firms' quality, different groups of firms in terms of quality self-select into the corresponding activities.[26] Therefore, our model can explain the entry patterns specific to a given industry or country.

In particular, we expect that M&A is particularly relevant for sectors where quality is of high importance and its perception can vary a lot across countries. This can be no longer the case for industries with more homogeneous products or services, as well as industries where the physical productivity explains most of the firm heterogeneity. The perception of quality in such industries does not play an important role, which changes the tradeoff between M&A and other entry types. Moreover, synergies in the technologies are more relevant for sectors with firms heterogeneous with respect to the physical productivity. Therefore, by introducing synergies in the model, we are able to capture the patterns arising in the manufacturing sector and allow for a reverse ordering of the export-acquisition cutoff.

Regarding the greenfield investment, in manufacturing, more productive firms can be more efficient in transferring their production technologies abroad and use of scale economies in building new foreign plants. Thus, greenfield investment entry costs can be lower for more efficient firms, which reverses the ordering of proximity-concentration cutoff with respect to the services sector.

3.4. Data

We rely on three main data sources for the empirical analysis: (i) the Microdatabase Direct investment (MiDi), (ii) the Statistics on International Trade in Services (SITS) database, and (iii) the AMADEUS database.

The data on the foreign affiliates of German multinational firms are obtained from MiDi.[27] According to the German Foreign Trade and Payments Regulation, all German firms are obliged to report outward FDI activities if (i) the share or voting rights of the German enterprise in the foreign affiliate constitutes at least 10% directly or 50% indirectly, and (ii) the balance sheet of the foreign affiliate exceeds 3 million Euros. The database is maintained since 1996 onwards and is available for researchers from 1999. Therefore, we observe the balance sheets of all German affiliates abroad that satisfy the above reporting requirements during the time period 1999 – 2014. In addition, MiDi provides information about the country of the foreign subsidiary and, since 2005,

[26]The detailed description of all possible orderings of cutoffs is provided in the Appendix M.

[27]Deutsche Bundesbank (2016): Microdatabase Direct Investment 1999-2014. Version: 2.0. Deutsche Bundesbank. Dataset. http://doi.org/10.12757/Bbk.MiDi.9914.02.03

the type of entry in the foreign market, distinguishing between newly established enterprises (greenfield investment) and purchases, mergers or acquisitions (M&A).

We combine MiDi with SITS, which documents international service transactions carried out by German residents, where activities correspond to modes 1, 2 and 4 in the GATS classification.[28] Differently from MiDi, the reporting requirement for SITS is more stringent, so that all transactions exceeding 12,500 Euros monthly are included. In order to make the reports of multinationals and exporters comparable, we consider only those transactions in SITS that would also be included in MiDi if carried out via commercial presence. In other words, we restrict our focus on those firms whose annual service exports exceed one million Euros.[29]

Finally, we use AMADEUS to obtain data on domestic activities of pure exporters, i.e. firms which are not present in MiDi, but only in SITS.[30]

Since we are concerned with the heterogeneity in the quality of the provided service, we focus on the professional services sector, among which are consulting, marketing, research and administrative activities.[31] This sector accounts for more than a half of all international transactions occurring in the services sector.[32] Together with financial services, the professional services sector is the one with the fastest growth of its share in the aggregate trade flow in developed countries. Figure 3.1 shows the evolution of international trade flows generated by German firms operating in this sector. We can see that the professional services represent a substantial share of international services flows from Germany.

[28]Refer to the Section 3.1 for the description of the modes according to the GATS classification.

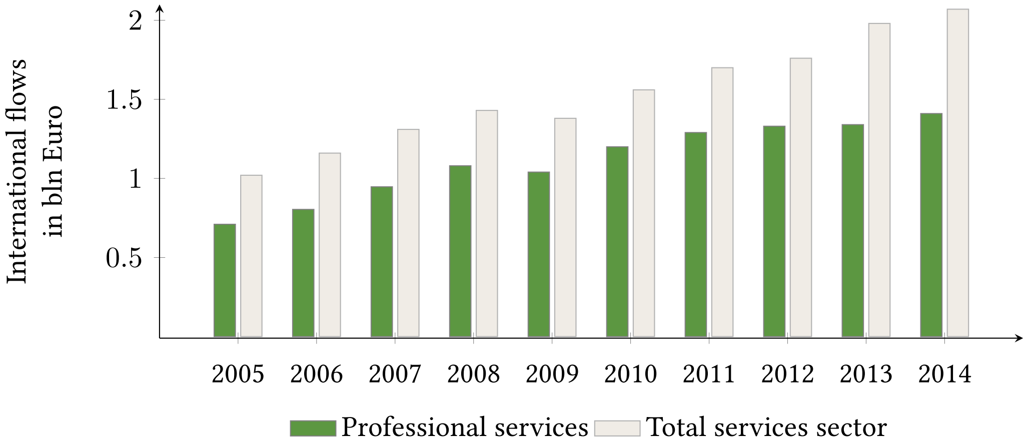
[29]Since the domestic sales of excluded exporters are comparable to those we consider in our analysis, the restriction of the sample does not drive main empirical results. Moreover, we note that requirements for MiDi are easier to satisfy for manufacturing firms rather than services. Therefore, we expect that larger proportion of services FDI is excluded from the database compared to manufacturing due to the features of FDI in these sectors. Specifically, un manufacturing, the settlement of a new plant requires larger capital investment which is more likely to overshoot the reporting threshold relative to the services FDI, where capital investment can be associated with renting the office for a consulting firm.

[30]SITS contains information exclusively about foreign transactions, but does not provide any data on operations in Germany. These data are recovered via matching with MiDi, as well as with AMADEUS. The matching of the AMADEUS with Bundesbank's datasets has been performed by the Research Data and Service Center of the Deutsche Bundesbank. For more details, please, refer to Schild, Schultz, and Wieser (2017). Accordingly, we consider the subset of firms that is present both in SITS and AMADEUS datasets.

[31]According to Francois and Hoekman (2010), professional services is one of the sectors most exposed to uncertainty in quality.

[32]See the International Trade Statistics report 2015 (WTO) and the World Investment Report 2015 (UNCTAD).

Figure 3.1.: International trade flows in services from Germany



Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, and Statistics on International Trade Services (SITS), 2001-2015, authors' calculations.

In the final sample, we consider German firms operating in the professional services sector in the period 2005 – 2014.[33] We exclude firm-market-specific observations starting before 2005, as this is the first year when the type of FDI entry is reported. This exclusion ensures that the perceived quality is unobserved in the foreign market before entering, as firms that operated in the market in previous years could already have developed their consumer network, so that they did not face uncertainty on the demand side. Moreover, we consider only the first entries for each market. Furthermore, we disregard those firms which operate exclusively in the foreign markets.[34] During the period of the analysis, we observe a sample of 2,589 market-specific entries by 2,049 German firms. Since the choice to operate abroad is endogenous, we extend our sample with 1,727 domestic firms.[35] We consider three foreign markets: the European Union countries,[36] the United States, and the rest of the world. Figure 3.2 presents the distribution of total sales of firms operating in the services sector and serving foreign markets.[37] The sales distribution is skewed and there is a substantial number of relatively small players in the market.

[33]See Appendix K for more detail on the combination of entries by multinationals and pure exporters by year.

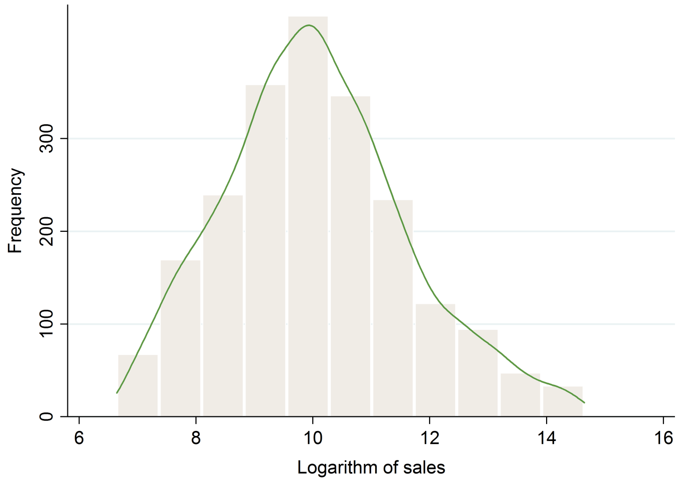
[34]We exclude from the sample firms with zero domestic sales.

[35]We consider firms which are not present in MiDi and SITS databases and that satisfy the reporting requirement for capital.

[36]In the EU countries we include only EU-15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

[37]We note that due to the presence of the missing data for sales, we proxy those missing entries by regressing sales on capital stock.

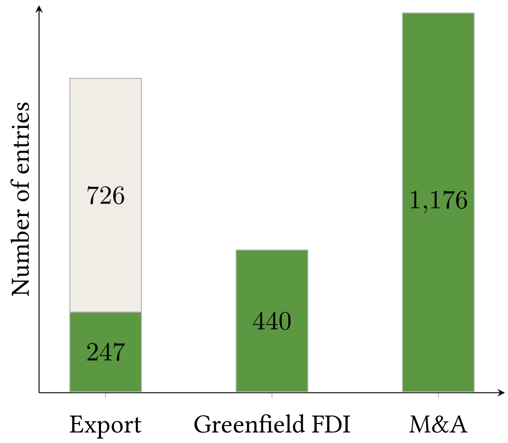
Figure 3.2.: Distribution of domestic sales



Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, and Statistics on International Trade Services (SITS), 2001-2015, authors' calculations.

Figure 3.3 displays that the patterns of entry into foreign markets are in line with the predictions of our theoretical model. Among multinational firms, most firms find it profitable to enter via M&A, followed by greenfield investment and exporting. As was noticed before, the requirements for reporting on exporting and FDI differ, so that the comparison made is based on the restricted sample. Moreover, we compare the entry patterns in the service industry with those in a less differentiated sector (wholesale) and find that the frequency of entry types is different from that discussed for professional services (see Appendix L). In particular, in the wholesale sector, most firms select export to FDI, which is in line with the predictions of the standard framework for manufacturing (Helpman et al., 2004).

Figure 3.3.: Frequency distribution of entry types



Note: The middle line represents the number of exporters that conduct multinational activity.
Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, and Statistics on International Trade Services (SITS), 2001-2015, authors' calculations.

Services firms operate in different markets and can select different entry types for each. Table 3.1 presents the statistics for pairs of entry types selected by firms in the sample, as well as combinations of markets firms select to be present in. The presence of firms conducting several multinational activities is important for our empirical analysis, since it reflects the differences in the entry-type choices of a given firm across markets.

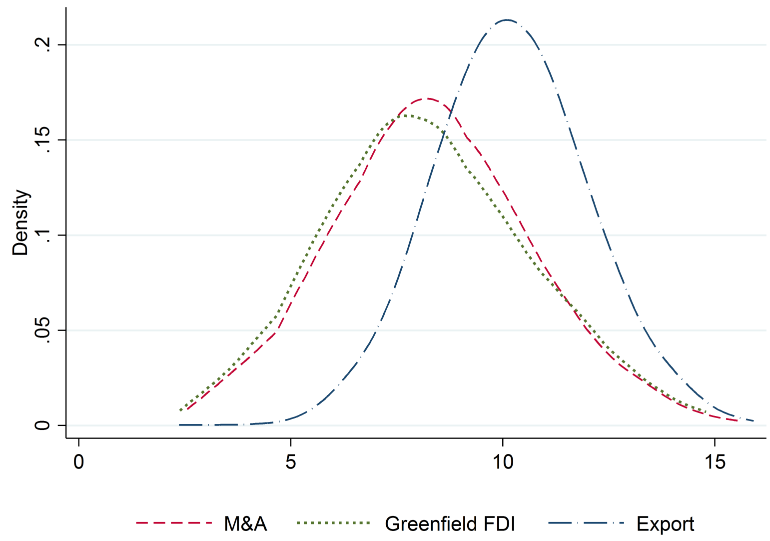
Table 3.1.: Frequency tabulation of entry types and markets

	Other activity					Other market		
	Export	Greenfield FDI	M&A	No other activity		US	RoW	No other market
Export	346	10	13	436	EU	160	485	737
Greenfield FDI		37	74	349	US		113	197
M&A			278	800	RoW			651

Notes: For combinations of entry types, we consider only those firms which enter one or two markets due to the confidentiality requirements. There are 246 firms that operate in all markets.
Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, and Statistics on International Trade Services (SITS), 2001-2015, authors' calculations.

Figure 3.4 shows the density of domestic sales of parent firms selecting different entry types in foreign markets. The average exporter is larger than the average firm entering with greenfield investment and average company acquiring a foreign firm. These descriptive statistics give an insight on the specifics of the services sector.

Figure 3.4.: Density of log-domestic sales, by entry type



Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, and Statistics on International Trade Services (SITS), 2001-2015, authors' calculations.

We also conduct tests for the cutoff ordering. Table 3.2 presents the sales premium associated to each entry type. In all three foreign markets, exporters sell significantly more at home, which suggest that high-quality firms self-select into exporting.[38] At the same time, the ordering of M&A and greenfield FDI differs across foreign markets. While in the US the sales premium is larger for firms conducting greenfield investment, it is smaller in other markets.

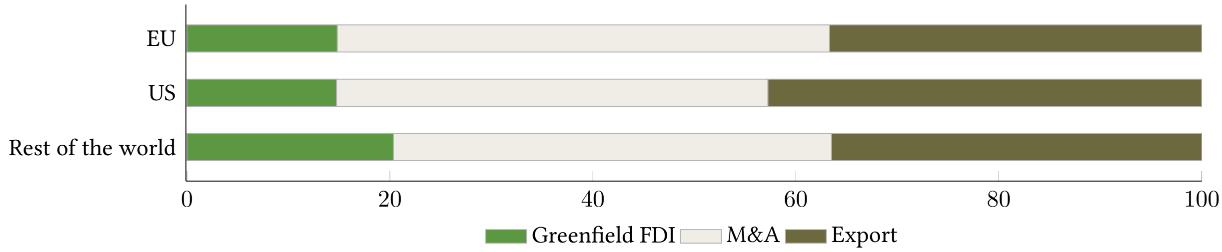
Table 3.3 presents a similar test for the cutoffs in terms of firm size. Again, exporters have more employees in Germany compared to firms conducting FDI. Here, the size premium is larger for greenfield investors in all foreign markets compared to acquires.

Next, we consider the importance of each entry alternative by foreign market. The frequency of entry types differs across foreign markets (see Figure 3.5). Greenfield FDI is a relatively more frequent entry type in the rest of the world. At the same time, M&A activity is more frequent in the EU compared to the US and the rest of the world. Our model would rationalize those differences with the level of fixed entry barriers associated to each foreign activity and the quality of foreign acquisition targets. With particular reference to the EU countries, this pattern could be explained by the relatively higher and less spread quality of potential targets. For the rest of the world, instead, the propensity of M&A might be linked to the high uncertainty of perceived

[38]Given the worldwide evidence on the international flows in services, we believe that the ordering of cutoffs for export and FDI are not peculiar to German services firms. In particular, we notice that worldwide i) most of transactions in the services sector occur via FDI, ii) value added of exports is generated in the services sector is larger than in the manufacturing sector. This observation shows that only a minority of firms self-select into exporting and this minority is highly productive.

quality related to greenfield FDI and exporting, as well as to the lower price for M&A. Therefore, we would expect that the role of M&A in resolving demand uncertainty is particularly relevant for these countries.

Figure 3.5.: Entry type, foreign market level



Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, and Statistics on International Trade Services (SITS), 2001-2015, authors' calculations.

Table 3.2.: Sales premium for exporters, acquirers and greenfield investors

Foreign market	Exporters Sales premium		Exporters 95% Conf. Interval		M&A Sales premium		M&A 95% Conf. Interval		Greenfield investment Sales premium		Greenfield investment 95% Conf. Interval	
EU	11.062	(0.205)	[10.661,	11.464]	8.776	(0.182)	[8.420,	9.133]	8.659	(0.266)	[8.138,	9.180]
US	10.994	(0.430)	[10.148,	11.840]	8.913	(0.428)	[8.072,	9.754]	9.173	(0.489)	[8.211,	10.134]
Rest of the world	10.461	(0.265)	[9.941,	10.980]	8.559	(0.262)	[8.046,	9.073]	8.142	(0.290)	[7.573,	8.710]
Total	10.806	(0.158)	[10.496,	11.116]	8.677	(0.151)	[8.381,	8.972]	8.472	(0.187)	[8.106,	8.839]

Notes: We estimate entry type premia as follows: $\log(Sales_{\omega,t}) = \beta_1 EXP_{\omega,t} + \beta_2 MA_{\omega,t} + \beta_3 GI_{\omega,t} + I_t + \xi_{\omega,t}$, where t is the year index, I are time dummies. All estimates are significant at the 1 percent level. $N = 2459, R^2 = 0.948$. Here for each entry type we consider only those firms, that do not conduct any other activity. Correspondingly, there are 1,094 observations ($R^2 = 0.951$) considered in the regression for the EU, 382 observations ($R^2 = 0.961$) for the US, and 983 observations ($R^2 = 0.941$) for the RoW.

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, and Statistics on International Trade Services (SITS), 2001-2015, authors' calculations.

Table 3.3.: Size premium for exporters, acquirers and greenfield investors

Foreign market	Exporters Size premium		Exporters 95% Conf. Interval		M&A Size premium		M&A 95% Conf. Interval		Greenfield investment Size premium		Greenfield investment 95% Conf. Interval	
EU	4.859	(0.267)	[4.334,	5.383]	2.542	(0.250)	[2.050,	3.034]	2.749	(0.396)	[1.971,	3.527]
US	5.034	(0.133)	[4.772,	5.296]	2.667	(0.226)	[2.222,	3.113]	2.936	(0.582)	[1.789,	4.084]
Rest of the world	4.813	(0.281)	[4.262,	5.363]	2.568	(0.270)	[2.038,	3.098]	2.586	(0.316)	[1.964,	3.207]
Total	4.919	(0.179)	[4.569,	5.269]	2.594	(0.172)	[2.257,	2.932]	2.730	(0.229)	[2.281,	3.179]

Notes: We estimate entry type premia as follows: $\log(Employment_{\omega,t}) = \beta_1 EXP_{\omega,t} + \beta_2 MA_{\omega,t} + \beta_3 GI_{\omega,t} + I_t + \xi_{\omega,t}$, where t is the year index, I are time dummies. All estimates are significant at the 1 percent level. $N = 1,508$, $R^2 = 0.832$. Here for each entry type we consider only those firms, that do not conduct any other activity. Correspondingly, there are 645 observations ($R^2 = 0.820$) considered in the regression for the EU, 242 observations ($R^2 = 0.864$) for the US, and 621 observations ($R^2 = 0.929$) for the RoW. We consider less observations due to the lack of information on the number of domestic employment.

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, and Statistics on International Trade Services (SITS), 2001-2015, authors' calculations.

3.5. Structural Estimation

In this section, we describe the empirical strategy for the estimation of the fundamental market-specific parameters determining returns and entry costs corresponding to each entry alternative. We use firm-level data for German multinationals described in the previous section. In the following paragraphs, we describe the parameterization, discuss the identification and estimation strategies, and present the estimation results.

3.5.1. Parametrization

Since in this section we consider only German firms, the origin country o is Germany for all firms.[39]

We make the following parametric assumptions on the distributions. The core quality φ is drawn independently across firms from a Pareto distribution with scale parameter a and shape parameter γ. The perceived quality shocks ϵ_i are drawn independently across firms and countries from a country-specific log-normal distribution, $\log \mathcal{N}(\mu_{\epsilon,i}, \sigma_\epsilon)$. We normalize $\mu_{\epsilon,\text{GER}}$ to zero and regard the quality perception relative to Germany. The M&A offers φ_i^M are drawn independently across firms and countries from a country-specific Pareto distribution with scale parameter a_i^M and shape parameter γ. Export-entry costs f_i^E are drawn from a log-normal distribution, $\log \mathcal{N}(f_i^E, \sigma_{f^E})$. Institutional entry greenfield costs $\bar{f}_i^G$ are drawn from a log-normal distribution, $\log \mathcal{N}(\bar{f}_i^G, \sigma_{f^G})$.[40] Finally, we parameterize the demand shifter Φ_i using country i's services sector absorption.[41] In particular, we take the market size of a country reported in MiDi or SITS as the recipient of a given transaction, rather than the average market value in the aggregated markets (the EU and the rest of the world). Then, we compute the average market size of a country in the aggregated market in each year, and take the maximum average market size when consider the outside option.

3.5.2. Identification Strategy

In this section, we briefly discuss the sources of variation we use to identify the parameters of interest. We separate the parameters into four groups: the domestic market parameters (a, γ), the export and greenfield investment parameters $\big(\{\mu_{\epsilon,i}\}_{i\in I^f}, \sigma_\epsilon, \{f_i^E\}_{i\in I^f}, \{\tau_i\}_{i\in I^f}, \sigma_{f^E}, \{\bar{f}_i^G\}_{i\in I^f}, \{\alpha_i^G\}_{i\in I^f}, \sigma_{f^G}\big)$, the M&A parameters $\big(\{s_i\}_{i\in I^f}, \{\bar{f}_i^M\}_{i\in I^f}, \{a_i^M\}_{i\in I^f}\big)$, and the general parameter

[39] In this section, we abstract from the use of the subscript o.

[40] This parametrization does not exclude the negative realizations of greenfield entry costs if α_i^G is negative. Therefore, in the estimation we restrict the realizations of total entry costs for greenfield investment, f_i^G, to be non-negative. Alternatively, one could make the mean of the underlying normal distribution to be dependent on ϕ, so that the total entry costs for greenfield investment would come from $\log \mathcal{N}(\bar{f}_i^G + \alpha_i^G v_i(\varphi), \sigma_{f^G})$.

[41] The data are taken from the World Bank database.

σ. In the next paragraphs, we describe the main source of variation used to identify each group of parameters.

Domestic Market Parameters. Given the structure of our model, the intensive margin of domestic activity is explained by the variation in quality. Therefore, the distribution parameters (a, γ) for the core quality φ are mainly determined by the sales generated by firms in Germany, as well as by the sales generated by firms outside Germany.

Export and Greenfield Investment Parameters. Everything else equal, the difference in the foreign sales realized with greenfield investment and exporting with respect to the domestic sales determines the shocks to perceived quality and the corresponding parameters $(\{\mu_{\epsilon,i}\}_{i\in I^f}, \sigma_\epsilon)$. Identification of greenfield investment quality costs $\{\alpha_i^G\}_{i\in I^f}$ is based on the tradeoff between greenfield FDI and exporting. In particular, the sign of these parameters determines if higher (or lower) quality firms self-select into exporting rather than opening new affiliates. The export entry costs and the institutional greenfield investment entry costs $\left(\{f_i^E\}_{i\in I^f}, \{\bar{f}_i^G\}_{i\in I^f}, \sigma_{f^E}, \sigma_{f^G}\right)$ are identified by observing the entry choices of firms conditional on their core quality. Finally, *ad valorem* trade costs $\{\tau_i\}_{i\in I^f}$ are evaluated from the difference in revenues generated by firms via exports and greenfield investment. In particular, the lower the intensive margin of exporting is, the higher are trade costs associated with services exports.

M&A Parameters. The parameters related to the M&A activity deserve some discussion, since the quality of potential acquisition targets, a_i^M, affects directly both intensive and extensive margins of M&A. Therefore, one can find different combinations of a triple $(a_i^M, s_i, \bar{f}_i^M)$ that can rationalize the distribution of M&A sales and entries in the market i. For instance, fixing one triple of M&A parameters, it could be possible to find another one with a higher magnitude of synergies, lower quality of acquisition targets and lower level of institutional M&A entry costs, that would fit the observed data.

To identify those parameters, we consider two specifications.[42] In the first specification, we assume that the magnitude of synergies depends on the relative advance of a firm with respect to the least productive firm in the industry. Accordingly, we restrict the magnitude of synergies

[42]Two natural restrictions are on the magnitude of synergies, which restricts the intensive margin, and the level of institutional entry costs, which puts restrictions on the extensive margin. The third restriction on the quality of M&A targets is less tractable, as it would imply restrictions not only on the parameters related to M&A entries, but also on the other entry modes. When conducting the Monte-Carlo simulations under an assumption that distribution parameters $\{a_i^M\}_{i\in I^f}$ are all the same and equal to a, we are able to show that it is not always possible to find the corresponding triple of M&A parameters in order to rationalize the observed data. The intuition behind this finding is that a_i^M enters revenues and entry costs simultaneously and it affects the Pareto distribution, which restrict the possible set of φ_i^M realizations.

and parametrize it to $s_i = 1/a_i$. This restriction implies that a firm with the core quality φ can increase the level of quality of acquisition target by φ/a, which represents the ratio of firm's core quality to the lowest core quality in the market. Moreover, it follows that the least productive firm in the industry is just indifferent between being engaged in M&A or not should there be no institutional entry costs. In this specification, the magnitude of synergies a firm can generate is the same across all markets. Everything else equal, the quality of acquisition targets would be the main determinant of the differences in M&A sales realized across locations. In the second specification, we assume that the institutional restrictions for M&A and greenfield investment are similar. In particular, we restrict the level of M&A institutional entry costs to be equal to the median of the distribution of the institutional entry costs for greenfield investment. Hence, in this specification we can talk only about overall institutional barriers for entering via FDI.

Independent of the restriction specification, the parameters related to the intensive margin of M&A are recovered from the sales firms generate via acquired affiliates. The extensive margin determines the related entry cost parameters. In the Appendix N we simulate the model and show that all parameters are identified for both specifications.

General Parameters. Since the assumption of CES preferences implies that markups are constant, we can use data on sales and variable costs to recover the corresponding σ parameter.[43]

3.5.3. Estimation Strategy

There are two sources of heterogeneity in service quality which are observed by firms, but not observed by the econometrician: the core quality φ and the draws for target firm quality $\left\{\varphi_i^M\right\}_{i\in I^f}$. When we construct the maximum likelihood function, we need to integrate over all possible realizations of the quality levels, so that the combination of the two sources determines the optimal choice of the entry type. Moreover, we need to account for all possible orderings of cutoffs with respect to the core quality depending on the distribution parameters of perceived quality shocks $(\{\mu_{\epsilon,i}\}_{i\in I^f}, \sigma_\epsilon)$, *ad valorem* trade costs $\{\tau_i\}_{i\in I^f}$ and quality transmission costs $\{\alpha_i^G\}_{i\in I^f}$.[44] In order to avoid this complication, we exploit the assumptions on the independence of draws for target firms' qualities and core quality, which allows us to separate entry choices across markets conditional on the firm's core quality.

[43]At the moment, we set $\sigma = 3.18$ to make our results comparable to Francois et al. (2013).

[44]Three possible orderings of cutoffs in ascending in core quality order are: $i)$ *M&A – Greenfield Investment – Export*, $ii)$ *Greenfield Investment – M&A – Export*, $iii)$ *M&A – Export – Greenfield Investment*.

The construction of the likelihood implies several steps. In particular, we divide the choice of entry type into two stages. If the firm ω selects the entry type $e_{\omega,i}$ in the foreign market i, it should prefer it to (i) entering via *M&A*, (ii) entering via any other entry type than *M&A*, i.e.

$$\begin{aligned} e_{\omega,i} &= \arg\max_{e'_i} \left\{ \mathbb{E}\Pi_i^{e'_i} \right\}_{e'_i \in \{0,E,G,M\}} \Leftrightarrow \\ e_{\omega,i} &= \arg\max_{e'_i} \left\{ \max_{e''_i} \left\{ \mathbb{E}\Pi_i^{e''_i} \right\}_{e''_i \in \{0,E,G\}}, \Pi^{e'_i = M} \right\}. \end{aligned} \tag{3.16}$$

Therefore, in the first stage we determine for each firm the probability of preferring observed entry types to entering into all markets with *M&A*. We note that conditional on the core quality and entry costs, choice of an alternative over *M&A* in one market is solely determined by the draw of target firm's quality. Given that *M&A* draws are i.i.d. across markets, we can consider probability of entry type choice over *M&A* in each foreign market separately. Then, for the firm ω with core quality level φ the probability of selecting alternative $e_{\omega,i}$ in the foreign market i over *M&A* is

$$\begin{aligned} &\Pr{}_i^1 \left(e_{\omega,i} \succeq M\&A \mid \varphi, f_i^{e_{\omega,i}}; \theta_i^1 \right) = \\ &\int \mathbb{1} \left\{ \mathbb{E}\Pi_i^{e_{\omega,i}} \left(\varphi, \varphi_i^M, \epsilon_i, f_i^{e_{\omega,i}}, \tau_i, s_i; \mu_{\epsilon,i}, \sigma_\epsilon \right) \right. \\ &\left. \geq \Pi_i^M \left(\varphi, \varphi_i^M, s_i, \bar{f}_i^M \right) \right\} dM(\varphi_i^M; a_i^M, \gamma), \end{aligned} \tag{3.17}$$

where $\theta_i^1 = \left\{ \mu_{\epsilon,i}, \sigma_\epsilon, a_i^M, \gamma, \tau_i, s_i \right\}$.

In particular, the draw of target firm's quality should be below the corresponding country-specific cutoff, which in turn is represented by a function in the core quality φ and (institutional) entry costs of a selected activity $f_i^{e_{\omega,i}}$. Let $\tilde{\Delta}_i^G$ denote firm's return to core quality associated to greenfield investment in a foreign market, respectively; that is,[45]

$$\tilde{\Delta}_i^G \equiv \mathbb{E}\epsilon_i^{\sigma-1} \tilde{\Phi}_i. \tag{3.18}$$

[45]Here we adopt a different notation for returns, as entry costs for greenfield investment should be considered in total when comparing this entry type to *M&A*.

Then, the corresponding upper bounds for the realization of φ_i^M for the choice of not entering into the market i, φ_i^{M0}, entering via exporting, φ_i^{ME}, and greenfield investment, φ_i^{MG}, for the firm with core quality $\varphi > 1/s_i$ are as follows

$$\begin{aligned}
\varphi_i^{M0} &= \left[\frac{\bar{f}_i^M}{\tilde{\Phi}_i(\varphi s_i)^{\sigma-1} - \tilde{\Phi}_i}\right]^{\frac{1}{\sigma-1}}, \\
\varphi_i^{ME} &= \left[\frac{\bar{f}_i^M + \Delta_i^E - f_i^E}{\tilde{\Phi}_i(\varphi s_i)^{\sigma-1} - \tilde{\Phi}_i}\right]^{\frac{1}{\sigma-1}}, \\
\varphi_i^{MG} &= \left[\frac{\bar{f}_i^M + \tilde{\Delta}_i^G - f_i^G}{\tilde{\Phi}_i(\varphi s_i)^{\sigma-1} - \tilde{\Phi}_i}\right]^{\frac{1}{\sigma-1}},
\end{aligned} \tag{3.19}$$

while if the firm has the core quality level $\varphi < 1/s_i$, it never finds it profitable to acquire a target firm in the market i, so that such firm selects any alternative over *M&A* with deterministic probability in the market i.[46]

In the second stage, we determine the probability of choosing a given entry type in each market over all other alternatives, but *M&A*. The cutoffs (if relevant[47]) in the core quality with respect to *Export*, *Greenfield investment*, and *No entry* are

$$\varphi_i^{0E} = \frac{f_i^E}{\Delta_i^E},\ \varphi_i^{0G} = \frac{\bar{f}_i^G}{\Delta_i^G},\ \varphi_i^{GE} = \frac{f_i^E - \bar{f}_i^G}{\Delta_i^E - \Delta_i^G}, \tag{3.20}$$

where φ_i^{jk} defines firm's threshold such that with core quality φ satisfying $\varphi_i^{\sigma-1} = \varphi_i^{jk}$ firm is indifferent between entering with the entry type j or k into the foreign market and enters with k if the core quality is above the relevant cutoff, where $j, k \in \{0, E, G\}$ with $j \neq k$.

The cutoffs for choosing *M&A* depend both on the core quality and realization of target firms' qualities. Thus, the density of the revenues in each location and the choice of *M&A* are inter-dependent. However, using the monotonicity of M&A revenues in the target firm's quality, we can constrain the possible realizations of target firms' draws of quality to rationalize the sales associated to M&A and observed in the data. In particular, we can express the target firm's qual-

[46]For simplicity, if $\varphi > 1/s_i$ we assume that *Greenfield Investment* is preferred to *M&A* with probability 1 in the market i. In this case, option of not entering dominates both *M&A* and *Greenfield investment*. Therefore, in the second stage the *Greenfield investment* will be dominated by *No entry*, so that the likelihood of selecting *Greenfield investment* will be zero independent of the value which we assign to the probability to select *Greenfield investment* over *M&A* in the first stage. The probability of selecting *M&A* over *M&A* is one.

[47]The relevance of cutoffs is discussed in the Appendix M.

ity as $\varphi^M_{\omega,i} = r^M_{\omega,i}/\tilde{\Phi}_i(s_i\varphi)^{\sigma-1}$ and redefine all cutoffs for firm ω for selecting *M&A* over other alternatives in terms of the sole core quality.[48]

Finally, the likelihood for each firm consists of (i) the probability of observing chosen entry types $\{e_{\omega,i}\}_{i\in I^f}$, (ii) the density of the country-specific revenues $\{r_{\omega,i}\}_{i\in I^f}$,[49] (iii) the density of the domestic revenues $r_{\omega,\text{GER}}$ conditional on the entry choices and firm's core quality. We transform the density of revenues into the density of perceived quality shocks for *Export*, *Greenfield investment*, and domestic sales. The density of M&A sales is transformed into the density of M&A quality draws. Since the perceived quality shocks are i.i.d. across firms and countries, the final representation of the contribution of the firm ω to the likelihood is

$$\begin{aligned}
&l_\omega\left(\theta;\{e_{\omega,i},r_{\omega,i}\}_{i\in I^f},r_{\omega,\text{GER}}\right)=\\
&\int \Pr\left(\boldsymbol{e}_\omega=\boldsymbol{e}\,\middle|\,\varphi;\{\theta^1_i\}_{i\in I^f}\right)\\
&\cdot\left|J^\epsilon_\omega\left(\varphi;\{\tau_i\}_{i\in I^f}\right)\right|\prod_{e_i\in\{E,G\}} y\left(r_i^{-1}(r_{\omega,i})\,\middle|\,\varphi;\{\mu_{\epsilon,i}\}_{i\in I^f},\sigma_\epsilon\right)\\
&\cdot\left|J^{\varphi^M}_\omega\left(\varphi;\{s_i\}_{i\in I^f}\right)\right|\prod_{e_i=M} m\left(r_i^{-1}(r_{\omega,i})\,\middle|\,\varphi;\left\{a^M_i\right\}_{i\in I^f},\gamma\right)\\
&\cdot\left|\frac{dr_{\text{GER}}(\epsilon_{\text{GER}})}{d\epsilon}\left(r^{-1}_{\text{GER}}(r_{\omega,\text{GER}})\right)\right|^{-1} y\left(r^{-1}_{\text{GER}}(r_{\omega,\text{GER}})\,\middle|\,\varphi;\sigma_\epsilon\right)dG(\varphi;a,\gamma),
\end{aligned}\tag{3.21}$$

where θ is the vector of parameters to estimate, $\left|J^\epsilon_\omega\left(\varphi;\{\tau_i\}_{i\in I^f}\right)\right|$ is the absolute value of the determinant of the Jacobian associated to the transformation of the density of foreign revenues generated via export and greenfield investment into the density of the perceived quality shocks, $\left|J^{\varphi^M}_\omega\left(\varphi;\{s_i\}_{i\in I^f}\right)\right|$ is the absolute value of the Jacobian associated to the transformation of the density of M&A foreign revenues into the density of the M&A quality draws, $y\left(\cdot\,\middle|\,\{\mu_{\epsilon,i}\}_{i\in I^f},\sigma_\epsilon\right)$ is the univariate density of the perceived quality shocks, $m\left(\cdot\,\middle|\,\left\{a^M_i\right\}_{i\in I^f},\gamma\right)$ is the univariate density of the M&A quality draws, and $G(\varphi;a,\gamma)$ is the distribution of the core quality.

To estimate the model we solve the constrained optimization problem, which is specified as follows

$$\begin{aligned}
&\max_{\theta,\{\varphi_i\}_{i\in I^f},\varphi_{\text{GER}}}\log\prod_{\omega\in\Omega_{\text{GER}}} l_\omega\left(\theta;\{e_{\omega,i},r_{\omega,i}\}_{i\in I^f},r_{\omega,\text{GER}}\right)\\
&\text{subject to: } r_{\omega,i}=r_i(\varphi_i)\wedge r_{\omega,\text{GER}}=r_{\text{GER}}(\varphi_{\text{GER}})\ \ \forall\,\omega\in\Omega_{\text{GER}},\ i\in I^f.
\end{aligned}\tag{3.22}$$

[48]Formal expressions for cutoffs in the core quality for selecting *M&A* over other alternatives can be found in the Appendix P.

[49]Here we drop the entry-type superscript for sales to reduce notation complication.

3.5.4. Estimation Results

Table 3.4 presents the estimates of the structural parameters.[50] Institutional entry costs of both types of FDI are below the institutional export-entry costs. Therefore, only the firms with the highest core quality find it profitable to export.[51] Entry costs of greenfield investment increase with the core quality of the firm, which confirms the hypothesis that transferring higher quality is more costly. The cost of quality for greenfield investment is higher in the US relative to the rest of the world and the EU. This result can be explained by higher average quality of services provided in the US market, as well as higher advertisement costs.

Table 3.4.: Maximum Likelihood Estimates

Common parameters	Estimates		
Scale parameter of core quality distribution, a		0.139	
Shape parameter of core quality distribution, γ		4.649	
S.d. log perceived quality shock, σ_ϵ		0.887	
S.d. log export-entry costs, σ_{f^E}		2.996	
S.d. log greenfield investment entry costs, σ_{f^G}		9.436	
Country-specific parameters	EU	US	RoW
Median entry cost with export, $\exp(f^E)$	4.455	1.069	3.803
Iceberg trade costs, τ	1.468	2.259	2.897
Median log perceived quality shocks, $\exp(\mu_\epsilon)$	0.858	0.375	0.655
Median institutional entry costs with greenfield FDI, $\exp\left(\bar{f}^G\right)$	0.279	0.611	0.764
Quality price for greenfield FDI, α^G	0.224	0.575	0.200
Median institutional entry costs of M&A, $\exp\left(\bar{f}^M\right)$	0.216	0.048	1.565
M&A synergies, s	6.457	1.729	3.934
Scale parameter of M&A quality distribution, a^M	0.115	0.148	0.368
	Number of firms		3776
	Log-Likelihood		-3.245E+4

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, and Statistics on International Trade Services (SITS), 2001-2015, authors' calculations.

Next, we discuss the parameters which determine the revenues associated with each activity. The perception of quality in the foreign markets is lower with respect to the median perceived quality in Germany. When the loss in the perception is only 14% for the EU, the mode perceived quality in the US and the rest of the world markets for German services is substantially lower. In particular, this results in the change of the cutoff ordering between M&A and greenfield for the US market: more productive firms prefer to acquire firms in the US. Iceberg trade costs in the services sector are mainly explained by the gravity parameters. Not surprisingly, an increase in the marginal costs is the lowest for the EU market. Finally, the magnitude of synergies generated via M&A is larger in the EU compared to the US and the rest of the world, which reflects larger applicability of German common practices in this market and better brand-name recognition.

[50] We note that results are subject to change.

[51] The orderings of the returns and fixed part of the entry costs across entry types are the same.

3.6. Counterfactual Analysis

In this section, we address the question of how the liberalization affects the services sector. Specifically, we examine the potential effect of the Transatlantic Trade and Investment Partnership (TTIP) related to the services sector on the average quality of services provided via each entry type and overall quality of services provided in the EU, the US, and the rest of the world.

We describe the main steps of conducting a counterfactual analysis with the proposed model. First, we discuss how to calibrate the iceberg trade costs and parameters of the origin-specific distributions of the perceived quality shocks to data on bilateral multinational and trade flows between markets. Second, we explain how to simulate a trade liberalization with our model and what can be the differences in liberalization outcomes in the services sector with respect to manufacturing. As previous steps done, we can analyze the effect of the introduction of quality and safety standards which result in the reduction of the costs of quality transfer with greenfield investment.

3.6.1. Calibration

Some additional data are needed to calibrate the general equilibrium of the model. For the multinational and trade outflows and inflows in the EU and the US, we use the data provided by the OECD. The multinational outflows type-specific FDI in Germany are taken from MiDi. We set the mass of firms in each market proportional to the number of listed companies in the region. Accordingly, we use data from the World Bank to determine the size of the labor force in each market and the share of labor employed in the services sector.

Taking Germany as a representative EU country, we set all origin-specific structural parameters for the EU firms equal to the ones estimated for Germany. Specifically, we assume that EU firms face the same uncertainty in quality perception in the foreign markets, draw entry costs from the same distributions and pay same iceberg trade costs. Moreover, as the magnitude of the iceberg trade costs in the professional services sector can be explained by gravity parameters, we restrict the trade costs to be symmetric.

Following the theoretical specification of our model, we account for the possibility that quality perception and the level of entry costs can depend not just on the destination country, but also on the origin of trade flows. The perception of quality can differ due to the presence of "country-brands", for instance German services could be perceived differently from those provided by US firms in the RoW market. The flexibility in parameters corresponding to the perceived quality shocks would allow us to match closer intensive margin of services trade. At the same time, the closeness of regulations on services sector between origin and host countries would make the institutional entry barriers different across various country pairs. When allowing for origin-and destination-specific entry costs, we are able to match better extensive margin, and therefore selection patterns into different activities. Moreover, those two assumptions allow us to regard all countries the same in terms of the core quality distribution.[52]

More specifically, we assume that $k_{i,o} = k_i + k_o$, where $k_{i,o} = \left\{\mu_{\epsilon,i,o}, f^E_{i,o}, \bar{f}^G_{i,o}, \bar{f}^M_{i,o}\right\}$ can be represented as a sum of the destination country component k_i, and the origin country component k_o. We normalize all parameters related to the EU market to zero, so that the estimates for entry costs and quality perception shocks obtained for Germany can be regarded as the corresponding destination country components.

Thus, there are eight parameters, θ^c, to be calibrated: (i – ii) US – RoW and RoW – RoW iceberg trade costs, and (iii – viii) origin country components of the perceived quality shocks' distribution and entry costs for the US and the rest of the world.

Using the predictions of the model on the export and FDI flows across foreign markets, we construct the set of moments for our calibration. The first subset of moments includes the shares of each foreign market in the US and the EU trade and multinational flows. The theoretical decomposition of export and import across foreign markets is given by

$$\kappa^{1,import}_{i,j} = \frac{\int_\varphi X^E_{i,j}(\varphi)dG(\varphi)}{\sum_{i\neq j}\int_\varphi X^E_{i,j}(\varphi)dG(\varphi)}, \quad \kappa^{1,export}_{i,j} = \frac{\int_\varphi X^E_{i,j}(\varphi)dG(\varphi)}{\sum_{i\neq j}\int_\varphi X^E_{i,j}(\varphi)dG(\varphi)}, \tag{3.23}$$

where $i \in \{EU, US\},\ j \in \{EU, US, RoW\}$.[53] For each country, we drop a moment with respect to one foreign country. This results in six moment conditions.[54]

Next, we take the shares of each foreign market in the FDI inflows and outflows in the US and the EU markets. The model prediction for these moments is

$$\begin{aligned} \kappa^{1,inflow}_{i,j} &= \frac{\int_\varphi \left[X^G_{i,j}(\varphi) + X^M_{i,j}(\varphi)\right] dG(\varphi)}{\sum\limits_{i\neq j}\int_\varphi \left[X^G_{i,j}(\varphi) + X^M_{i,j}(\varphi)\right] dG(\varphi)}, \\ \kappa^{1,outflow}_{i,j} &= \frac{\int_\varphi \left[X^G_{j,i}(\varphi) + X^M_{j,i}(\varphi)\right] dG(\varphi)}{\sum\limits_{i\neq j}\int_\varphi \left[X^G_{j,i}(\varphi) + X^M_{j,i}(\varphi)\right] dG(\varphi)}, \end{aligned} \tag{3.24}$$

where $i \in \{EU, US\}, j \in \{EU, US, RoW\}$. Accordingly, we consider six additional moment conditions.

[52]With non-origin specific institutional entry barriers the model will predict the same cutoffs for a given country for all entrants independent of their origin. This would largely restrict the set of possible market shares of foreign suppliers and make the calibration of the model not feasible.

[53]We allow for trade between countries within the same aggregated region (the EU and the rest of the world). Therefore, only non-feasible pair of i and j combination is $US - US$.

[54]Correspondingly, there are two moment conditions for flows associated to the US and four moment conditions for the EU.

Then, we include the shares of each foreign market in the greenfield investment and M&A services flows from Germany. Here we assume that the German FDI composition is similar to the aggregate EU composition of FDI. The proportion of country j in the greenfield investment and M&A outflows from Germany is

$$\kappa_{EU,j}^{1,G} = \frac{\int_\varphi X_{j,EU}^{G}(\varphi)dG(\varphi)}{\sum\limits_j \int_\varphi X_{j,EU}^{G}(\varphi)dG(\varphi)}, \quad \kappa_{EU,j}^{1,M} = \frac{\int_\varphi X_{j,EU}^{M}(\varphi)dG(\varphi)}{\sum\limits_j \int_\varphi X_{j,EU}^{M}(\varphi)dG(\varphi)}, \tag{3.25}$$

where $j \in \{EU, US, RoW\}$. This condition gives us four additional moments.

The second set of moments defines the composition of a trade flow to each foreign destination by export and FDI. First, the theoretical share of import from country j to country i in total expenditure of country i to services from country j is given by

$$\kappa_{i,j}^{2,import} = \frac{\int_\varphi X_{i,j}^{E}(\varphi)dG(\varphi)}{\sum\limits_{e\in\{E,G,M\}} \int_\varphi X_{i,j}^{e}(\varphi)dG(\varphi)}, \tag{3.26}$$

where $i \in \{EU, US\}$, $j \in \{EU, US, RoW\}$. Analogously, the theoretical share of export in total sales flows from country i to country j is given by

$$\kappa_{i,j}^{2,export} = \frac{\int_\varphi X_{j,i}^{E}(\varphi)dG(\varphi)}{\sum\limits_{e\in\{E,G,M\}} \int_\varphi X_{j,i}^{e}(\varphi)dG(\varphi)}, \tag{3.27}$$

where $i \in \{EU, US\}$, $j \in \{EU, US, RoW\}$.

Finally, we include the proportion of destination-specific greenfield investment flows and M&A flows in outward German activities. The proportion of M&A in the total FDI flow to the foreign market from the EU is

$$\kappa_{EU,j}^{2,M} = \frac{\int_\varphi X_{j,EU}^{M}(\varphi)dG(\varphi)}{\int_\varphi \left[X_{j,EU}^{M}(\varphi) + X_{j,EU}^{M}(\varphi)\right] dG(\varphi)}, \tag{3.28}$$

where $j \in \{EU, US, RoW\}$. This condition gives us three additional moments.

Therefore, we construct 31 moments, $\boldsymbol{\kappa}$. We then minimize the squared difference between theoretical moments and the data targets conditional on the vector of the aggregate market parameters satisfying the model equilibrium

$$\begin{gathered} \max_{\theta^c} \left(\boldsymbol{\kappa}(\theta^c) - \boldsymbol{\kappa}\right)' \left(\boldsymbol{\kappa}(\theta^c) - \boldsymbol{\kappa}\right) \\ \text{subject to: } L_i(\theta^c) = L_i \wedge P_i(\theta^c) = P_i \wedge Y_i(\theta^c) = Y_i \; \forall i \in I, \end{gathered} \tag{3.29}$$

where $L_i(\theta^c)$ is given by (3.13), $P_i(\theta^c)$ is given by (3.14), and $Y_i(\theta^c)$ is given by (3.15). We take all moments with the equal weights.

3.6.2. Counterfactual Analysis

In the counterfactual analysis, we simulate the liberalization in the services sector as it is described for TTIP agreement. According to the proposals of the European Commission,[55] the services sector liberalization has two important policies which are the reduction of the non-tariff trade barriers and introduction of services quality standardization. In terms of the model, an increase in mobility of professional consultants, fastening of licenses approvals and elimination of legal restrictions of professional services trade will be reflected in the reduction of the institutional trade barriers, that is $\boldsymbol{f^E}$, $\boldsymbol{\bar{f}^G}$ and $\boldsymbol{\bar{f}^M}$. Standardization of the quality requirements can decrease costs of entering foreign markets with the greenfield investment by facilitating the transferring of quality overseas; therefore, we would expect that the costs of quality transfer, $\boldsymbol{\alpha^G}$, will decrease.

The reduction in the institutional entry costs does not change the relative quality provided by each entry mode, but in turn it affects the absolute value of the average quality supplied by exporters, FDI-makers and domestic firms as institutional barriers determine the proportions of firms selecting in one or another entry mode. Contrarily, the introduction of quality standards results in an increase of a return to greenfield investment and therefore could have implications on the sorting entry patterns. A sufficiently stringent quality requirements could revert the sorting between export and greenfield investment and result in the highest quality services to be provided with FDI. Moreover, an increase in the return to greenfield investment would have an effect on the acceptance of M&A offers, leading to less M&A but of a higher quality.

Following Francois and Hoekman (2010), we consider two possible scenarios for trade liberalization. In the moderate scenario, we simulate a 10%-reduction of the non-tariff barriers, where we reduce bilateral institutional entry costs for the US and the EU markets. In the more ambitious scenario, we simulate a 25%-reduction of institutional entry barriers. For each case we consider a change in the aggregate income, as defined by (3.15); a change in the average quality $\tilde{\varphi}_i$ of services in the market i, as defined by (3.30); and a change in the average quality provided by exporters and FDI-makers, that is by groups g_i^e separated according to different entry types e, as defined by (3.31)

$$\tilde{\varphi}_i = \left[\sum_{j \in I_i^f} n_j \int_{\varphi} \zeta_{i,j}^e(\varphi) \varphi^{\sigma-1} dG(\varphi) + n_i \varphi^{\sigma-1} dG(\varphi) \right]^{\frac{1}{\sigma-1}}, \tag{3.30}$$

[55] Detailed information about proposals could be found on the website of the European Commission.

$$\tilde{\varphi}_{i,g_i^e} = \left[\sum_{j \in g_i^e} n_j \int_{\varphi} \zeta_{i,j}^e(\varphi) \varphi^{\sigma-1} dG(\varphi) \right]^{\frac{1}{\sigma-1}}. \tag{3.31}$$

Given the structural parameter estimates obtained in Section 3.5, we can expect the main effect of liberalization to come from the changes in the multinational activity in the services sector. As non-tariff trade barrier fall, previously domestic firms can become profitable for starting the FDI activity in the foreign market. While export can increase, this would be mainly due to selection into exporting over FDIrather than deriving from entries of previously internationally inactive firms. This is a crucial difference with the effect of liberalization in manufacturing, which highlights the importance of a proper consideration of the selection patterns into foreign activities across industries and countries.

3.7. Conclusion

This chapter analyzes the entry patterns into foreign markets specific to the professional services sector. We explain theoretically why the largest service firms in the industry export, while the smaller companies open new foreign affiliates or acquire preexisting foreign targets. Since international activities are associated with high uncertainty in the perception of service quality in the non-tested destination markets, most firms find it profitable to enter a new market by buying foreign firms with an already established consumer network in order to avoid demand risks. At the same time, the most productive firm can generate higher sales by engaging in greenfield FDI or by exporting the quality of their origin country abroad subject to entry costs.

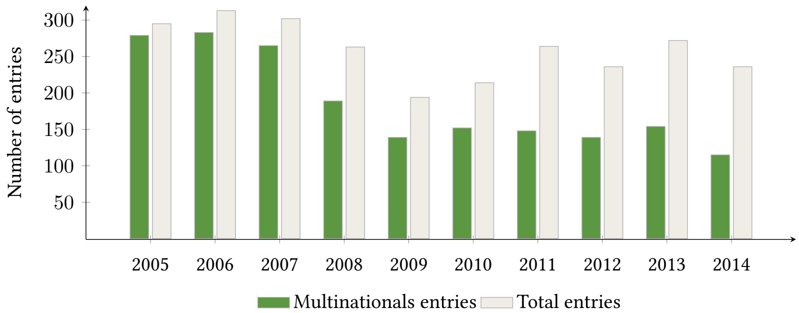
Our parsimonious model fits the empirical evidence on German firms. We find that entry patterns are reversed compared to the standard sorting in manufacturing: only the firms providing the highest service quality export, while lower-quality firms conduct FDI. The relative sorting of M&A vs. greenfield FDI in terms of firm quality is market-specific and depends on the relative importance of uncertainty about quality perception, the structure of entry costs, and size of synergies associated with M&A. Finally, we calibrate the model equilibrium to the data on multinational and trade flows between the EU, the US, and the rest of the world. The theoretical model suggest that the service-trade liberalization, based on the reduction of non-tariff trade barriers and introduction of quality standards, can reallocate quality across entry alternatives, increase quality of acquired targets, and make FDI a more prominent entry type.

K. Entry by Year

Figure K.1 reports the number of entries by year into foreign countries observed in the sample of firms supplying professional services. The green bars refer only to entries related to multinational enterprises whereas the gray bars include also pure exporters. We note that entry activity is larger at the beginning of the sample (2005 – 2007). However, starting from 2008, we note that the economic crisis reduced the entries activity of both groups of firms (especially for multinationals).

Entries has been slowly reverting to the levels observed before the crisis with respect to pure exporters, whereas they are still below the pre-crisis level with respect to multinational enterprises.

Figure K.1.: Foreign Market Entries

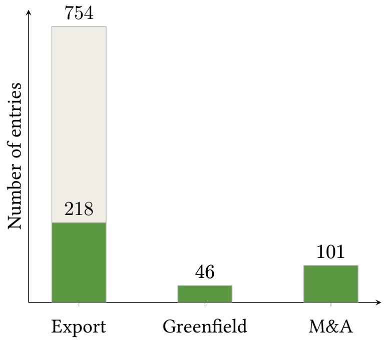


Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, and Statistics on International Trade Services (SITS), 2001-2015, authors' calculations.

L. Wholesale

Figure L.1 displays the patterns of entries into foreign markets. Generally, in the wholesale sector the quality is not the most important business driver. The patterns we observe for this sector are in line with the literature describing entry behavior for manufacturing (Helpman et al., 2004). In particular, we observe that most firms enter via export whereas entry by greenfield investment activity is the less frequent, differently from professional services.

Figure L.1.: Entry type in wholesale



Note: The middle line represents the number of exporters that conduct multinational activity.
Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, and Statistics on International Trade Services (SITS), 2001-2015, authors' calculations.

The results in Table L.1 are also in line with patterns described for manufacturing. In particular, we find that the sales premium for the exporters is the lowest across the various entry types, reflecting that exporters are relatively less productive than foreign direct investors.

Table L.1.: Sales and size premia in wholesale sector

	Premia		95% Conf. Interval	
	Exporters			
Sales premia	11.667	(0.254)	[11.168,	12.165]
Size premia	4.483	(0.221)	[4.049,	4.917]
	M&A			
Sales premia	11.765	(0.271)	[11.226,	12.305]
Size premia	4.949	(0.237)	[4.478,	5.420]
	Greenfield investment			
Sales premia	11.759	(0.331)	[11.109,	12.408]
Size premia	4.418	(0.288)	[3.853,	4.983]

Notes: We estimate entry type premia as follows: $Y_{\omega,t} = \beta_1 EXP_{\omega,t} + \beta_2 MA_{\omega,t} + \beta_3 GI_{\omega,t} + I_t + \epsilon_{\omega,t}$, where t is the year index, I are year dummies, and Y is the log of firm characteristic for which the premia are estimated. All estimates are significant at the 1 percent level. Estimation of sales premia: $N = 901$, $R^2 = 0.9760$. Estimation of size premia: $N = 894$, $R^2 = 0.8773$.

Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, Microdatabase Direct investment (MiDi), 1999-2014, and Statistics on International Trade Services (SITS), 2001-2015, authors' calculations.

M. On the Intuition of Cutoff Ordering

Let Δ^E, Δ^M, and Δ^G denote firm's return to core quality associated to export, M&A, and greenfield investment in a foreign market, respectively;[1] that is,

$$\Delta^E := \mathbb{E}\epsilon^{\sigma-1}\tau^{1-\sigma}\tilde{\Phi},$$
$$\Delta^M := \left(\varphi^M\right)^{\sigma-1} s^{\sigma-1}\tilde{\Phi},$$
$$\Delta^G := \left(\mathbb{E}\epsilon^{\sigma-1} - \alpha^G\right)\tilde{\Phi}.$$

Let φ^{jk} define firm's threshold such that with core quality φ satisfying $\varphi^{\sigma-1} = \varphi^{jk}$ firm is indifferent between accessing the foreign market with entry type j or k, where

$$j, k \in \{0, \textit{Export}, \textit{Greenfield investment}, \textit{M\&A}\} \text{ with } j \neq k.$$

We distinguish six cases depending on the relation between returns to core quality and then specify sub-cases according to the relation between fixed part of entry costs. This case distinction allows us to determine the relevant intervals of core quality corresponding to the selection into one of three activities (if any). Depending on the structure of the entry costs, some option can dominate another one in terms of profits. Firm's choice between alternatives is determined by the level of core quality. Therefore, we can describe firm's optimal choices given the level of its core quality.

Case 1. $\Delta^E > \Delta^G \geq \Delta^M$.[2]
This case corresponds to the situation in which firm's largest returns to core quality are associated to *Export*, whereas lowest returns are associated to *M&A*.

Case 1.1. $f^E > \bar{f}^G > f^M$.[3]
In this case, the activity with the highest return to core quality is also the most expensive in

[1]Hereafter, we skip country index.
[2]For illustrative purpose, we provide for all sub-cases of case 1 the corresponding figure with profit lines. For the next cases, we skip figures as they are analogous to the case 1.
[3]For the simplicity of notation, in this section we denote $f^M := f^M\left(\varphi^M\right)$.

terms of entry costs. According to the ordering of zero cutoffs (that is, φ^{E0}, φ^{G0}, and φ^{M0}), we specify four possible sub-cases.

Case 1.1.1. $\varphi^{M0} < \varphi^{G0} < \varphi^{E0}$.

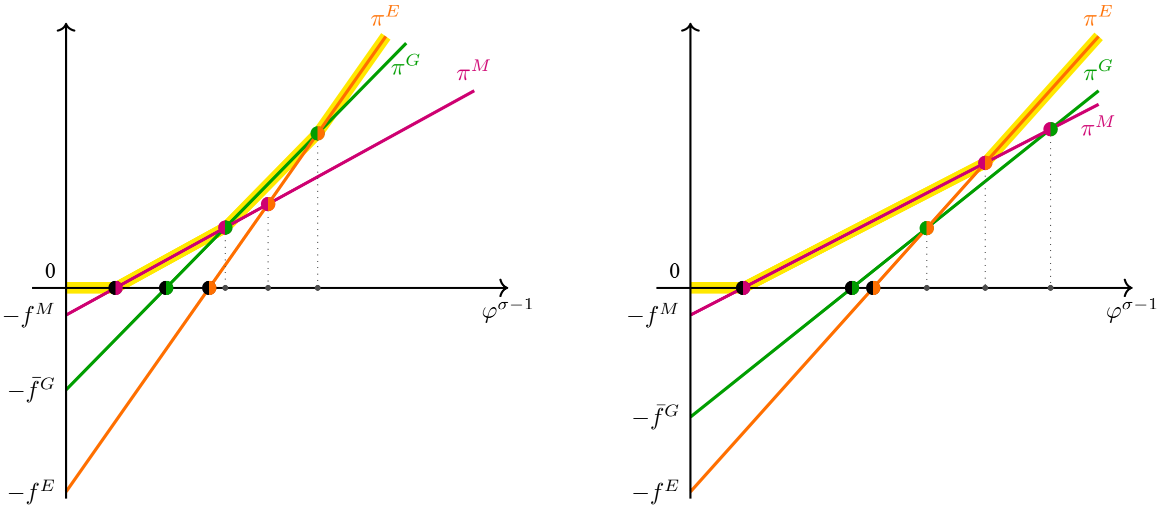
We further separate two sub-cases depending on the relation between the quality level required to switch from *M&A* to *Greenfield investment* or to *Export*.

Case 1.1.1.1. $\varphi^{EM} \geq \varphi^{GM}$.

In this case, all alternatives can be optimal for some intervals of core quality. In particular, the firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; firm chooses *M&A* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{GM}$; firm chooses *Greenfield investment* if $\varphi^{GM} \leq \varphi^{\sigma-1} < \varphi^{EG}$; firm chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{EG}$.

Case 1.1.1.2. $\varphi^{EM} < \varphi^{GM}$.

In this case, *Greenfield investment* is not optimal. Indeed, *Greenfield investment* becomes more profitable than *M&A* at a larger level of quality than that required for *Export* to become more profitable than *M&A*. Hence, firm decides to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; firm chooses *M&A* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{EM}$; firm chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{EM}$.



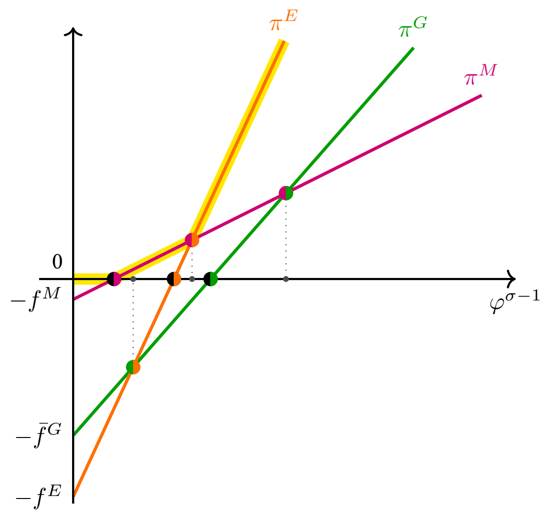
Case 1.1.1.1. $\varphi^{M0} < \varphi^{G0} < \varphi^{E0} \wedge \varphi^{EM} \geq \varphi^{GM}$.

Case 1.1.1.2. $\varphi^{M0} < \varphi^{G0} < \varphi^{E0} \wedge \varphi^{EM} < \varphi^{GM}$.

Zero cutoff for *M&A* with x-coordinate φ^{M0}
Zero cutoff for *Greenfield investment* with x-coordinate φ^{G0}
Zero cutoff for *Export* with x-coordinate φ^{E0}
Maximum profits for a given level of core quality
Cutoff between *M&A* and *Greenfield investment* with x-coordinate φ^{GM}
Cutoff between *Greenfield investment* and *Export* with x-coordinate φ^{EG}
Cutoff between *M&A* and *Export* with x-coordinate φ^{EM}

Case 1.1.2. $\varphi^{M0} < \varphi^{E0} \leq \varphi^{G0}$.

In this case, *Export* provides a higher return than *Greenfield investment*, while it becomes profitable at the lower level of quality. Thus, *Greenfield investment* is not optimal. If $\varphi^{\sigma-1} < \varphi^{M0}$, then firm chooses to stay out. If $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{EM}$, firm chooses *M&A*. If $\varphi^{\sigma-1} \geq \varphi^{EM}$, firm chooses *Export*.

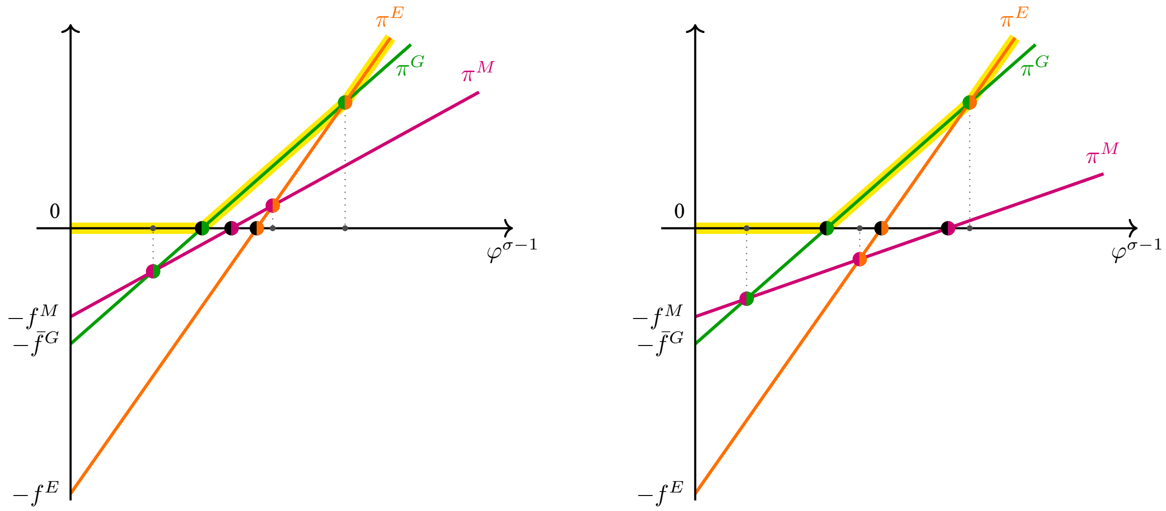


Case 1.1.2. $\varphi^{M0} < \varphi^{E0} \leq \varphi^{G0}$.

Zero cutoff for *M&A* with x-coordinate φ^{M0}
Zero cutoff for *Greenfield investment* with x-coordinate φ^{G0}
Zero cutoff for *Export* with x-coordinate φ^{E0}
Maximum profits for a given level of core quality
Cutoff between *M&A* and *Greenfield investment* with x-coordinate φ^{GM}
Cutoff between *Greenfield investment* and *Export* with x-coordinate φ^{EG}
Cutoff between *M&A* and *Export* with x-coordinate φ^{EM}

Case 1.1.3. $\varphi^{G0} \leq \varphi^{M0} \wedge \varphi^{G0} < \varphi^{E0}$.

In this case, *Greenfield investment* provides a higher return than *M&A*, while is becomes profitable at the lower level of core quality than *M&A*. Thus, no firm finds it optimal to serve foreign markets via M&A. In this case, firm stays out if it is not productive enough to conduct greenfield investment, i.e. $\varphi^{\sigma-1} < \varphi^{G0}$; firm chooses *Greenfield investment* if $\varphi^{G0} \leq \varphi^{\sigma-1} < \varphi^{EG}$; finally, firm chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{EG}$.



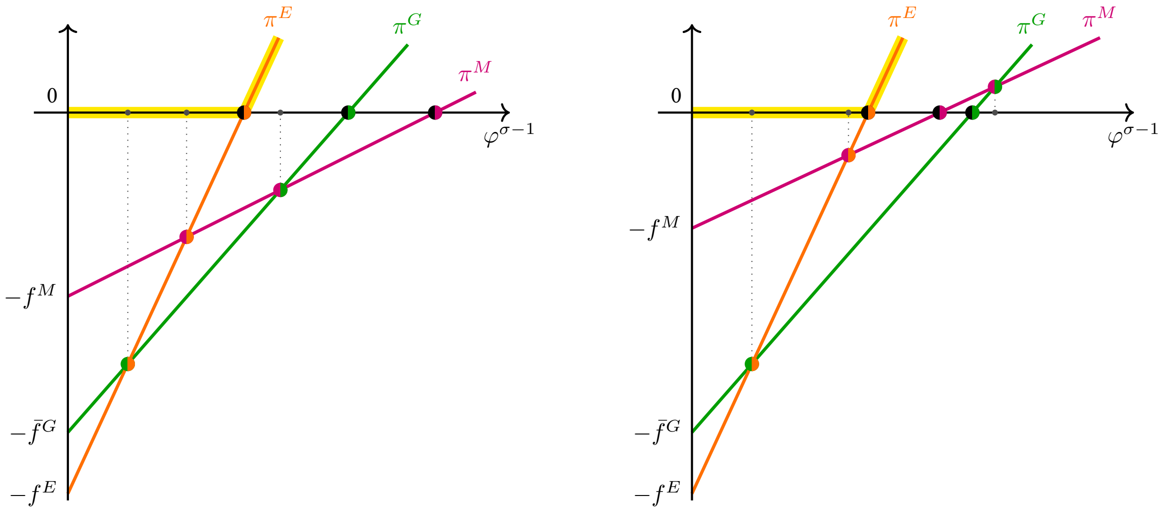
(a) $\varphi^{M0} < \varphi^{E0}$. (b) $\varphi^{M0} \geq \varphi^{E0}$.

Case 1.1.3. $\varphi^{G0} \leq \varphi^{M0} \wedge \varphi^{G0} < \varphi^{E0}$.

- Zero cutoff for *M&A* with x-coordinate φ^{M0}
- Zero cutoff for *Greenfield investment* with x-coordinate φ^{G0}
- Zero cutoff for *Export* with x-coordinate φ^{E0}
- Maximum profits for a given level of core quality
- Cutoff between *M&A* and *Greenfield investment* with x-coordinate φ^{GM}
- Cutoff between *Greenfield investment* and *Export* with x-coordinate φ^{EG}
- Cutoff between *M&A* and *Export* with x-coordinate φ^{EM}

Case 1.1.4. $\varphi^{E0} \leq \min\{\varphi^{M0}, \varphi^{G0}\}$.

In this case, only *Export* can be optimal since this alternative provides the highest return to core quality and is the first alternative to become profitable among the available ones. In particular, firm chooses *Export* if it is efficient enough to export, i.e. $\varphi^{\sigma-1} \geq \varphi^{E0}$, and stays out otherwise.



(a) $\varphi^{G0} < \varphi^{M0}$.

(b) $\varphi^{G0} \geq \varphi^{M0}$.

Case 1.1.4. $\varphi^{E0} \leq \min\{\varphi^{M0}, \varphi^{G0}\}$.

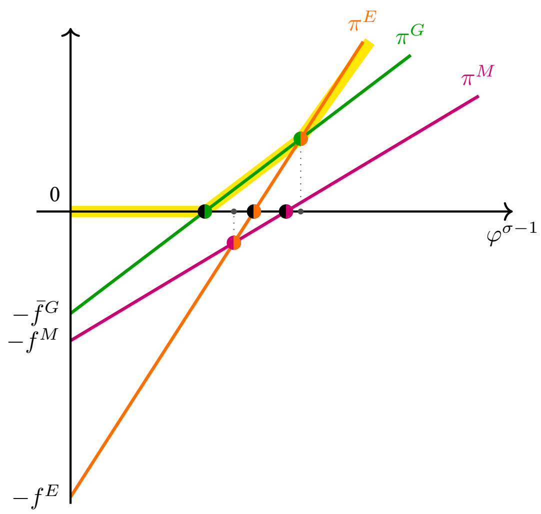
- Zero cutoff for *M&A* with x-coordinate φ^{M0}
- Zero cutoff for *Greenfield investment* with x-coordinate φ^{G0}
- Zero cutoff for *Export* with x-coordinate φ^{E0}
- Maximum profits for a given level of core quality
- Cutoff between *M&A* and *Greenfield investment* with x-coordinate φ^{GM}
- Cutoff between *Greenfield investment* and *Export* with x-coordinate φ^{EG}
- Cutoff between *M&A* and *Export* with x-coordinate φ^{EM}

Case 1.2. $f^M \geq \bar{f}^G \wedge f^E > \bar{f}^G$.

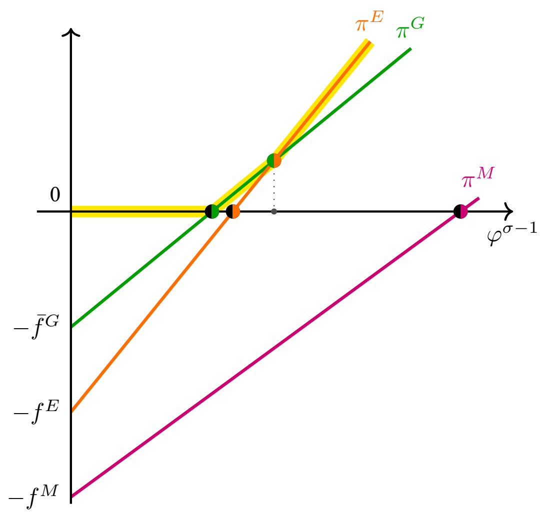
In this case, *M&A* cannot be optimal since it provides lower return than *Greenfield investment* but requires larger entry costs. We distinguish two additional sub-cases depending on the relation between zero cutoffs associated to *Greenfield investment* and *Export*.

Case 1.2.1. $\varphi^{E0} > \varphi^{G0}$.

In this case, both *Export* and *Greenfield investment* can be profitable at some levels of core quality. Firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{G0}$; it chooses *Greenfield investment* if $\varphi^{G0} \leq \varphi^{\sigma-1} < \varphi^{EG}$; finally, it selects *Export* if $\varphi^{\sigma-1} \geq \varphi^{EG}$.



(a) $f^M < f^E$.



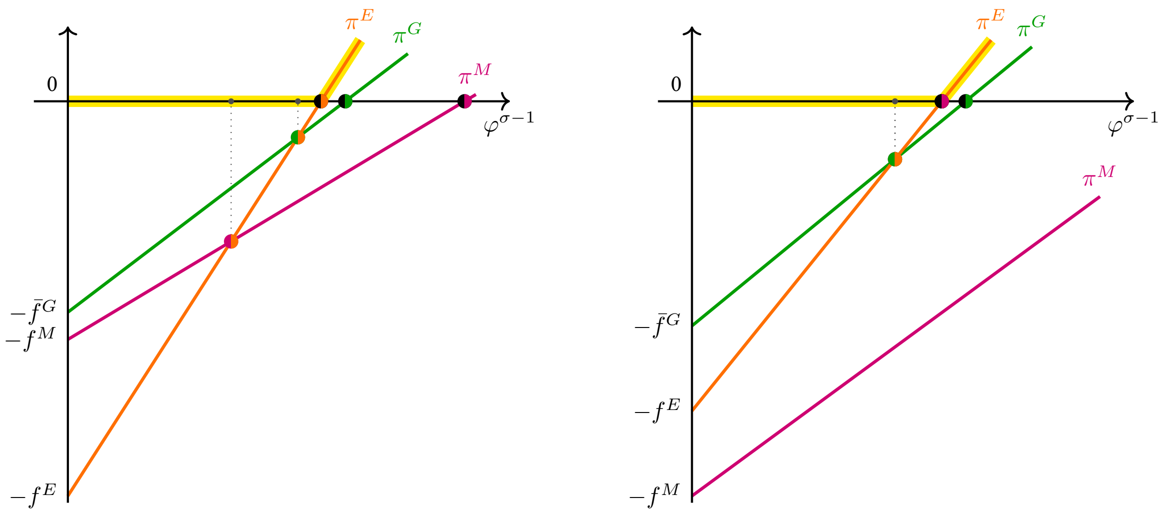
(b) $f^M \geq f^E$.

Case 1.2.1. $\varphi^{E0} > \varphi^{G0}$.

Zero cutoff for *M&A* with x-coordinate φ^{M0}
Zero cutoff for *Greenfield investment* with x-coordinate φ^{G0}
Zero cutoff for *Export* with x-coordinate φ^{E0}
Cutoff between *Greenfield investment* and *Export* with x-coordinate φ^{EG}
Cutoff between *M&A* and *Export* with x-coordinate φ^{EM}
Maximum profits for a given level of core quality

Case 1.2.2. $\varphi^{E0} \leq \varphi^{G0}$.

In this case, the activity yielding the largest returns, *Export*, becomes profitable at a lower level of core quality compared with *Greenfield investment*. Thus, only *Export* can be optimal. In particular, if $\varphi^{\sigma-1} \geq \varphi^{E0}$, firm chooses *Export* and stays out otherwise.



(a) $f^M < f^E$. (b) $f^M \geq f^E$.

Case 1.2.2. $\varphi^{E0} \leq \varphi^{G0}$.

Zero cutoff for *M&A* with x-coordinate φ^{M0}
Zero cutoff for *Greenfield investment* with x-coordinate φ^{G0}
Zero cutoff for *Export* with x-coordinate φ^{E0}
Cutoff between *Greenfield investment* and *Export* with x-coordinate φ^{EG}
Cutoff between *M&A* and *Export* with x-coordinate φ^{EM}
Maximum profits for a given level of core quality

Case 1.3. $\bar{f}^G \geq f^E > f^M$.

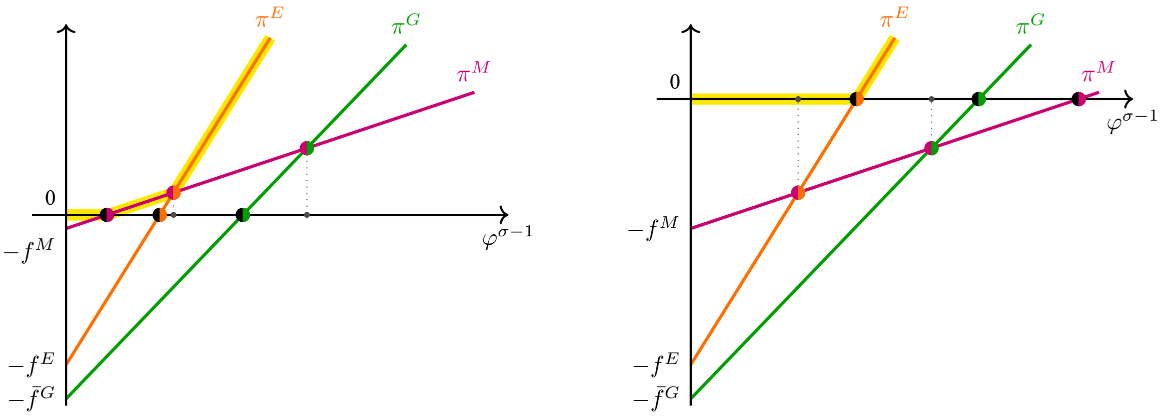
In this case, *Greenfield investment* is more costly than *Export* but has lower return. Thus, no firm finds it optimal to conduct *Greenfield investment*. We further separate two sub-cases depending on the relative positioning of the zero cutoffs for *M&A* and *Export*.

Case 1.3.1. $\varphi^{M0} < \varphi^{E0}$.

In this case, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; it chooses *M&A* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{EM}$; it chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{EM}$.

Case 1.3.2. $\varphi^{M0} \geq \varphi^{E0}$.

In this case, only *Export* can be optimal. This occurs since *M&A* requires higher core quality than *Export* to be profitable although it gives a lower return. Thus, firm chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{E0}$ and stays out otherwise.

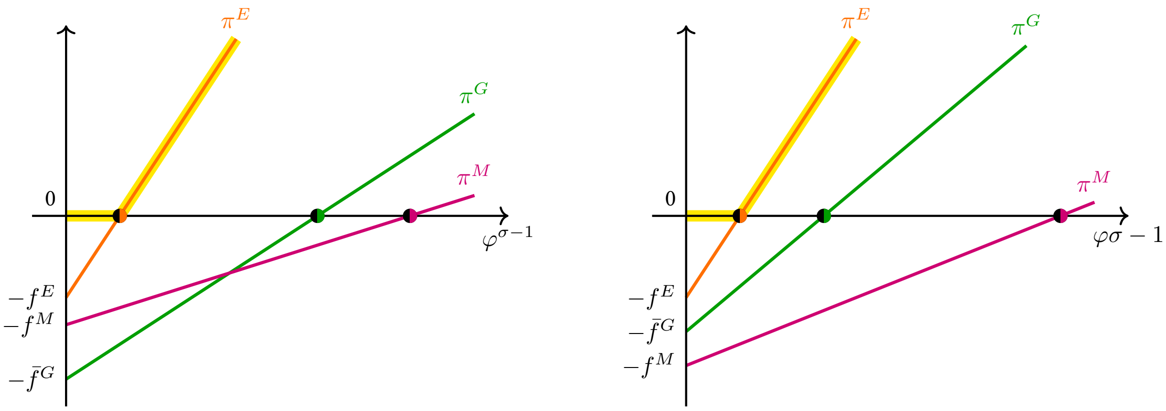


Case 1.3.1. $\varphi^{M0} < \varphi^{E0}$. Case 1.3.2. $\varphi^{M0} \geq \varphi^{E0}$.

- Zero cutoff for *M&A* with x-coordinate φ^{M0}
- Zero cutoff for *Greenfield investment* with x-coordinate φ^{G0}
- Zero cutoff for *Export* with x-coordinate φ^{E0}
- Cutoff between *M&A* and *Greenfield investment* with x-coordinate φ^{GM}
- Cutoff between *M&A* and *Export* with x-coordinate φ^{EM}
- Maximum profits for a given level of core quality

Case 1.4. $f^E \leq \min\{f^M, \bar{f}^G\}$.

In this case, only *Export* can be optimal since this option yields the highest return to core quality and, at the same time, is the cheapest, in terms of entry costs. Thus, firm chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{E0}$ and stays out otherwise.



(a) $f^M < \bar{f}^G$. (b) $f^M \geq \bar{f}^G$.

Case 1.4. $f_i^E \leq \min\{f_i^M, \bar{f}_i^G\}$.

- Zero cutoff for *M&A* with x-coordinate φ^{M0}
- Zero cutoff for *Greenfield investment* with x-coordinate φ^{G0}
- Zero cutoff for *Export* with x-coordinate φ^{E0}
- Maximum profits for a given level of core quality

Case 2. $\Delta^E \geq \Delta^M > \Delta^G$.

In this case, *Export* is still providing the largest return to core quality, followed by *M&A* and *Greenfield investment*. Similarly to the first case, we distinguish all relevant cases depending on the structure of the entry costs for three activities.

Case 2.1. $f^E > f^M > \bar{f}^G$.

In this case, more expensive in terms of entry costs alternative is also providing higher return to core quality, so that all activities can be potentially optimal for some levels of core quality.

Case 2.1.1. $\varphi^{G0} < \varphi^{M0} < \varphi^{E0}$.

Next two sub-cases are specified according to the position of cutoffs between *Greenfield investment* and two other choice options.

Case 2.1.1.1. $\varphi^{EG} \geq \varphi^{GM}$.

In this case, *Greenfield investment* becomes more profitable than *M&A* at the lower level of quality than *Export*. This means that medium-productive firms will find it profitable to acquire foreign firms. In particular, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{G0}$; it chooses *Greenfield investment* if $\varphi^{G0} \leq \varphi^{\sigma-1} < \varphi^{GM}$; it chooses *M&A* if $\varphi^{GM} \leq \varphi^{\sigma-1} < \varphi^{EM}$; it chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{EM}$.

Case 2.1.1.2. $\varphi^{EG} < \varphi^{GM}$.

In this case, *M&A* is never optimal. Thus, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{G0}$; firm chooses *Greenfield investment* if $\varphi^{G0} \leq \varphi^{\sigma-1} < \varphi^{EG}$; finally, firm chooses *Export* if $\varphi^{\sigma-1} > \varphi^{EG}$.

Case 2.1.2. $\varphi^{G0} < \varphi^{E0} \leq \varphi^{M0}$.

Since the quality required for *M&A* to be profitable is higher than the one for *Export*, firm will not go for *M&A*. Hence, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{G0}$; it chooses *Greenfield investment* if $\varphi^{G0} \leq \varphi^{\sigma-1} < \varphi^{EG}$; it chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{EG}$.

Case 2.1.3. $\varphi^{M0} \leq \varphi^{G0} \wedge \varphi^{M0} < \varphi^{E0}$.

In this case, *Greenfield investment* cannot be optimal, as it becomes profitable at the higher level of core quality than *M&A*, which provides higher return. Therefore, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; firm chooses *M&A* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{EM}$; firm chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{EM}$.

Case 2.1.4. $\varphi^{E0} \leq \min\{\varphi^{G0}, \varphi^{M0}\}$.

In this case, only *Export* can be optimal. This happens since this alternative is of the highest return and becomes profitable at the lowest level of core quality. In this case, firm chooses *Export* if it is efficient enough, i.e. $\varphi^{\sigma-1} \geq \varphi^{E0}$, and stays out otherwise.

Case 2.2. $\bar{f}^G \geq f^M \wedge f^E > f^M$.

In this case, *Greenfield investment* cannot be optimal, as it is dominated by *M&A* which provides higher return for lower price. Depending on the ordering of zero cutoffs for *Export* and *M&A* we can distinguish two sub-cases.

Case 2.2.1. $\varphi^{E0} > \varphi^{M0}$.

In this case medium-productive firms find it profitable to acquire foreign targets. In particular, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; it chooses *M&A* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{EM}$; finally, it chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{EM}$.

Case 2.2.2. $\varphi^{E0} \leq \varphi^{M0}$.

In this case, *Export* is the only alternative that can be optimal. This is due to the fact that *Export* provides a higher return to core quality and requires lower quality to become profitable. In particular, if $\varphi^{\sigma-1} \geq \varphi^{E0}$, firm chooses *Export* and stays out otherwise.

Case 2.3. $f^M \geq f^E > \bar{f}^G$.

In this case, *M&A* is dominated by *Export* which provides higher profit at all quality levels.

Case 2.3.1. $\varphi^{E0} > \varphi^{G0}$.

In this case, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{G0}$; it chooses *Greenfield investment* if $\varphi^{G0} \leq \varphi^{\sigma-1} < \varphi^{EG}$; it chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{EG}$.

Case 2.3.2. $\varphi^{E0} \leq \varphi^{G0}$.

If *Greenfield investment* becomes profitable at the higher level of core quality than *Export*, then only *Export* can be optimal. In particular, firm chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{E0}$ and stays out otherwise.

Case 2.4. $f^E \leq \min\{\bar{f}^G, f^M\}$.

In this case, only *Export* can be optimal as the alternative with the highest return to core quality and the lowest entry costs. In particular, firm chooses *Export* if $\varphi^{\sigma-1} \geq \varphi^{E0}$ and stays out otherwise.

Case 3. $\Delta^G \geq \Delta^E > \Delta^M$.

We switch to the case when *Greenfield investment* provides the largest return to core quality; the middle-level return is provided by *Export* and the lowest return corresponds to *M&A*.

Case 3.1. $\bar{f}^G > f^E > f^M$.

First we consider the subcase, when the entry costs increase with the return to core quality that entry type provides.

Case 3.1.1. $\varphi^{M0} < \varphi^{E0} < \varphi^{G0}$.

In this case case, an activity with higher return becomes profitable at the higher level of core quality.

Case 3.1.1.1. $\varphi^{GM} \geq \varphi^{EM}$.

In this case, all activities can be optimal for some levels of core quality. In particular, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; it chooses *M&A* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{EM}$; it chooses *Export* if $\varphi^{EM} \leq \varphi^{\sigma-1} < \varphi^{EG}$; it chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{EG}$.

Case 3.1.1.2. $\varphi^{GM} < \varphi^{EM}$.

In this case, *Greenfield investment* becomes more profitable than *M&A* at the lower level of quality than *Export*. Thus, *Export* cannot be optimal. Firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; it chooses *M&A* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{GM}$; it chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{GM}$.

Case 3.1.2. $\varphi^{M0} < \varphi^{G0} \leq \varphi^{E0}$.

In this case, *Export* cannot be optimal, since it becomes profitable at the higher level of quality than *Greenfield investment*. Firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; it chooses *M&A* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{GM}$; it chooses *Greenfield investment* otherwise.

Case 3.1.3. $\varphi^{E0} \leq \varphi^{M0} \wedge \varphi^{E0} < \varphi^{G0}$.

M&A cannot be optimal, as it requires higher level of core quality to be profitable than *Export*. Thus, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{E0}$; firm chooses *Export* if $\varphi^{E0} \leq \varphi^{\sigma-1} < \varphi^{EG}$; firm chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{EG}$.

Case 3.1.4. $\varphi^{G0} \leq \min\{\varphi^{M0}, \varphi^{E0}\}$.

Greenfield investment becomes profitable at the lowest level of core quality among three options being of the highest return. Thus, only *Greenfield investment* can be optimal in this case. In particular, firm chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{G0}$ and stays out otherwise.

Case 3.2. $f^M \geq f^E \wedge \bar{f}^G > f^E$.

In this case, *M&A* is dominated by *Export* which has higher profit at all levels of core quality.

Case 3.2.1. $\varphi^{G0} > \varphi^{E0}$.

Firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{E0}$; it chooses *Export* if $\varphi^{E0} \leq \varphi^{\sigma-1} < \varphi^{EG}$; it chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{EG}$.

Case 3.2.2. $\varphi^{G0} \leq \varphi^{E0}$.

In this case, *Export* is not optimal for firms in the middle range of quality. Therefore, only *Greenfield investment* can be optimal. In particular, firm chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{G0}$ and stays out otherwise.

Case 3.3. $\bar{f}^E \geq f^G > f^M$.
In this case, *Export* provides lower profit than *Greenfield investment* at all levels of core quality. Thus, this option cannot be optimal.

Case 3.3.1. $\varphi^{G0} > \varphi^{M0}$.
In this case, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; firm goes for *M&A* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{GM}$; finally, it chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{GM}$.

Case 3.3.2. $\varphi^{G0} \leq \varphi^{M0}$.
In this case, only *Greenfield investment* can be optimal, as it becomes profitable at the lower level of core quality than *M&A*, but provides higher return. Therefore, firm chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{G0}$ and stays out otherwise.

Case 3.4. $\bar{f}^G \leq \min\{f^M, f^E\}$.
In this case, *Greenfield investment* dominate both *Export* and *M&A*. Thus, firm chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{G0}$ and stays out otherwise.

Case 4. $\Delta^G > \Delta^M \geq \Delta^E$.
In this case, we keep *Greenfield investment* as the activity which provides the firm with the highest return to core quality. On the contrary, the lowest returns are associated with *Export*, followed by *M&A*.

Case 4.1. $\bar{f}^G > f^M > f^E$.
Under the above assumption, none of the alternatives is *a priori* dominated by another one, as higher entry costs correspond to higher returns from a given action. Depending on the position of the zero cutoffs, we distinguish four sub-cases.

Case 4.1.1. $\varphi^{E0} < \varphi^{M0} < \varphi^{G0}$.
In this case, relevant cutoffs of quality are determined by the position of *Export* cutoff with respect to the other two entry types.

Case 4.1.1.1. $\varphi^{EG} \geq \varphi^{EM}$.
If *M&A* becomes more profitable than *Export* at a lower level of core quality than *Greenfield investment*, firms in the middle range of quality find it optimal to acquire foreign targets. In particular, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{E0}$; it chooses *Export* if $\varphi^{E0} \leq \varphi^{\sigma-1} < \varphi^{EM}$; it chooses *M&A* if $\varphi^{EM} \leq \varphi^{\sigma-1} < \varphi^{GM}$; it chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{GM}$.

Case 4.1.1.2. $\varphi^{EG} < \varphi^{EM}$.

If *M&A* becomes more profitable than *Export* at a higher level of core quality than *Greenfield investment*, *M&A* cannot be optimal. Thus, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{E0}$; it chooses *Export* if $\varphi^{E0} \leq \varphi^{\sigma-1} < \varphi^{EG}$; it chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{EG}$.

Case 4.1.2. $\varphi^{E0} < \varphi^{G0} \leq \varphi^{M0}$.

M&A cannot be optimal as this activity provides lower returns than *Greenfield investment* but becomes profitable at a higher level of core quality. In this case, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{E0}$; it chooses *Export* if $\varphi^{E0} \leq \varphi^{\sigma-1} < \varphi^{EG}$; finally, firm chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{G0}$.

Case 4.1.3. $\varphi^{M0} \leq \varphi^{E0} \wedge \varphi^{M0} < \varphi^{G0}$.

In this case, *Export* cannot be optimal. This is due to the fact that *Export* provides lower returns than *M&A* but requires a larger level of core quality to become profitable. Therefore, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; firm chooses *M&A* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{GM}$; finally, firm goes for *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{GM}$.

Case 4.1.4. $\varphi^{G0} \leq \min\{\varphi^{E0}, \varphi^{M0}\}$.

Only *Greenfield investment* can be optimal since it provides higher returns to core quality than other alternatives and, at the same time, becomes profitable at a lower level of quality. In particular, firm chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{G0}$ and stays out otherwise.

Case 4.2. $f^E \geq f^M \wedge \bar{f}^G > f^M$.

In this case, *Export* cannot be optimal as it provides lower profits than *M&A* for any level of core quality.

Case 4.2.1. $\varphi^{G0} > \varphi^{M0}$.

In this case, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; it chooses *M&A* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{GM}$; it chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{GM}$.

Case 4.2.2. $\varphi^{G0} \leq \varphi^{M0}$.

In this scenario, only *Greenfield investment* can be optimal. Therefore, firm chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{G0}$ and stays out otherwise.

Case 4.3. $f^M \geq \bar{f}^G > f^E$.

In this case, *M&A* cannot be optimal as it is dominated by *Greenfield investment*. Indeed, *Greenfield investment* yields higher returns to core quality than *M&A* does at a lower fixed cost.

Case 4.3.1. $\varphi^{G0} > \varphi^{E0}$.

In this case, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{E0}$; it chooses *Export* if $\varphi^{E0} \leq \varphi^{\sigma-1} < \varphi^{EG}$; it chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{EG}$.

Case 4.3.2. $\varphi^{G0} \leq \varphi^{E0}$.

In this case, only *Greenfield investment* can be optimal. This happens because this action provides higher returns than *Export* and becomes profitable at the lower level of core quality. In particular, firm chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{G0}$ and stays out otherwise.

Case 4.4. $\bar{f}^G \leq \min\{f^E, f^M\}$.

In this case, *Greenfield investment* dominates *Export* and *M&A*. In particular, firm chooses *Greenfield investment* if $\varphi^{\sigma-1} \geq \varphi^{G0}$ and stays out otherwise.

Case 5. $\Delta^M > \Delta^E > \Delta^G$.

In this case, we assume that *M&A* provides the largest return to core quality; middle-range return is provided by *Export*; finally, the lowest return to core quality corresponds to *Greenfield investment.*

Case 5.1. $f^M > f^E > \bar{f}^G$.

For the given structure of entry costs, all three alternatives can be optimal for some level of core quality.

Case 5.1.1. $\varphi^{G0} < \varphi^{E0} < \varphi^{M0}$.

Firm's choice as a function of core quality is driven by the ordering of the cutoffs for switching between from *Greenfield investment* to either *M&A* or *Export.*

Case 5.1.1.1. $\varphi^{GM} \geq \varphi^{EG}$.

In this case, all entry types can be optimal for some level of core quality. In particular, the firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{G0}$; it chooses *Greenfield investment* if $\varphi^{G0} \leq \varphi^{\sigma-1} < \varphi^{EG}$; firm selects *Export* if $\varphi^{EG} \leq \varphi^{\sigma-1} < \varphi^{EM}$; finally, firm chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{EM}$.

Case 5.1.1.2. $\varphi^{GM} < \varphi^{EG}$.

In this case, *M&A* becomes more profitable than *Greenfield investment* at a lower level of core quality than *Export.* Since *M&A* provides the firm with a higher return to core quality than *Export,* the later cannot be optimal. Hence, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{G0}$; it chooses *Greenfield investment* if $\varphi^{G0} \leq \varphi^{\sigma-1} < \varphi^{GM}$; finally, firm goes for *M&A* if $\varphi^{\sigma-1} \geq \varphi^{GM}$.

Case 5.1.2. $\varphi^{G0} < \varphi^{M0} \leq \varphi^{E0}$.

In this case, *Export* cannot be optimal since it becomes profitable at a higher level of quality than *M&A* which yields higher returns to core quality. Therefore, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{G0}$; it chooses *Greenfield investment* if $\varphi^{G0} \leq \varphi^{\sigma-1} < \varphi^{GM}$; finally, it chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{GM}$.

Case 5.1.3. $\varphi^{E0} \leq \varphi^{G0} \wedge \varphi^{E0} < \varphi^{M0}$.

In this case, *Greenfield investment* cannot be optimal. This is due to the fact that *Greenfield investment* provides the firm with a lower return than *Export*, but becomes profitable at a higher level of core quality. Therefore, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{E0}$; firm selects *Export* if $\varphi^{E0} \leq \varphi^{\sigma-1} < \varphi^{EM}$; firm chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{EM}$.

Case 5.1.4. $\varphi^{M0} \leq \min\{\varphi^{G0}, \varphi^{E0}\}$.

In this case, *M&A* provides the firm with the highest return and becomes profitable at a lower level of core quality than the other two alternatives do. Therefore, only *M&A* can be optimal. In particular, firm chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{M0}$ and stays out otherwise.

Case 5.2. $\bar{f}^G \geq f^E \wedge f^M > f^E$.

In this case, *Greenfield investment* cannot be optimal as this option is dominated by *Export*.

Case 5.2.1. $\varphi^{M0} > \varphi^{E0}$.

In this case, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; it chooses *Export* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{EM}$; it chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{EM}$.

Case 5.2.2. $\varphi^{M0} \leq \varphi^{E0}$.

Since *M&A* gives a higher return to core quality than *Export* and, at the same time, becomes profitable at a lower level of quality, *Export* cannot be optimal. In particular, firm chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{M0}$ and stays out otherwise.

Case 5.3. $f^E \geq f^M > \bar{f}^G$.

In this case, *Export* cannot be optimal as it provides the firm with a lower profit than *M&A* for any level of core quality.

Case 5.3.1. $\varphi^{M0} > \varphi^{G0}$.

In this case, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{G0}$; firm picks *Greenfield investment* if $\varphi^{G0} \leq \varphi^{\sigma-1} < \varphi^{GM}$; it chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{GM}$.

Case 5.3.2. $\varphi^{M0} \leq \varphi^{G0}$.

In this case, only *M&A* can be optimal since this option yields the largest return and becomes profitable at a lowest level of core quality than *Greenfield investment* and *Export* do. In particular, firm chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{M0}$ and stays out otherwise.

Case 5.4. $f^M \leq \min\{\bar{f}^G, f^E\}$.

In this case, *M&A* provides the firm with higher profit than other alternatives for any level of quality. Therefore, firm chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{M0}$ and stays out otherwise.

Case 6. $\Delta^M \geq \Delta^G \geq \Delta^E$.

In the last case, we assume that *M&A* gives the largest return to core quality, followed by *Greenfield investment* and *Export*.

Case 6.1. $f^M > \bar{f}^G > f^E$.

In this scenario, all three alternatives can be optimal as higher returns to core quality is associated to higher entry costs.

Case 6.1.1. $\varphi^{E0} < \varphi^{G0} < \varphi^{M0}$.

In this scenario, *Export* becomes profitable before *Greenfield investment* and *M&A*. Hence, the possibility of engaging in each of the alternatives crucially depends on the relative position of the cutoffs for switching from *Export* to either *Greenfield investment* or *M&A*.

Case 6.1.1.1. $\varphi^{EM} \geq \varphi^{EG}$.

In this case, middle-range quality firms find it profitable to conduct greenfield investment. Thus, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{E0}$; it chooses *Export* if $\varphi^{E0} \leq \varphi^{\sigma-1} < \varphi^{EG}$; it selects *Greenfield investment* if $\varphi^{EG} \leq \varphi^{\sigma-1} < \varphi^{GM}$, finally, firm chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{GM}$.

Case 6.1.1.2. $\varphi^{EM} < \varphi^{EG}$.

Since the level of quality that makes *M&A* more productive than *Export* is lower than the level of quality required for *Greenfield investment* to be more productive than *Export*, *Greenfield investment* is not optimal. Therefore, firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{E0}$; it chooses *Export* if $\varphi^{E0} \leq \varphi^{\sigma-1} < \varphi^{EM}$; finally, it goes for *M&A* if $\varphi^{\sigma-1} \geq \varphi^{EM}$.

Case 6.1.2. $\varphi^{E0} < \varphi^{M0} \leq \varphi^{G0}$.

In this case, *Greenfield investment* cannot be optimal as this activity becomes profitable at a larger level of quality than the one at which *M&A* does. In particular, firm decides to stay out if $\varphi^{\sigma-1} < \varphi^{E0}$; firm chooses *Export* if $\varphi^{G0} \leq \varphi^{\sigma-1} < \varphi^{EM}$; firm goes for *M&A* if $\varphi^{\sigma-1} \geq \varphi^{EM}$.

Case 6.1.3. $\varphi^{G0} \leq \varphi^{E0} \wedge \varphi^{G0} < \varphi^{M0}$.

In this scenario, *Export* cannot be optimal due to the fact that it provides lower returns than *Greenfield investment* but requires a higher level of quality to be profitable.

Therefore, firm decides to stay out if $\varphi^{\sigma-1} < \varphi^{G0}$; it chooses *Greenfield investment* if $\varphi^{G0} \leq \varphi^{\sigma-1} < \varphi^{GM}$; finally, firm chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{GM}$.

Case 6.1.4. $\varphi^{M0} \leq \min\{\varphi^{E0}, \varphi^{G0}\}$.

In this case, only *M&A* can be optimal since this is the alternative yielding the highest return and becomes profitable at a lower level of quality than the other two options. Thus, firm chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{M0}$ and stays out otherwise.

Case 6.2. $f^E \geq \bar{f}^G \wedge f^M > \bar{f}^G$.

In this case, *Export* gives lower profits than *Greenfield investment* for any level of core quality and, thus, it cannot be optimal.

Case 6.2.1. $\varphi^{M0} > \varphi^{G0}$.

Firm chooses to stay out if $\varphi^{\sigma-1} < \varphi^{M0}$; it chooses *Greenfield investment* if $\varphi^{M0} \leq \varphi^{\sigma-1} < \varphi^{GM}$; it chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{GM}$.

Case 6.2.2. $\varphi^{M0} \leq \varphi^{G0}$.

In this case, only *M&A* can be optimal as it becomes profitable at a lower level of core quality than *Greenfield investment* but also gives higher returns. Hence, firm chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{M0}$ and stays out otherwise.

Case 6.3. $\bar{f}^G \geq f^M > f^E$.

In this case, *M&A* dominates *Greenfield investment*.

Case 6.3.1. $\varphi^{M0} > \varphi^{E0}$.

In this case, firm decides to stay out if $\varphi^{\sigma-1} < \varphi^{E0}$; it chooses *Export* if $\varphi^{E0} \leq \varphi^{\sigma-1} < \varphi^{EM}$; finally, it goes for *M&A* if $\varphi^{\sigma-1} \geq \varphi^{EM}$.

Case 6.3.2. $\varphi^{M0} \leq \varphi^{E0}$.

In this case, only *M&A* can be optimal. This happens as *M&A* provides the firm with a higher return to core quality than *Export* does, and it requires lower quality to become profitable. Hence, firm chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{M0}$ and stays out otherwise.

Case 6.4. $f^M \leq \min\{f^E, \bar{f}^G\}$.

In this case, only *M&A* can be optimal as it dominates profits associated to the other two alternatives. Therefore, firm chooses *M&A* if $\varphi^{\sigma-1} \geq \varphi^{M0}$ and stays out otherwise.

N. Sensitivity Analysis for Two Specifications for M&A Parameters

In order to identify the parameters of the model, we need to put restrictions on those parameters affecting M&A profitability. We specify two possible restrictions: (i) the magnitude of synergies is determined by the relative productivity of a firm with respect to the least productive firm in the market, (ii) the medians of the institutional entry costs for the two types of FDI are the same. For each specification, we simulate 10 datasets with 10,000 firms. Each dataset keeps the same parameters, except those related to M&A, across the two specifications. We take the elasticity of substitution $\sigma = 6$ and set demand shifters to $\Phi_{GER} = 100,\ \Phi_{EU} = 90,\ \Phi_{US} = 100,\ \Phi_{RoW} = 80$. Then, we estimate the model using each simulated dataset. The averages of estimated parameters are reported in Table N.1 for the first specification and in Table N.2 for the second one.

Table N.1.: Specification of M&A with $s = 1/a$

Common parameters	True parameters			$s = 1/a$		
Scale parameter of core quality distribution, a	0.4			0.400		
Shape parameter of core quality distribution, γ	8.0			7.899		
S.d. log perceived quality shock, σ_ϵ	0.05			0.051		
S.d. log export-entry costs, σ_{fE}	0.1			0.082		
S.d. log greenfield investment entry costs, σ_{fG}	0.1			0.049		
Country-specific parameters	EU	US	RoW	EU	US	RoW
Median entry cost with export, $\exp(f^E)$	0.091	0.067	0.050	0.087	0.066	0.051
Iceberg trade costs, τ	1.020	1.050	1.070	1.027	1.052	1.072
Median log perceived quality shocks, $\exp(\mu_\epsilon)$	0.970	0.905	0.932	0.974	0.907	0.934
Median institutional entry costs with greenfield FDI, $\exp\left(\bar{f}^G\right)$	0.082	0.050	0.030	0.080	0.050	0.030
Quality price for greenfield FDI, α^G	0.100	0.200	0.300	0.126	0.201	0.311
Median institutional entry costs of M&A, $\exp\left(\bar{f}^M\right)$	0.100	0.050	0.010	0.098	0.050	0.011
Scale parameter of M&A quality distribution, a^M	0.350	0.300	0.310	0.349	0.299	0.311

Table N.2.: Specification of M&A with $\bar{f}^M = \exp\left(\bar{f}^G\right)$

Common parameters	True parameters			$\bar{f}^M = \exp\left(\bar{f}^G\right)$		
Scale parameter of core quality distribution, a	0.4			0.401		
Shape parameter of core quality distribution, γ	8.0			8.183		
S.d. log perceived quality shock, σ_ϵ	0.05			0.051		
S.d. log export-entry costs, σ_{f^E}	0.1			0.072		
S.d. log greenfield investment entry costs, σ_{f^G}	0.1			0.054		
Country-specific parameters	EU	US	RoW	EU	US	RoW
Median entry cost with export, $\exp(f^E)$	0.091	0.067	0.050	0.086	0.066	0.050
Iceberg trade costs, τ	1.020	1.050	1.070	1.046	1.057	1.071
Median log perceived quality shocks, $\exp\left(\mu_\epsilon\right)$	0.970	0.905	0.932	0.979	0.908	0.935
Median institutional entry costs with greenfield FDI, $\exp\left(\bar{f}^G\right)$	0.082	0.050	0.030	0.079	0.051	0.031
Quality price for greenfield FDI, α^G	0.100	0.200	0.300	0.164	0.201	0.306
M&A synergies, s	2.300	2.500	3.700	2.292	2.509	3.747
Scale parameter of M&A quality distribution, a^M	0.400	0.300	0.200	0.403	0.300	0.203

O. Technical Notes on the Constrained Maximum Likelihood Estimation

In the estimation, we simulate and numerically integrate the likelihood function. We discuss in detail the integration procedure for each dimension of heterogeneity.

Core Quality φ. The core quality φ is drawn independently across firms from a Pareto distribution. We simulate a grid of 50 points in order to integrate the likelihood function with respect to φ. First, we generate 50 random points that come from the different quartiles of the Pareto distribution.

If firm does not acquire a foreign firm in any market, we follow the procedure applied in Tintelnot (2017). In particular, we construct 10 intervals using the following set of points

$$\{0, 0.2, 0.4, 0.6, 0.8, 0.9, 0.95, 0.98, 0.99, 0.999, 1\},$$

and draw 5 points from each interval assuming they constitute the support of a uniformly distributed random variable. This allows us to obtain the corresponding nodes of a Pareto cumulative distribution function. Each node has a weight proportional to the length of the interval. For example, a node from the interval $[0, 0.2]$ enters the estimation with a weight 0.04. Since the underlying distribution of the core quality is Pareto, we attribute more weight to the nodes in the first percentiles of the distribution.

If firm acquires a foreign firm abroad, this implies restrictions on the possible realizations of φ. Recall that in order to estimate the constrained maximum likelihood, we use (i) a transformation of the density of M&A foreign sales into the density of the M&A quality draws, (ii) the restrictions implied by realized M&A sales in order to rewrite the whole problem in terms of φ. In particular, the density of M&A draws reads as $m(\varphi_i/(s\varphi_M)|\varphi; a_i^M, \gamma)$. Since M&A quality draws come from a Pareto distribution, this implies a technical restriction, which makes the likelihood equal to zero when integrating in the regions $\varphi > \varphi_i/(s_i a_i^M)$. In this case, we account for the presence of the technical restrictions of φ realizations that can result in non-zero likelihood and construct the grid for nodes of φ distribution accordingly. In order to do so, we first take the technical upper bound implied by M&A choices for each firm. If M&A is selected as an entry type for several foreign markets, we take the minimum of upper bounds, that is $\bar{\varphi}_{\omega}^{tech} = \min\{\varphi_i/(s_i a_i^M) \mid e_{\omega,i} = M\&A\}$. Then, we compute the value of the Pareto cumulative distribution function for the obtained upper bound and check in which of the previously discussed 10 intervals the value falls. We set the upper bound of this interval to the cdf $\bar{\varphi}_{\omega}^{tech}$ and take all lower quartile intervals as given. To select the number of points to sample from each interval, we weights the *importance* of the interval as a length of the interval relative to its initial length. For example, if $\bar{\varphi}_{\omega}^{tech}$ felt into the second interval, $[0.2, 0.4]$, we will assign weight $(\bar{\varphi}_{\omega}^{tech} - 0.2)/(0.4 - 0.2)$ and weight 1 to the first interval, $[0, 0.2]$. Here we draw nodes using the quasi-random Hatlon number generator to grant more representation of the integration region and to avoid any random component in the realization of the likelihood function. Similarly to the benchmark case without M&A choice, the weights are taken proportionately to the length of the interval. Therefore, for each firm conducting M&A in any of the regions we obtain a firm-specific grid for the numerical integration needed to compute the likelihood function. It is important to note that without this correction we would underestimate likelihood for firms engaged in M&A, as we would sample integration points for φ from the interval where the likelihood is equal to zero.

Export Entry Costs f^E and Institutional Entry Costs for Greenfield Investment $\bar{f}^G$. Entry costs are drawn from a destination-specific log-normal distribution. We simulate 1,000 draws for each entry costs using the quasi-random Hatlon number generator. Recall that we divide the entry choice into two stages. In the first stage, we compute the probability of selecting the observed entry types over entering in all foreign markets with M&A. In the second stage, we condition on the observed choice by using an indicator function of choosing the observed entry type in each region over *No entry*, *Greenfield investment*, and *Export*. Following Train (2009), we approximate the indicator choice function with a smooth, strictly positive function. This is done in order to avoid jumps in the likelihood value across different simulations and make the likelihood function differentiable.

We normalize all profits with respect to the most profitable alternative and use the logit transformation function with a scale factor λ, that is

$$\mathbb{E}\tilde{\Pi}_i^{e_i} = \mathbb{E}\Pi_i^{e_i} - \max\left\{\mathbb{E}\Pi_i^{e_i'}\right\}_{e_i' \in \{0,E,G\}} \text{ and } S^{e_i} = \frac{\exp\left(\mathbb{E}\tilde{\Pi}_i^{e_i}/\lambda\right)}{\sum \exp\left(\mathbb{E}\tilde{\Pi}_i^{e_i}/\lambda\right)}, \tag{O.1}$$

where S^{e_i} approximates the identity function for choice e_i. We note that the limit of the approximated identity function as λ goes to zero is the identity function. Normalization allows us to make λ smaller and therefore increase the precision of the approximation.

To make the estimation procedure consistent for M&A, we use an approach similar to that implemented for the other entry types by adding a noise to $\bar{f}^M$, such that $\tilde{\bar{f}}_i^M = \bar{f}_i^M + \epsilon_i^M$, where ϵ_i^M is drawn from $\mathcal{N}(0, 1\text{E}{-6})$.

Perceived quality shocks ϵ. The perceived quality shocks follow a destination-specific log-normal distribution. We use the closed form of the log-normal expected value.

Quality of M&A Targets φ^M. The quality of M&A targets is drawn independently across markets and firms from a destination-specific Pareto distribution. The integration with respect to M&A quality draws is done at the first stage of the entry choice, when a firm decides whether to enter a market via M&A or via any other entry type. We derive a closed form for the probability of this choice. Here we eliminate the simplification assumed in the footnote 46 that *Greenfield investment* is preferred to *M&A* in the first stage if *M&A* is dominated by *No entry* (when firm has low core quality and it not able to generate positive synergies). This simplification was valid under the fact that *Greenfield investment* is never selected in the second stage being dominated by *No Entry*. However, this is not necessarily true with an introduction of the approximation of the identity function for the second stage entry choice, which can be larger than zero even if *Greenfield investment* yields lower returns than *No Entry*. Accordingly, we take the probability of the first stage as given and revert the cutoff condition, meaning that we compute the probability that the M&A quality draw is large enough to make costs of acquiring a foreign firm large enough for *M&A* to be less profitable that non-profitable *Greenfield investment*.

The constrained maximum likelihood function estimation follows the procedure described by Su and Judd (2012). First, for a given guess of parameters, we invert the sales function in order to obtain the level of the perceived quality which rationalizes the observed in the data foreign sales. Second, we compute the likelihood function and iterate till it is maximized. According to Su and Judd (2012), the proposed approach is asymptotically equivalent to a nested fixed-point approach in terms of results. Similarly to Tintelnot (2017), who implements the proposed algorithm in his estimation, we face the problem that the estimates are bias as the model is estimated on the finite sample of firms. In Appendix N we show that the estimates obtained with a proposed algorithm are close to the true parameters of the data generation process.

We maximize the likelihood with the simulated annealing algorithm together with the hybrid global maximizing algorithm patternsearch. Same algorithms are used in the calibration of the general equilibrium.

P. Cutoffs for Selecting M&A

To select *M&A* over *No entry* the core quality φ of the firm ω should satisfy the following inequality

$$\left(\varphi_i^{0M}\right)^{\sigma-1} \geq \frac{r_{\omega,i}}{s_i^{\sigma-1}\left[r_{\omega,i} - \bar{f}_i^M\right]}.$$

However, if the sales realized via M&A, $r_{\omega,i}$, do not exceed the level of the institutional entry costs for M&A $\bar{f}_i^M$ in country i, firm will not be involved in M&A independently on its level of core quality.

To select *M&A* over *Export* the core quality φ of the firm ω should be in the interval

$$\left(\varphi_i^{EM}\right)^{\sigma-1} \in \left[\frac{f_i^E - \bar{f}_i^M + r_{\omega,i} - \sqrt{D_i^E}}{2\Delta_i^E}, \frac{f_i^E - \bar{f}_i^M + r_{\omega,i} + \sqrt{D_i^E}}{2\Delta_i^E}\right],$$

where $D_i^E = \left[f_i^E - \bar{f}_i^M + r_{\omega,i}\right]^2 - 4r_{\omega,i}\Delta_i^E s_i^{1-\sigma}$. If $D_i^E < 0$, then firm will not be involved in M&A independently on its level of core quality.

To select *M&A* over *Greenfield investment* the core quality φ of the firm ω should be in the interval

$$\left(\varphi_i^{GM}\right)^{\sigma-1} \in \left[\frac{f_i^G - \bar{f}_i^M + r_{\omega,i} - \sqrt{D_i^G}}{2\tilde{\Delta}_i^G}, \frac{f_i^G - \bar{f}_i^M + r_{\omega,i} + \sqrt{D_i^G}}{2\tilde{\Delta}_i^G}\right],$$

where $D_i^G = \left[f_i^G - \bar{f}_i^M + r_{\omega,i}\right]^2 - 4r_{\omega,i}\tilde{\Delta}_i^G s_i^{1-\sigma}$. If $D_i^G < 0$, then firm will not be involved in M&A independently on its level of core quality.

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Ehrenwörtliche Erklärung

Ich versichere hiermit, dass ich die Dissertation selbstständig und ohne Benutzung anderer als der angegebenen Quellen und Hilfsmittel angefertigt und die den benutzten Quellen wörtlich oder inhaltlich entnommenen Stellen als solche kenntlich gemacht habe. Diese Arbeit hat in gleicher oder ahnlicher Form noch keiner Prufungsbehorde vorgelegen.

Mannheim, den 23.08.2018 Francesco Paolo Conteduca