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Quantifying Adaptation Costs in Sequential FDI Location Choices: Evidence from German Firms[1]

Dong Lu[2]，Aiyong Zhu[3]

Abstract

Initiating foreign direct investment (FDI) is expensive for multinational firms due to the need to adapt to new business practices, ethical norms, and regulations in a foreign country. This paper examines how such adaptation costs affect firms' FDI decisions in current and subsequent periods. We develop a dynamic structural model of how firms make sequential decisions regarding where to invest. Using unique data cover- ing all German firms' FDI from 2002 to 2009, we estimate the model that allows for country-specific adaptation costs and firms' heterogeneous preferences for location at- tributes. The estimation results suggest that the adaptation costs are statistically and economically significant, ranging from 0.9% to 22.4% of a firm's average expected dis- counted profits. If adaptation costs were completely subsidized, firms' FDI location choices would change drastically. Moreover, the average expected discounted profit would increase by 10.9%, not only because of the reduction in adaptation costs but more importantly, due to better matching between firms and locations.

JEL Codes: F14, F23, L23

Keywords: adaptation costs, sequential FDI, location choice, structural estimation

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1.Introduction

Foreign direct investment (FDI) has attracted considerable attention from economists and policymakers. Global FDI grew by 64% in 2021, reaching nearly $1.6 trillion. The outflow of FDI from developed countries accounted for 75% of the total volume, implying that it plays a dominant role in shaping the global economy.[4] Numerous studies on FDI (Carr, Markusen, and Maskus (2001), etc) have empirically explained the fundamental fac- tors that make host countries attractive to multinational corporations (henceforth MNCs). However, little attention has been paid to the determinants of the dynamics of MNCs. FDI process-firms' investment histories can substantially influence their FDI decisions in the cur- rent and subsequent periods. Earlier papers in the management literature (Johanson and Vahlne (1977), etc) have demonstrated that MNCs' global expansion is "a process rooted in uncertainty reduction" through experience accumulation. They also find an interesting sequential FDI pattern: firms in the initial stage of foreign expansion exhibit a strong pref- erence for markets that are culturally and economically similar to their home country. As firms gain international experience, they consider investing in a wider range of locations.[5]

Owing to the enormous variety of business environments across countries, there is a lack of knowledge about foreign cultures, social norms, and legal systems can be a major im- pediment to MNCs' global expansion. Typically, MNCs acquire country-specific knowledge by operating in that local market. Thus, the presence of subsidiaries in a foreign market increases the propensity of multinational firms for subsequent market investment. In this study, we introduce adaptation costs for first-time foreign entrants. to capture the fact that it is expensive for MNCs to adapt to various institutions and economic environments. However, this expensive adaptation process does not need to occur again if firms decide to invest in the same country in the future. The concept of adaptation costs is essentially similar to the entry costs defined in exports in the sense that they are both sunk. However, some fundamental differences remain because of the different ways in which FDI and ex- ports enter foreign markets. The entry costs for exporting primarily involve selling products in a new market, while the adaptation costs in FDI includes establishing and operating a foreign affiliate in a new market. Therefore, we use a more general definition of adaptation costs to highlight the focused FDI entry pattern in this study.

Based on plant-level panel data on German MNCs' outward FDI behavior,[6] we find that there indeed exists a persistent pattern in firms' FDI location choice. MNCs are more likely to continue investing in the country in which they previously invested.4 Thus, a firm's investment history in each market is crucial. A concern is that this persistence in firms' location choices may not be due to a reduction in adaptation costs. by prior experience. Rather, firms have different preferences for locations for unknown reasons unrelated to past decision histories. Thus, heterogeneous preferences across firms must be considered to isolate spurious state dependence (Heckman 1981).

At the firm level, we first establish that the presence of adaptation costs generates observed path persistence in the data after firm heterogeneity is controlled for. We then quantify the magnitude of the adaptation costs using the newly developed methodology from the empirical industrial organization literature. Building on the methodology devel- oped by Berry, Levinsohn and Pakes (1995, 2004) and Gowrisankaran and Rysman (2012), each

[4] Data source: UNCTAD 2022.

[5] Location and country are used interchangeably throughout this paper.

[6] Theoretical studies often break down FDI into horizontal and vertical FDI because of the different incentives. Horizontal FDI is defined as activities in which MNCs produce the same goods and services in multiple countries to serve local markets. Vertical FDI is defined as firms located at different stages of production in different countries employing international factors-price differences. Considering that the bulk of FDI is horizontal rather than vertical, in our dataset, we will focus on horizontal FDI. Details on the definition of FDI can be found in the following section.

location in this model is characterized by a bundle of both observed and unobserved attributes. The profits earned by MNCs are approximated as a function of both location and firm characteristics. To incorporate state dependence into MNCs' FDI location decisions, we propose a dynamic discrete choice model, in which firms sequentially choose a location for FDI to maximize the expected discounted profit considering the adaptation costs. The empirical results show that the adaptation costs vary substantially across locations, ranging from 0.9% to 22.4% of the average expected discounted profits.[7]

Based on these estimation results, we conduct several policy experiments involving FDI promotion schemes. These counterfactuals suggest that firms change their location choices dramatically in response to the subsidization of adaptation costs. Additionally, firms with distinct experience levels respond systematically and differently to different FDI promotional policies. Generally, the expected discounted profit across all firms would increase by 10.9% on average over time if the adaptation costs were completely subsidized. Notably, this increase in profits is largely due to better matching between locations and firms. These findings show that adaptation costs significantly influence firms' FDI location choices, which is particularly important for both host and home countries. For home countries, these results provide new insights into the benefits of subsidizing firms to enter foreign markets. For host countries, a proper short-run promotion policy effectively attracts long-run FDI because of state dependence.

Our paper complements previous studies on how MNCs expand globally (e.g., Johanson and Vahlne (1977), Davidson (1980)). They demonstrate that international expansion is "a process rooted in uncertainty reduction" through the accumulation of relevant types of experience. Barkema et al. (1996), Shaver et al. (1997), and Delios and Henisz (2003) provide empirical evidence for the importance of organizational learning in firms' internationalization, and find that country-specific experiences can help firms reduce entry barriers, such as cultural distance and political hazards for subsequent FDI in the same or related countries. These papers establish persistence in firms' sequential FDI patterns, but they ignore firm heterogeneity that can generate the same observed persistence as experience.[8] In this study, we consider firm heterogeneity to demonstrate that the observed state dependence in the data is indeed driven by adaptation costs.

Most empirical literature on FDI focuses on static settings to study important determinants of the different types of FDI. Carr et al. (2001) show that similarities between market size and economic endowments between countries are important for horizontal FDI, whereas labor costs are relatively more important for vertical FDI. More recent studies investigate the role of firm heterogeneity in productivity for FDI. Examples are Aw and Lee (2008), Yeaple (2009), and Chen and Moore (2010). They find that firms choose their locations for FDI. Productive firms invest in a larger number of foreign countries and can access countries with less attractive attributes. Less-productive firms concentrate only on a smaller set of countries with better location attributes. Tintelnot (2017) develops a general equilibrium model to study the location choices of multinational firms, nesting both export and FDI decisions simultaneously. A tractable static model facilitated the identification of the distribution of fixed costs of establishing foreign production. These large fixed costs can considerably influence firms' globalization strategies.

In the related trade literature, several recent studies have examined the entry patterns of sequential exports, such as Roberts and Tybout (1997), Das, Roberts, and Tybout (2007), and

[7] "average" refers the mean value across all observed German MNCs in the data and over the entire sample period.
[8] For the recent management literature on FDI location choices, see Mart´ı, Alguacil, and Orts (2017), Ting and Gray (2019), Wang, Zhang, and Zhang (2019), Kohlhase and Pierk (2020), Loncan (2021), and Zhu, Sardana, and Tang (2022). For the recent economic literature on FDI location choices, see Barrios, Huizinga, Laeven, and Nicodème (2012), Gumpert, Hines Jr, and Schnitzer (2016), Alfaro and Chen (2018), Chen and Lin (2020) and Alguacil, Mart´ı, and Orts (2023).

Morales, Sheu, and Zahler (2019). They empirically identify a similar persistence pat-tern in dynamic export behavior. Roberts and Tybout (1997) first infer the presence of sunk entry costs from the persistence of export patterns. for Colombian manufacturing firms. Das et al. (2007) structurally estimate the sunk entry costs using the same dataset, and find these costs to be at least $344, 000 (in 1986 U.S. dollars). The estimated sunk costs are interpreted as the average cost of breaking into a new market. This study focuses on the country- specific adaptation costs of FDI. Consequently, firms make decisions about whether to invest and decide which location to enter conditional on engaging in FDI. This is in contrast to the binary decision setting (whether to export) in Das et al. (2007). In addition to the status persistence of exports, Morales et al. (2019) find that the path per- sistence of exports across destination markets and propose an extended gravity model to identify country-level sunk costs in a parametric way. Their model allows for a comprehen- sive choice set (location set)[9] of exporting destinations at the expense of solving the model and implementing a counterfactual policy analysis. We develop a computationally feasible model with additional assumptions based on the nature of entry pattern of FDI. Further- more, we quantify the magnitude of adaptation costs and use it to analyze the impact of counterfactual FDI promotion policy. Finally, all the aforementioned related studies on exports define persistence as firms' current decisions, depending only on the last period's status. By contrast, we define it as a firm's current location choice depending on the last period's decision and all the previous period choices in their investment history. Thus, firms are inclined to engage in FDI at certain locations as long as they have been presented before the current period. This definition of persistence in FDI is consistent with observations in the data that few affiliates exited the market during the sample period.

The main contributions of this study to the FDI literature is twofold. First, we use unique plant-level panel data to empirically validate the existence of adaptation costs, while allowing for firm heterogeneity in their sequential FDI location choices. To the best of our knowledge, this study is the first to identify the path persistence pattern in FDI be- yond previous findings on status persistence in the literature. Second, the newly developed methodology from industrial organizations enables us to quantify the distinct magnitudes of adaptation costs at different locations. Adaptation costs are critical to policy evaluation; however, their magnitudes have not yet been estimated. These costs can be identified only through their nonlinear effects on the dynamic entry patterns of firms in different states, for example, whether to enter a market for the first time. Moreover, using the estimated adaptation costs, we investigate the impact of a series of counterfactual FDI promotion policies for MNCs' FDI reallocation patterns.

The remainder of this paper is organized as follows: Section 2 describes the dataset and presents empirical evidence of the persistence of German firms' sequential FDI pat- terns. Section 3 presents details of the estimated model and discusses how it considers the findings from the data. Section 4 presents our estimation strategy, and identification argu- ments. Section 5 discusses the estimation results and counterfactual analyses, and Section 6 concludes the paper.

2.Data

We use the confidential Microdatabase Direct Investment (MIDI) provided by Deutsche Bundesbank (German Central Bank).[10] The Bundesbank has been collecting annual statis-tics on foreign direct investment stocks in accordance with the provisions of the Foreign Trade and Payments Regulation since 1976. German enterprises and individuals need to re-

[9] The term "choice set" is widely used in the literature of consumer theory. We would switch to the term "location set," which represents the set of available host countries for MNCs in the literature of international trade.

[10] Owing to the confidentiality rule, we cannot show any statistics aggregated for fewer than three German firms.

port their international capital links if the direct investment enterprises abroad meet reporting requirements involving both their total assets and the shareholdings of the associated German parent firm. Reporting thresholds have been altered many times in recent decades owing to changes in Accounting and Reporting Law.[11] The MIDI forms an unbalanced panel dataset[12] at the affiliate level from 1996 onwards. Additionally, since 2002, information on attributes including total assets, turnover, number of employees, and other features of the reporting enterprise has become available. Therefore, the general data description in the next subsection is based on the sample from 1996 to 2009, whereas the sample used for the estimation only covers 2002 to 2009 owing to the availability of parent firms' attributes. The sample ends in 2009 to avoid two potential problems. First, the information of eco- nomic sector for German outward FDI (defined by NACE Rev.1[13]) is available from 1999 to 2009. After that, NACE Rev.1 was superseded by NACE Rev.2 with many changes in economic sectors' classification, especially for non-manufacturing and non-finance German firms. These differences in economic sectors' classification will cause potential distortions in our structural estimation. Second, the landscape of international business has changed dramatically after 2009. There have been many events that would affect FDI flows, such as the China's one-belt-and-one-road initiatives, US-China trade wars, and heightened geopolitical risk in the late 2010s. If we analyze the more recent data of 2010-2019, it would require a reconstruction of the structural model and estimation strategy. Given these potential problems, we are refraining from estimating the same model with extended sample periods.[14]

2.1Definition of FDI

As different types of FDI arise from different incentives, this study focuses on the more prevalent horizontal FDI. While firms in the manufacturing sector can engage in both types of FDI (horizontal and vertical), investments by firms in non-manufacturing industries is often regarded as horizontal FDI because non-tradable products can be consumed only by the local market. No additional information is available to distinguish the purposes of FDI manufacturing firms in the dataset; therefore, we restrict the sample to firms in non-manufacturing industries.[15] Moreover, FDI in this study is defined as a new affiliate over the reporting threshold set by German parent firms. Particularly, shareholding by the parent firm must be larger than 50%; that is, an absolute majority shareholder for the investment to be considered FDI. One concern with this arbitrary cutoff in the shareholdings is whether the sample of the remaining firms is representative of the estimation. To address this concern, we implement a simple t−test for firms' most important characteristic: size, measured by total assets. The results suggest that there are no significant differences in firm size between the full and remaining samples. Hereinafter, "German firms" are German non-manufacturing firms, and both are used interchangeably.

2.2Overview of FDI Pattern

Regarding potential locations for FDI, we focus on most of the OECD countries and China and Hong Kong. We group them in different regions, primarily based on geographical

[11] The reporting threshold in 2002 is relevant to our study. It requires the total assets of subsidiaries larger than 3 million Euro with the share of German parent firms larger or equal to 10%.

[12] The unbalanced panel is driven mainly by new firms entering the sample every year. However, the change in the reporting threshold is another driving factor.

[13] Please see more details in the latest version of the description of the MiDi dataset: https://www.bundesbank.de/resource/blob/745186/8d5a001f3fba76a7b561bb13e3c53821/mL/2021-23- midi-data.pdf

[14] Gumpert et al. (2016) use the same MiDi dataset covering a similar sample period from 2002 to 2008 to study the multinational firm's location choice with the focus on tax haven affiliates.

[15] If the German parent firms are classified as holding companies, the data contain the sector information of their main subgroups, which enables us to group them into manufacturing and non-manufacturing firms.

proximity, cultural similarity, and economic development.[16] The United Nations geoscheme is used as the main grouping criterion. A slight modification is that we include the United Kingdom and Ireland in Western Europe group and leave only nordic countries in the Northern Europe group. This grouping of locations will be used as the basis for defining the regional experience at later stages of the estimation. The United States (USA) and Canada (CAN) are grouped under North America. France (FRA), Austria (AUT), Switzerland (CHE), Belgium (BEL), Ireland (IRL), Luxembourg (LUX), the Netherlands (NLD), and Great Britain (GBR) are grouped under Western Europe. Italy (ITA), Spain (ESP), Greece (GRC), and Portugal (PRT) are grouped under Southern Europe. Poland (POL), the Czech Republic (CZE), Hungary (HUN), and the Slovak Republic (SVK) are grouped under Eastern Europe. Denmark (DNK), Finland (FIN), Norway (NOR), and Sweden (SWE) are grouped under Northern Europe. China (CHN) and Hong Kong (HKG) are grouped under Eastern Asia.[17] Despite this relatively small location set with only 24 locations, it covers approximately 81% of the selected locations for German firms in the sample period.

Given the definition of FDI and the location set used in this study, interesting patterns can be observed in sequential FDI location decisions as listed in Table 1. The first column of Table 1 shows the top 10 locations among all German non-manufacturing firms. The second column presents the top 10 locations for firms that invested only once between 1996 and 2009. The three columns on the right are related to firms that invested more than once, and t0 denotes the year in the sample when firms engage in FDI for the first time. The top 10 locations are concentrated in developed countries, and all but the USA are located in Europe. This observation is consistent with the conventional theory that horizontal FDI is positively correlated with similarities in market size and factor endowments (Carr et al., 2001). In this case, German non-manufacturing firms prefer to establish subsidiaries in countries with high GDP and high GDP per capita. Approximately 60% of firms invested only once during the entire period. Among these firms, the USA is the most preferred investment location. By contrast, the remaining 40% of firms that have invested multiple times choose France and Austria as their top two locations. However, if we focus on the timing (t = t0, t > t0) of FDI decisions, we find that first-time (t = t0) FDI top two location choices are the same as the overall pattern for firms investing multiple times, but in the subsequent periods (t > t0), France and Poland are the top two locations. Top 10 locations, except Belgium, for subsequent investment coincided with the most preferred locations for their first-time decisions, although there is a slight difference between the respective orders.

Table 1: Top 10 locations for different groups of German firms 1996-2009

Overall	Single time	Multiple times		
		overall	$t = t_0$	$t > t_0$
USA	USA	FRA	FRA	FRA
FRA	AUT	AUT	AUT	POL
AUT	CHE	CHE	NLD	AUT
CHE	FRA	NLD	USA	USA
NLD	POL	GBR	GBR	GBR
GBR	NLD	USA	BEL	NLD
POL	GBR	ITA	CHE	CHE
CZE	CZE	POL	ITA	CZE
ITA	HUN	CZE	POL	ITA
ESP	ESP	ESP	CZE	ESP

[16] This grouping approach is consistent with the extended gravity model for exporting used by Morales et al. (2019).

[17] We restrict the location set to be such a small sample because of data availability.

Note: In this table, we present the top 10 attractive host countries for German non-manufacturing firms. In the first column, "Overall" denotes the top countries with the largest number of German subsidiaries, regardless whether German parent firms invest once or more. In the second column, "Single time" denotes the top countries where German parent firms only invested once. In the column of "Multiple times", t0 denotes the first period (year) when the firm engaged in FDI and t > t0 represents that German parent firms engaged in another FDI after the initial period.

As in Table 2, the conditional probability in the second column is significantly higher than another conditional probability in the third column. The contrast between these two conditional probabilities clearly presents an interesting persistence pattern in sequential FDI location choices. In addition, the conditional probability in the second column in less developed countries such as Poland, Czech and China is also very different (higher) compared

to more developed nations. This difference suggests that the level of persistence seems to vary across countries. In general, location attractiveness, firm heterogeneity and adaptation costs are three main sources that could generate the path persistence pattern in the data. If the attractiveness of economic situation is the only incentive for firms to invest in the same location repeatedly over time, firms will engage in FDI in these countries independent of their previous experience. In this case, the two conditional probabilities discussed above should be very close to each other rather than diverging as much as in Table 2. Thus the divergence indicates that location attractiveness is not the only source for observed persistence and the remaining two channels (adaptation costs and firm heterogeneity) play a vital role. However it is very difficult to disentangle adaptation cots from firm heterogeneity based on mere descriptive statistics.

Table 2: Probability of choosing a location given different initial conditions

Location	$Pr(a_{it} = j \mid a_{it_0} = j, t > t_0, a_{it} \neq 0)$	$Pr(a_{it} = j \mid a_{it_0} \neq j, t > t_0, a_{it} \neq 0)$
FRA	0.21	0.08
AUT	0.13	0.06
CHE	0.17	0.06
NLD	0.20	0.06
GBR	0.16	0.08
USA	0.42	0.05
ITA	0.12	0.05
ESP	0.13	0.05
POL	0.39	0.05
CZE	0.27	0.05
China	0.65	0.01

Note: In this table, we present two conditional probabilities with different initial conditions on how German firms make sequential FDI decisions in the most attractive host countries. Variable t0 denotes the first period (year) when firm engaged in FDI. The conditional probability in the second column shows how likely firms are to invest in the same country again given that they have invested in this country in the early periods. The conditional probability in the third column shows how likely firms are to invest in a country given that they have not invested in this specific country in the early periods.

2.3Summary of Data

To elucidate the factors behind the persistence in German firms' sequential FDI decisions, we present additional empirical evidence. In the following empirical analysis, we restrict the sample period to the years from 2002 to 2009 due to the availability of firm attributes. During the sample period of 2002–2009, the most active German non-manufacturing firms that engage in FDI are in the wholesale (23.73%)[18], household-related services (14.24%), real estate (7.92%), retail (4.89%)[19], and business activities (4.68%).

Numerous German non-manufacturing firms, around 88.5%, choose at most one location for FDI every year. Among these firms, 43% never engaged in FDI again from 2002 to 2009 because, as shown in the previous table, most firms only invested once, and these firms invested before 2002. Only 11.5% of firms choose more than one location for FDI in a given year, and we drop these observations to be consistent with the structural choice model described in the following section.[20] Moreover, we also drop firms that have ever invested in

[18] The wholesale sector excludes motor vehicles and motorcycles.
[19] Motor vehicles, motorcycle repair of personal and household goods are excluded from this sector.

[20] There are alternative ways to deal with the multiple choices, i.e., engaging in FDI at more than one location at some year. We can redefine the location set, incorporating all possible combinations of any two locations in the original location set.

locations out of the predetermined location set, i.e., 24 locations;[21] and firms in the financial sector are excluded from the estimation because they may follow a particular path to enter a foreign market due to the certain financial regulations outside the model.

Table 3: Summary of FDI during 2002-2009

Locations(#)	Overall	Timing	Obs(firm-year)
1	14.74%	45.33% $(t = t_0)$	803
		54.67% $(t > t_0)$	969
0	85.26%	-	10247

Note: Column "Locations(#)" denotes the total number of countries of German firms' FDI every year. Column "Overall" denotes the share of Location(#) when equal to 1 and 0, respectively. In the "Timing" column, variable t0 denotes the first period (year) when the firm engaged in FDI. and the associated value represents the share of first-time FDI (t = t0) and subsequent FDI (t > t0). Column "Obs(firm-year)" denotes the total number of observations at the firm-year level.

Table 3 provides summary statistics of the FDI choices in the final sample. The first column presents the total number of locations chosen by German firms in every period. Value 1 represents the observation of an FDI engagement during 2002-2009, which accounts for 14.74% of total observations. Value 0 represents no FDI engagement in the sample period, but these firms invested before 2002, accounting for 85.26% of total observations. Among the firms that invested during 2002-2009, the third column shows that 45.33% engaged in FDI for the first time (t = t0). The associated total number of these new subsidiaries is 803. The remaining 54.67% invested again after the initial period (t > t0). In the final sample, the number of firm-year observations reaches more than 12,000, providing a large sample for estimation.[22]

2.4Empirical evidence of adaptation costs

To address firm heterogeneity and location attributes, a reduced-form regression analysis helps identify the channels influencing the observed persistence in sequential FDI location choices. When firm i sets up a new subsidiary in location j in period t, its latent profit (or attractiveness) $\pi i*jt$ can be approximated using the following equation:

$$\pi^*_{ijt} = F_{ij} + C_j + \beta_1 s_{ijt} + \sum_k \alpha_k x_{jkt} + \varepsilon_{ijt} \qquad (1)$$

where j = {1, . . . , 24} denotes locations, xjkt denotes location attributes: market size (measured by real gdp), GDP per capita (gdppc), economic growth (growth rate), labor cost, average tax rate on profit, unemployment rate, and the institutional features captured by corruption perception index (CI)[23], a higher CI indicates less corruption, Cj denotes the location fixed effect, and firm-location fixed effect (firm heterogeneity) is captured by Fij. Variable experience-country sijt = {0, 1} denotes firm i's experience in this specific location.

But this implies there are potential combination effects between locations to be identified, which is far beyond the framework of this paper.

[21] Therefore, the outside option in the discrete-choice model is the standard no-investment decision, which can be normalized to a constant number.

[22] To address the potential bias of sample selection, we also implement the t−test for firms' size between the original and final sample and do not find any significant difference.

[23] All annual location attributes: gdp, gdppc, growth rate, unemployment rate, and the average tax rate on profits are taken from the World Bank: World Development Indicators. Labor cost is measured by hourly wages in the manufacturing sector in the US $. This is obtained from the Bureau of Labor Statistics. CI is obtained from the Corruption Perceptions Index, Transparency International.

)

If firm i invests in location j before period t, then sijt = 1; otherwise 0. Profit shock εijt follows iid type 1 extreme value distributions across firm locations and times. Therefore, if we observe firm i setting up a new subsidiary at location j in period t, that is, ait = j, it must be that the latent profit in location j is higher than that in any other location for firm i in this period, Since the latent profit πi∗jt is not observable in the data, we will apply McFadden's condi- tional logit model with multiple choice of countries to estimate the equation (2) and it will provide us with estimated parameters in equation (1). For comparison purposes, we also estimate several variants of equation (2). We replace experience-country (sijt) with the variable experience-region (sirt) to determine whether regional experience works in the same direction as country-specific experience.23 sirt = 1 indicates that firm i has invested in at least one country within region r before period t; otherwise, it is 0. In addition, we interact the CI with both regional and country-specific experience. The interaction term captures whether institutional features (CI) has different impacts on the location choices of firms with distinct experience states.

The regression results in Table 4 are based on the observations in which firms invest, because we focus on the factors that determine firm's FDI location choice, conditional on firms making an investment and, in particular, whether experience (adaptation costs) rather than heterogeneity, matters in location decisions. Accordingly, we control for the firm-location pair effect (firm heterogeneity) Fij. The most straightforward way to control for the firm-country effect is to create an interaction between all firm dummies and all country dummies; however, this generates the typical incidental parameter problem in the estimation. Conversely, the coefficient of the experience variable will be upward biased if we completely ignore the fixed effects in the error term. To address this concern, we use dummies for firm type in terms of sector and size to interact with country dummies to control for the firm-country pair effect. Firm size, measured by total assets, can be grouped into three types: Small, medium, and large, and the sectors are divided into financial and non-financial industries among all the non-manufacturing firms.[24] Thus, there are six types of firms in this estimation. This classification implies that we must assume that the firm-country pair effect is constant for firms within each type; that is, there is no other unobserved firm heterogeneity within each type. The estimation results under this approach are presented in columns S2 to column S4 in Table 4. Another way to fully control for the fixed effect, Fij is used to explore the panel structure suggested by Chamberlain (1980). Chamberlain's technique enables us to control for all time-invariant terms in the conditional logit model, including the observed and unobserved fixed effect. However, Honor´e and Kyriazidou (2000) highlighted that the approach proposed by Chamberlain to control for firm heterogeneity requires strict exogeneity of the observed covariates. It is clearly violated in the current model that the lagged dependent variable (experience) is included in the covariates. Nevertheless, Chamberlain's approach provides a lower bound for the coefficient (β1) of the experience variable (Chintagunta et al., 2001).[25] The corresponding estimation results are presented in Column S5–S7. An alternative method of obtaining a consistent estimator for parameter β1 is to impose an additional assumption about the distribution of Fij; that is, the random effects approach, which is widely used in the literature. The estimation results under the

[24] In the current reduced-form estimation results, we keep financial firms in the sample. As a robustness check, we run the same regression by excluding firms from the financial sector, and the estimation results for the final sample remain similar to the current one.

[25] Chintagunta et al. (2001) compared the method developed by Honor´e and Kyriazidou (2000) using Chamberlain's approach and found that the estimation results under Chamberlain's technique are underes- timated in both the Monte Carlo simulations and real-data applications. It is crucial to show a significantly positive coefficient for firms' country experience, in line with the presence of adaptation costs. Therefore, a lower bound of positive β1 is sufficient to support the fact that adaptation costs account for the observed persistence pattern in firms' sequential FDI location choices even after controlling for firm heterogeneity and location attributes.

random effects approach are presented in the Appendix A.

Table 4: Results of conditional logit model

	S1	S2	S3	S4	S5	S6	S7
gdp	1.0502**	0.9544*	1.0265*	1.1726**	6.5286***	6.6428***	6.5855***
	(0.5163)	(0.5520)	(0.5375)	(0.6131)	(0.0083)	(0.0095)	(0.0093)
gdppc	-0.0172	-0.0007	0.0006	-0.0172	-0.0435***	-0.1084***	-0.0733***
	(0.0460)	(0.0483)	(0.0467)	(0.0446)	(0.0057)	(0.0068)	(0.0065)
growth rate	0.0671*	0.0717**	0.0714**	0.0781**	-0.0147	-0.0222	-0.0444
	(0.0343)	(0.0356)	(0.0356)	(0.0306)	(0.0343)	(0.0341)	(0.0338)
labor cost	0.0076	0.0071	0.0092	0.0160	0.0844***	0.0988***	0.0968***
	(0.0171)	(0.0159)	(0.0157)	(0.0156)	(0.0124)	(0.0125)	(0.0097)
tax rate	-0.1653	-0.7569	-0.8039	-0.9520	-0.3956***	-0.4508***	-0.3067**
	(1.5121)	(1.5085)	(1.5497)	(1.4464)	(0.1148)	(0.0453)	(1.2780)
unemployment	0.0390***	0.0386***	0.0365***	0.0427***	0.0392***	0.0515***	0.0403***
	(0.0117)	(0.0117)	(0.0118)	(0.0139)	(0.0067)	(0.0068)	(0.0065)
CI	0.0474	0.0492	0.1139*	0.1993***	-0.0754	-0.0615	-0.0771
	(0.0638)	(0.0592)	(0.0618)	(0.0773)	(0.0483)	(0.0542)	(0.0413)
experience-country	2.4009***	2.3390***	4.0740***		0.3153***	2.0644***	
	(0.2823)	(0.2695)	(0.4642)		(0.1115)	(0.1856)	
experience-region				4.4256***			1.3931***
				(0.5371)			(0.3263)
experience-country*CI			-0.2460***			-0.2424***	
			(0.0420)			(0.0276)	
experience-region*CI				-0.3349***			-0.1853***
				(0.0463)			(0.0408)
C FE	✓	✓	✓	✓	✓	✓	✓
C FE*sector FE		✓	✓	✓	✓	✓	✓
C FE*size FE		✓	✓	✓	✓	✓	✓
Unobserved FE					✓	✓	✓
$-L$	-7543.68	-7534.02	-7399.13	-7655.64	-173.43	-173.37	-173.07

Notes: "gdp" and "gdppc" denote Gross Domestic Product (GDP) and GDP per capita, respectively. "growth rate" denotes annual percentage of growth rate of GDP at market price based on constant local currency. "labor cost" denotes hourly wages in the manufacturing sector in US $. "tax rate" denotes the average tax on income, profits, and capital gains. "unemployment" denotes the share of the labor force that is without work but available for and seeking employment. "CI" denotes corruption perceived index. "experience-country" is an indicator, which equals to 1 if the firm invested in this specific country before period t, otherwise 0. "experience-region" is also an indicator and it equals to 1 if the firm invested in at least one country within the region before period t, otherwise equals 0. "C FE", "sector FE" and "Unobserved FE" denote country fixed effect, sector fixed effect and all other fixed effect, respectively. ***, ** and * denote significance at the 1, 5 and 10 percent level, respectively.

Table 4 presents estimated coefficients from the conditional logit model. We can see that market size[26] has a significantly positive effect on firms' FDI location decisions, which supports the theory of horizontal FDI in which firms make investments to maximize profits in the local market. Another important factor in a firm's previous experience in a specific country is highly significant and has a positive effect, as expected, for all specifications. Thus, conditional on firms making a new investment, firms are more likely to choose the same location for that FDI as where they have invested before. Variable experience-region represents whether firms have experience in any country within the same region, as defined in the previous section. Significant positive effects from the regional experience also confirms the previous literature on MNCs' globalization patterns. Owing to the similarity in culture and institutional systems, as well as proximity in geography, the regional experience

[26] The growth rate is a one-period lagged value, and all the other variables are the current values.

has the same effect on the operating experience of a specific country within the same region.

The interaction term between experience and CI is significantly negative, implying that firms with prior operating experience are less sensitive to institutional features than firms that engage FDI in this country for the first time. The interaction term also corrects the sign of CI in specification S2-S5, although this is not significant. The higher CI is, the less corruption there is; thus, firms are more likely to invest, leading to a positive sign of CI.[27] The regional experience is a perfect substitute for the specific country experience in this aspect. After controlling for the additional unobserved firm-country fixed effects in specification S5–S7, both country-specific and regional experience, as well as gdp maintain the positive and significant effects, which have the same sign as the results for S1–S4. The significantly negative coefficients for the interaction between experience and CI also indicates that institutional entry barriers can be reduced by the former's presence in the country or that region. In addition to the consistent sign, differences in the parameter scales arise under the two different approaches. The coefficient of experience is considerably smaller than those of S2–S4. This suggests that an unobserved heterogeneity persistent over time may confound the experience effect it is not considered. However, it could also be due to an underestimation bias when applying Chamberlain's technique (Chintagunta et al., 2001). Nevertheless, the positive effects of country-specific and regional experiences remain highly significant. All significance is achieved after controlling for the location fixed effect and firm-location pair effect (firm heterogeneity) under different approaches. This result provides convincing evidence of the presence of adaptation costs, i.e., MNCs incur huge costs by adapting to different business practices, legal systems, etc. when entering a foreign country for the first time. Valuable experience from prior operations enables firms to more easily adjust to local market environment if they invest in the same country.

Rather than using a dummy variable—whether the firm has operated in the previous location or region—we use another measure to represent country-specific and regional experience: The time span of a firm that has been present in the country or region before we observe another new FDI in our data. This new measure yields similar and robust results, as shown in Table 4. In summary, the empirical evidence establishes that experience in both specific countries and regions has a positive effect on firms' subsequent FDI location decisions, owing to the elimination of adaptation costs. This result is consistent with the findings of firms' dynamic export behavior Morales et al. (2019).

3.Model

Based on previous empirical evidence, we present a structural model in this section that accounts for the experience effects. Building upon the methodologies developed by Berry et al. (1995, 2004) and Gowrisankaran and Rysman (2012), we comprehensively incorporate the presence of adaptation costs and firm and country heterogeneity into this structural model. The timing of the decision process is as follows: at the beginning of each period, firms observe all the necessary information that affects their profits. This information includes observed and unobserved (to researchers) exogenous location characteristics that are common to all firms. It also includes firms' own FDI history, including the countries they have invested in before, the number of subsidiaries in each country, and the firms' own profit shocks. After forming an expectation of the relevant future information, firms decide whether to engage in FDI. They must also select the location for FDI conditional on investing to maximize the expected discounted profits. There is no strategic interaction between firms, and profit flow is realized at the end of each period. Moreover, we also abstract from the decision to exit production and instead focus on the investment decision for the location

[27] The insignificant coefficient of CI may imply the presence of the contrast forces in Egger and Winner (2005).

choice. This is because we observe that only 3% of the German parent firms, on average, have their subsidiaries exiting the markets in the dataset.[28] Finally, firms are assumed to engage FDI in at most one location every period in this parsimonious model, because we observe only 11.5% of firms selecting more than one location during the entire sample period. Moreover, there is no systematic size difference between these firms and the remaining firms based on the distribution observed in the sample. Notably, this exclusion does not reduce the power to identify the presence of the adaptation costs.

Firm i's profit flow in period t, πit is given by

$$\pi_{it} = \begin{cases} -\eta_j \mathbb{1}_{(n_{ijt-1}=0)} + f_i(\vec{X}_{jt}, n_{ijt}) + \varepsilon_{ijt} + \sum_j n_{ijt} f_i(\vec{X}_{jt}, n_{ijt}) & \text{if } a_{it} = j \\ \sum_j n_{ijt} f_i(\vec{X}_{jt}, n_{ijt}) + \varepsilon_{i0t} & \text{if } a_{it} = 0 \end{cases} \tag{3}$$

where

$$\begin{aligned} f_i(\vec{X}_{jt}, n_{ijt}) &= \sum_k (\bar{\alpha}_k + \sum_r \tilde{\alpha}_{kr} z_{irt}) x_{jkt} + \xi_{jt} - \alpha_I I_t - \alpha n_{ijt} \\ &= \sum_k \bar{\alpha}_k x_{jkt} + \xi_{jt} - \alpha_I I_t + \sum_k \sum_r \tilde{\alpha}_{kr} z_{irt} x_{jkt} - \alpha n_{ijt} \end{aligned} \tag{4}$$

Generally, πit is composed of two parts: the profit from the new subsidiary set up in this period (−ηj1(nijt−1=0) + fi(X→ jt, nijt) + εijt) and the profit from existing subsidiaries (j nijtfi(X→ jt, nijt)). ηj denotes the adaptation costs in location j and is assumed to be a fixed cost constant over time, but differs across countries. The variable nijt = {0, 1, . . . , n¯} is the total number of affiliates belonging to firm i at location j at the end of period t; n denotes the finite upper bound for the total number of affiliates. Notation 1(nijt−1=0) is an indicator function, equal to 1 if nijt−1 = 0, otherwise it is 0. If firm i sets up a subsidiary in location j in period t for the first time, that is, nijt−1 = 0, then it must pay the costs ηj to start a new business there. However, if firm i has been operating before this period, it does not need to incur adaptation costs again in the same location, that is, nijt−1 > 0. In principle, some additional fixed startup costs need to be incurred when a new subsidiary is set up by the parent firms, independent of their experience in the local market. However, because we focus on the non-manufacturing parent firms, the additional startup costs for their new subsidiaries are trivial in the magnitude compared with manufacturing parent firms. For example, when the wholesale/retail parent firms set up subsidiaries abroad for the first time, they must pay adaptation costs to enter a new market. However, the additional fixed startup costs are neglectable compared with annual business expenses in property renting, employee salaries and others.[29] These variable costs are approximated using the observed and unobserved location attributes in the profit function.

[28] To reconcile with the fact that there exists, although a small percentage of subsidiaries exiting from the market, we could incorporate an exogenous exiting rates for every subsidiary at all locations in the current model. The estimation results remain robust.

[29] The identification of adaptation costs does not depend on the presence of fixed startup costs in the profit function. Please find detailed arguments in the identification subsection.

he right arrow above the variable denotes the vector. Hence Xjt represents the at- tributes in location j, comprising the observed characteristics {xj1t, . . . , xjkt}, similar to the control variables as in equation (1) and unobserved (to researchers) characteristics ξj such as the business operating costs incurred in each period, which are constant for all firms. Variable It is the interest rate in the domestic country (Germany) used to capture the common macroeconomic profit shock (or opportunity cost) for all firms.[30] εijt is the random profit shock across firms, locations, and time, following an independent identical type 1 extreme value distribution.[31] If firm i does not engage in FDI in this period, it earns a profit only from existing subsidiaries plus the iid profit shock εi0t with the same distribution as εijt. The function fi(X→ jt, nijt) captures the deterministic profit flow generated by each of firm i's subsidiaries at location j in period t, depending on the location attributes and firm attributes (zirt).[32] Its parametric form shows how firm heterogeneity affects the profits given the same location attributes. Specifically, firms attributes also consist of observed and unobserved components, zi1, zi2t, both of which interact with location attributes.[33] The ob- served characteristics zi1 without the subscript t is to model persistent firm heterogeneity, and it is measured by firm's size in terms of total assets; whereas zi2t represents the unob- served heterogeneity, e.g., the productivity of the firm. The unobserved component differs across firms and over time, which can be interpreted as a time-varying productivity shock for each firm. We assume that there are two types of productivity shock: low and high. The productivity shock is assumed to follow a simple Bernoulli distribution (with probability λ as less productive) iid across firms and over time.[34] Given the simple iid distribution of productivity shocks, the parameter λ can be regarded as the average share of less productive firms over time. Another feature of this profit function is that it includes the term nijt and its coefficient α to capture diminishing returns to total investment, because there always exists an upper bound $\bar{n}$ for every firm observed in the data. The parameter α is expected to be positive, implying that firms are less likely to set up a new affiliate abroad where they already have numerous subsidiaries.[35]

The expected discounted profit, that is, the value function of firm i in period t is given by:

$$V_i(\vec{\varepsilon}_{it}, \vec{n}_{it-1}, \Omega_t) = \max_{a_{it} \in \{0,1,\ldots,J\}} \pi_{it} + \beta E[V_i(\vec{\varepsilon}_{it+1}, \vec{n}_{it}, \Omega_{t+1}) | \Omega_t, \vec{n}_{it-1}] \qquad (5)$$

where the state variables in firm i's value function Vi(→εit, →nit, Ωt) are the vectors of profit shock: →εit = {εi0t, . . . , εiJt}, a vector of the number of subsidiaries in each location before period t: →nit−1 = {ni1t−1, . . . , niJt−1} and the exogenous information set Ωt including the location attributes in all locations and firm characteristics. ait is the choice variable in which firm decides whether to invest and the location in which to invest, conditional on making an investment (ait 0) after observing the location attributes and

[30] The interest rate in domestic country refers to the real one-year lending rate.

[31] This random profit shock is observed by firms when they make the decision, but unobserved to re- searchers. In this sense, the unobserved is only from researchers' perspectives throughout this study.

[32] Note that the deterministic profit flow generated by existing and new subsidiaries are both equal fi(X→ jt, nijt), only differing in whether they involve adaptation costs. Thus, function fi(X→ jt, nijt) can be regarded as the average profit flow per subsidiary of the parent firm.

[33] We use the interaction term to capture profit heterogeneity of different firms in the same destination country. Many recent papers consider both firm characteristics and country attributes, as well as their interaction terms, in their empirical studies. For instance, Chen and Moore (2010) interact firm-level char- acteristics with host country attributes (page 195, Table 5), and find that in countries such as Germany, UK, Spain, Belgium, US and China where the estimated attractiveness is high, the effect of firm's TFP on the location choices is relatively small.

[34] In principle, we could extend the simple two-type distribution to multiple types, even to a continuum- type distribution. However, this requires the assumption of a known distribution and increases the compu- tational burden exceptionally when estimating the continuum case.

[35] The linear function is a parsimonious way to model the effect of diminishing returns. Of course, one can use a more sophisticated function form, but we find the linear function is a simple and representative way to handle it.

realized profit shock. Due to the arbitrary high-dimensional state space, solving the above Bellman equation is computationally unfeasible.[36] As it is necessary to solve the Bellman equation infinitely many times, to search for the optimal parameters in the late estimation stage, we must impose additional assumptions to transform the original problem into a tractable form. Please find the detailed descriptions in the Appendix B.

4.Estimation and Identification

4.1The Estimator

The most important parameters to be estimated are the adaptation costs ηj and the preference coefficients αik[37], including the mean coefficients of the location attributes, α¯k and random components that vary with firms' attributes, α˜kr,[38] and λ governs the distribution of firms' productivity. There are also nuisance parameters, such as, γi and ρi for firms' beliefs about the evolution of inclusive logit value and the mean profit flow from existing subsidiaries, respectively; σ1i and σ2i are the corresponding variances of belief shocks. The detailed estimation procedure can be found in the Appendix C.

4.2Identification

As the discount factor (β) is not identified in the class of the dynamic discrete choice model, we set β = 0.9, which is commonly used in the literature. Given the exogenous discount factor and the parametric form of the profit function, different sources of variation in the data help to identify different sets of parameters in the dynamic discrete choice model (Arcidiacono and Ellickson (2011)). The key to identifying the adaptation cost ηj is that FDI is made by firms entering the country for the first time, because only these firms incur the adaptation costs. Everything else being equal, we should observe that the share of new entrants decreases monotonically with adaptation costs. That implies that a country with high adaptation costs is less attractive to new entrants than a country with low adaptation costs; whereas the decisions made by existing entrants with prior experience in both locations should be independent of the costs. Moreover, the share of experienced firms choosing to invest in existing locations should be larger that of new entrants as long as the reduction in adaptation costs can provide a high compensation for the negative effect of diminishing returns. In summary, the ranking of adaptation costs is identified by the varying percentage of new entrants engaging in FDI across locations, conditional on location characteristics, and the absolute value of adaptation costs is identified by the difference in the share between new entrants and existing entrants conditional on location attributes.[39] As in Berry et al. (1995, 2004), we identify the mean coefficients on the location at- tributes, α¯k and the random component varying with firms' attributes, α˜kr, r = 1, 2 by exploring the variation in the the share of firms that have invested more than once in the same location.[40] Specifically, the coefficient (α˜k1) for the interaction between firm size and market size can be identified by

[36] The vector profit shock →εit can be more than one billion. analytically integrated out according to the assumption of iid type 1 extreme value distribution. However, the total number of all possible combinations of the variable →nit alone is 1424, let alone information set Ωt including the location attributes in all locations.

[37] The term "preference coefficients" is borrowed from consumer theory and it can also be interpreted as parameters of profit attractiveness. We use preference coefficients here to keep the term consistent with theprevious description in this paper.

[38] Allowing all of location attributes to interact with firms' characteristics would provide a very flexible firm heterogeneity, but restricting the interaction with one location attributes makes the estimation tractable. Thus, we only interact the most important variable market size, for horizontal FDI, using both observed and unobserved firms' characteristics to capture firm heterogeneity.

[39] The identification of adaptation costs is independent of the presence of fixed startup costs in the profit function, because both new entrants and existing entrants need to pay the costs of engaging in FDI and they are canceled out in the difference conditional on in the same location.

[40] The two unobserved types of firms iid over time in this paper are a special case of general random coefficients in the discrete choice model, but the identification argument for other parameters form Berry et al. (1995, 2004) still applies.

the variation in the locations chosen by the firms belonging to different size groups. Parameter λ, which governs the distribution of unobserved productivity shocks, can be directly identified from the data. As the unobserved productivity shock is assumed to be iid across firms and over time, then λ is equal to the average share of the unproductive firms observed in the data. The productivity in this paper is defined in the same manner as the parent firm's sales as in Yeaple (2009).[41] Then λ is identi- fied as the average share of firms with below-mean productivity over time. Regarding the the coefficient (α˜k2) for the interaction between the unobserved firm attributes and location attributes, this can be determined by the magnitude of a firm's response to positive produc- tivity shocks. As unobserved firm types follow a Bernoulli distribution, the relatively more productive firms can make better use of market size through that parameter. Therefore, the variation in locations chosen by firms over time helps to identify that parameter. For example, if the mean coefficients were simply zero, the less-productive firms would choose each location with equal probability; however, productive firms would always choose the location with the largest market size over time.

5.Results and Counterfactual Analysis

5.1Estimated Parameters

The estimation results for parameter vectors (Θ1) and (Θ2) are presented in Table 5.[42] The table shows that all variables in Θ1 have expected effects. The significantly positive coefficient of market size (gdp) is consistent with the incentives for horizontal FDI to serve the local market. As Germany is a highly developed country, horizontal FDI by German firms is likely to be attractive to countries with similar economic endowments. This effect is confirmed by the positive coefficient of GDP per capita. Significant negative effects from labor costs and unemployment in the dynamic model suggest that firms prefer locations with low labor costs and good economic prospects, that is, a low unemployment rate. The language dummy equals 1 if the country uses German as its first language and 0 otherwise. It takes the value of 1 for Austria and Switzerland in the sample and 0 for all other countries. The significantly positive sign of language and the negative effect of distance are in line with the conventional theory that firms prefer to invest in more integrated locations in proximity, with everything else being equal. Additionally, the negative coefficient of the interest rate.

[41] Because of the limited information about parent firms' attributes in the data, we could only use sales to define the productivity. Calculating the direct measure of total factor productivity (TFP) requires additional information.

[42] As mentioned in the estimation section, we only need to search Θ2 in the maximum likelihood function. Therefore, the parameters are divided into two groups in the table.

Table 5: Estimation results

Θ_1		Θ_2	
gdp	1.13*	η_{WE}	0.09
	(0.5910)		(0.4300)
gdp per capita	0.01	η_{SE}	0.39**
	(0.0272)		(0.1639)
language (German)	0.96***	η_{NE}	2.33***
	(0.0603)		(0.0913)
CI	0.35	η_{EE}	0.89***
	(0.3309)		(0.1736)
labor cost	-0.37***	η_{NA}	0.49
	(0.1048)		(0.4184)
unemployment	-0.26***	η_{EA}	2.19***
	(0.0817)		(0.6042)
tax rate	-2.45	α	2.50***
	(2.5315)		(0.0421)
interest rate	-7.39***	$\tilde{\alpha}_1$	0.11**
	(2.5944)		(0.0449)
distance	-3.72***	$\tilde{\alpha}_2$	0.03
	(1.0460)		(0.0566)
λ	0.87***		
	(0.3273)		

Notes: “gdp” and “gdppc” denote Gross Domestic Product (GDP) and GDP per capita, respectively. “language” is an indicator equal to 1 if the country uses German as the first language. “CI” denotes corruption per- ceived index. “labor cost” denotes hourly wages in the manufacturing sector in US $. “unemployment” denotes the share of the labor force that is with- out work but available for and seeking employment. “tax rate” denotes the average tax on income, profits, and capital gains. “interest rate” denotes the real one-year lending rate in Germany. “distance” denotes the physical distance between the capitals of FDI country and Germany. λ denotes the share of unproductive firms. Standard errors are reported in the paren- theses. ***, ** and * denote significance at the 1, 5 and 10 percent level, respectively.

in Germany indicates high opportunity costs for German firms investing abroad. Owing to the missing value in the profit tax rate, we use the share of taxes on income, profits, and capital gains of total taxes as a proxy. Although insignificant, the sign of the proxy for the tax rate is negative, as expected. A positive coefficient of CI indicates that low CI is detrimental to FDI. However, its insignificance seems to suggest that firms do not really concern themselves with the corruption index compared with the attraction of other characteristics.[43]

The important parameters Θ2 include the adaptation costs in each region as well as random coefficients. As we aggregate country-specific experience at the regional level for computational ease, the estimated adaptation costs are also at the regional level. Thus, they can be interpreted as common components of the country-specific adaptation costs within the same region. As presented in Table 5, all estimated adaptation costs are significant except in Western Europe and North America.[44] Northern Europe ηNE incurred the highest adaptation

[43] Please recall that, because of the intensive computational burden, we did not directly search for param- eters in Θ1 via MLE; instead, we use the recovered $\bar{\pi}_{jt}$ in the middle-loop optimization to estimate Θ1. It is clear that the total number of observations of $\bar{\pi}_{jt}$ is the product of the number of locations and the length of periods. Because the location set is fixed (24 locations), only the time length can add identification power.

[44] Recall that country-specific adaptation costs within the same region are assumed to be the same for ease of computation. This may partially explain the lack of statistical significance for adaptation costs in Western Europe. Eight countries are grouped in this region. Hence, this large region may contain relatively more variety in the adaptation process compared to any other region. Another reasonable explanation is that German firms did not perceive any significant adaptation costs to

costs for German firms. These results can be understood and validated from two perspectives. First, the top ten attractive locations reported in Table 1 do not include any countries in Northern Europe, regardless of whether they are single or multiple times. This finding indicates that German firms rarely choose these countries for FDI. This is due to either high entry costs or low revenue in the local market. We further calculate the conditional probabilities given different initial conditions, as in Table 2, and find that Northern European countries have relatively high entry costs and low revenue in local markets. Second, we find direct evidence of entry costs in Northern European countries. We obtain FDI restriction data from the OECD dataset. The FDI Regulatory Restrictiveness Index (FDI Index) measures statutory restrictions on foreign direct investment across 22 economic sectors.[45] Table 9 in Appendix C shows that, compared to Japan, the North European countries of Norway, Sweden, and Finland have relatively high FDI restrictions, ranking 24, 25, and 28, respectively, among OECD countries. Overall, northern European countries have higher FDI restrictions, which provides us with further validation of the estimated high adaptation costs.

Table 5 also shows that the adaptation costs in Eastern Asia ηEA are the second highest, and their magnitude is very close to that of the top one, more than 20 times larger than the lowest cost in Western Europe and $\eta W E$. The costs in Eastern Europe (EE) are ranked third, whereas North America ηNA and Southern Europe ηSE are similar to each other in terms of both ranking and magnitude of costs from the German firms' perspective. The ranking of adaptation costs across regions is supported by the identification argument presented in the previous section. As the share of firms entering each market for the first time monotonically decreases with adaptation costs, conditional on location attributes, we observe that on average, 5.1% (highest) of firms without any experience choose countries in Western Europe to engage in FDI annually, whereas it is only 0.5% and 0.47% (lowest) for Northern Europe and Eastern Asia, respectively. As these estimated values themselves do not provide us with any meaning about how large they are economically, we are going to quantify the magnitude of these adaptation costs in terms of the firms' expected discounted profits. We find that these adaptation costs range from 0.9% to 22.4% times the mean value of German firms' expected discounted profits.[46] As shown in the ranking in Table 5, the lowest adaptation costs in Western Europe are the lower bound for the range, and the upper bound is from the highest adaptation cost in Northern Europe.

With respect to parameter α, the significantly positive sign establishes diminishing returns on FDI at the aggregate level. Thus, firms with numerous affiliates abroad are less likely to set up one or more new subsidiaries in any country because this diminishing marginal return decreases the option value generated by the previous operational experience in several countries. The coefficient $\alpha\tilde{}1$ is significantly positive, indicating the presence of persistent heterogeneity in that large firms can earn high profits by making better use of a given market size. Parameter $\alpha\tilde{}2$ is also positive, although insignificant, as expected. This suggests that time-varying productivity heterogeneity may affect a firm's location choice, although the effect is not significant. Generally, all firms engaging in FDI are regarded as more productive than those that serve only domestic markets. However, the significance of $\alpha\tilde{}1$ indicates that the size difference still generates nontrivial heterogeneity among the most productive firms. The heterogeneity among German multinational firms is consistent with recent findings for US firms by Yeaple (2009) and French firms by Chen and

Western Europe and North America.

[45] The FDI Index gauges the restrictiveness of a country's FDI rules by looking at the four main types of restrictions on FDI: 1) Foreign equity limitations; 2) Discriminatory screening or approval mechanisms; 3)Restrictions on the employment of foreigners as key personnel and 4) Other operational restrictions.

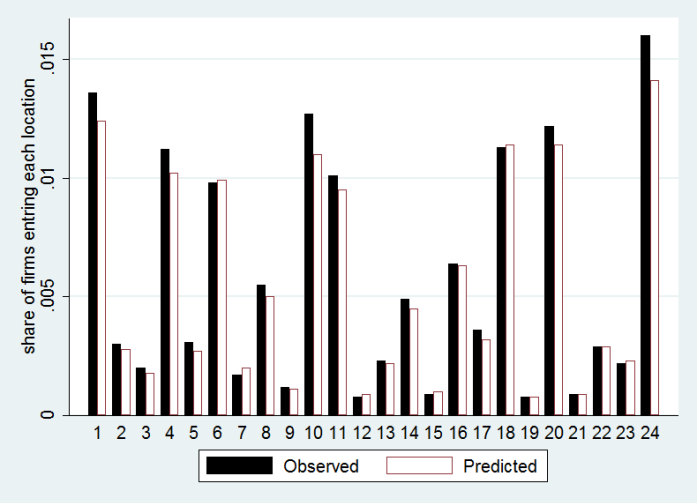
[46] The mean is defined as the arithmetic average value across all firms for the entire data sampling period.

Moore (2010).Finally, parameter λ indicates that, on average, approximately 13% of firms are relatively more productive than others in the data.

5.2Model Fit

Before conducting counterfactual analysis, we present how these estimated parameters fit the data. First, we randomly draw iid profit shocks (εijt) from the type 1 extreme value distribution and then provide the estimated parameters. From the dynamic model, together with exogenous location attributes, firms need to reoptimize each period, that is, choose the best location to engage in FDI to maximize the expected discounted profit. After observing the new FDI choices made by every firm, we can compute the percentage of firms engaging in FDI in each location. By integrating these predicted probabilities for all firms and sample periods, we obtain the predicted share of firms engaged in FDI in each location in every period, which is then averaged over time, as shown in Figure 1. Generally, the estimated parameters fit the data well for all 24 locations. Thus, we use the same estimated parameters for counterfactual analysis in the next subsection.

Figure 1: Model fit



Note: Location 1-24 denotes France, Portugal, Norway, Nether- lands, Sweden, Czech Republic, Luxembourg, Spain, Ireland, Austria, Poland, Greece, Denmark, Hungary, Canada, Italy, Bel- gium, Great Britain, Hong Kong, Switzerland, China, Slovak Re- public, Finland, United States, respectively.

5.3Counterfactual Analysis

Table 6: National regulatory changes 2002-2009

Item	2002	2003	2004	2005	2006	2007	2008	2009
Number of countries that introduced changes	43	59	80	77	74	49	41	45
Number of regulatory changes	94	126	166	145	132	80	69	89
Liberalization/promotion	79	114	144	119	107	59	51	61
Regulation/restriction	12	12	20	25	25	19	16	24

Source: UNCTAD, Investment Policy Monitor database

Table 6 suggests that policy experiments may be useful. In the early 2000s, the overall policy trend favored the continuous liberalization and promotion of foreign investment. Undoubtedly, higher subsidization would make a host country relatively more attractive for FDI, but it remains unclear how multinational firms would reallocate their investment if all countries implemented the FDI promotion scheme to the same extent. Using the structural

model, we can explicitly identify firms' optimal responses under the counterfactual FDI promotion policy associated with the reduction in adaptation costs. However, the methods for reducing the different components of the adaptation cost are not unified. For components involving the business environment and government regulations, the host country can adopt standard international business practices. such as using English as the common working language and reducing regulations to facilitate foreign investment. Other components, such as social culture and legal systems, are quite stable and very difficult to change; however, both home and host countries can provide subsidies that help firms enter local markets.

In brief, we conduct two counterfactuals. First, the adaptation costs are reduced by the same proportion as in the original scale in all countries. Second, adaptation costs are reduced by the same amount in all countries. In each counterfactual, firms are required to re-optimize in response to exogenous changes in adaptation costs. Thus, firms' location choices for FDI can change during a given period. Additionally, firms have different beliefs about the evolution of the state variables, leading to different solutions to the Bellman equation for the counterfactuals: There are two reasons why we are interested in these two different scenarios. First, it is not surprising that countries with the highest adaptation costs would benefit the most from new market share by scaling down the same proportion, simply because of its highest magnitude of reduction. This is true given everything else, such as location attributes, is equal, but we can then compare it with the second scenario to see whether it is really the case if adaptation costs in all countries are reduced by the same amount. Second, we define two distinct groups of firms based on whether they engage in FDI for the first time and will make systematically different responses to the above two counterfactuals. In contrast to the first scenario, the relative attractiveness of locations in terms of per-period profit flows does not change for firms engaging in FDI for the first time in the second scenario because this policy only introduces a constant shift for all alternatives. However, it still affects their location choice through intertemporal linkages, making future investments in the same location relatively less attractive, thus isolating the impact of adaptation costs on the allocation of FDI for these firms. However, it affects both the per-period profit flow and the option value of investing in the same location for firms with operating experience in the second scenario. The firms in both counterfactuals have distinct experience states and could change location choices due to re-optimization in reaction to this policy change. Regarding the timing of FDI, both counterfactuals make investments more attractive than not investing. In summary, both counterfactuals affect firms' decisions about when to invest but induce different behaviors with respect to where to invest in different groups of firms.

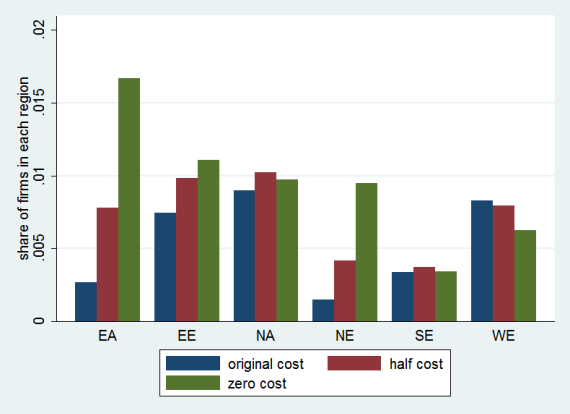
We use the parameters estimated from the dynamic model as true parameters to calcu- late the benchmark expected discounted profit (henceforth EDP) for every firm based on each individual observation in the data. For each counterfactual, we then compute the EDP change, which is essentially a compensating variation that induces an equivalent change in the EDP, considering firms' reoptimizing investment behavior. McFadden (1999) outlines the methodology in standard discrete choice models. However, the random coefficients and dynamic part require an additional calculation step. To deal with the random coefficients, we first calculate the compensating variation separately for each firm type and then inte- grate them over the distribution of types. The dynamics are accounted for by including the continuation value of the profit for every firm. In addition to the change in the EDP, the actual and counterfactual shares of firms entering each location are reported.

5.3.1Counterfactual (1): scale down adaptation costs

In this counterfactual, the adaptation costs in every location are permanently set to half

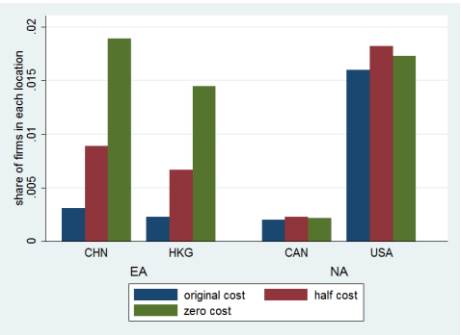
the original scale and zero. That is, policy would eliminate the adaptation cost completely to zero, there are ways to do so, such as subsidies from both hosts and the home country, which can substantially reduce its adaptation costs. Every year during the sampling period, firms face new adaptation costs (ηnew) in every location, and they decide whether to engage in FDI and then select a location conditional on investment to maximize the expected discounted profit.

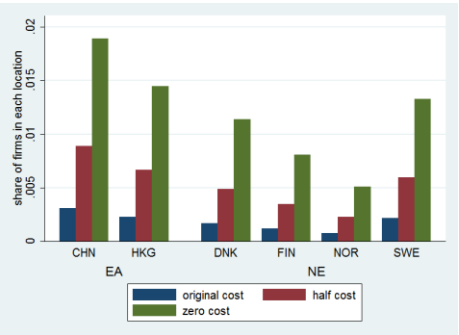
Figure 2: Change of the share in regions if scaling down adaptation costs



Note: EA denotes countries of China and Hong Kong located in Eastern Asia. EE denotes countries of Poland, Czech Republic, Hungary, and Slovak Republic located in Eastern Europe. NA denotes countries of United States and Canada located in North America. NE denotes countries of Denmark, Finland, Norway, and Sweden located in Northern Europe. SE denotes countries of Italy, Spain, Greece, and Portugal located in Southern Europe. WE denotes countries of France, Austria, Switzerland, Belgium, Ireland, Luxembourg, Netherlands and Great Britain located in Western Europe.

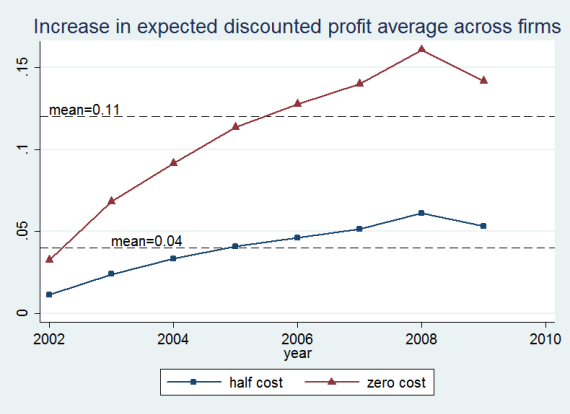
Figure 3: Change of the share in countries if scaling down adaptation costs





(a) Eastern Asia and North America (b) Eastern Asia and Northern Europe Note: CHN and HKG denote China and Hong Kong respectively. CAN and USA denote Canada and United States respectively. DNK, FIN, NOR and SWE denote Denmark, Finland, Norway, and Sweden respectively.

Figure 4: Change of firms' profit if scaling down adaptation costs

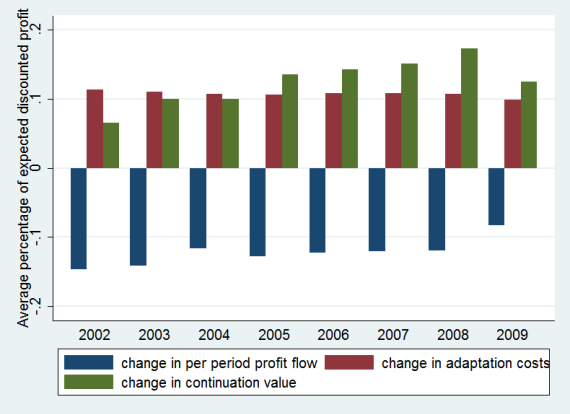


The actual and counterfactual aggregated shares of firms investing in each region and country are reported in Figure 2 and Figure (3), respectively. Countries in all regions, except Western Europe (WE), would become more attractive than in the real world if the adaptation costs everywhere were scaled down (subsidized) to half or zero. For example, in the zero-adaptation cost scenario, the share of firms entering Eastern Asia and Northern Europe rose by more than 10 times on average over the sample period. As expected, these regions would benefit the most from the complete elimination of the largest adaptation costs. However, in addition to the reduction in adaptation costs, it is a new matching process that contributes to the highest expansion. Under this counterfactual with zero adaptation cost everywhere, we observe that 13.1% of the firms would change their location choice on average every period, which implies that most of the variation in counterfactual share comes from new firm location matching. What drives the matching process in this counterfactual depends entirely on location attributes. China has a large market and has enjoyed high economic growth for decades. It would attract most firms that are investing and surpass the USA as the most preferred location for FDI in the absence of adaptation costs as in Figure 3a. By contrast, the share of countries in Western Europe (WE) falls by one- quarter with zero adaptation costs because more attractive countries such as China may provide a better match for firms originally investing in this region. Figure 3b shows the country-level expansion pattern for the regions with the largest adaptation costs. Although adaptation costs in Northern Europe are slightly higher than those in Eastern Asia, complete subsidization of costs would not make countries in Northern Europe more attractive than those in China. This figure reinforces the role of matching channels in counterfactuals, indicating that investments would be attracted to countries with large markets as well as other promising economic conditions.

Regarding the change in profits in this counterfactual, Figure 4 shows that an increase in firms' expected discounted profits increases over time. This increment in profit is also contributed to by the same two sources: the reduction in adaptation costs per se; the other is even more important and comes from the new matching between locations and firms. Moreover, as market size grows exogenously over time, the gap between profit increases also expands under two different levels of reduction in adaptation costs. During the sampling period, the increase in the average expected discounted profits across all firms is 4.0% on average over time if adaptation costs in all countries are scaled down by half, whereas the increase would soar to 10.9% if all adaptation costs are completely eliminated. Figure 5 shows the decomposition of the changes in firms' expected discounted profit under the counterfactual with zero adaptation costs. In the absence of adaptation costs, on average, the first period's profit flows across firms decrease after switching to a new location, but the total profit still increases because of the large compensation generated by the continuation value

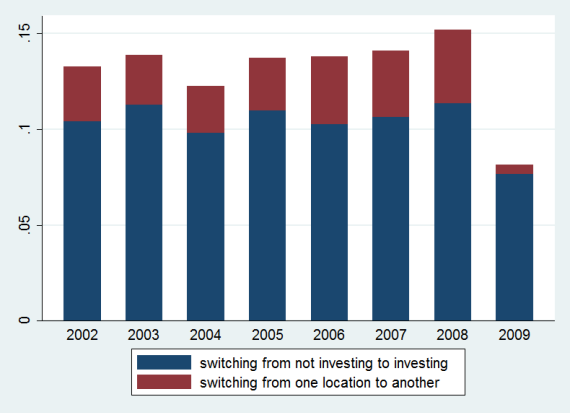
from switching, which eliminates adaptation costs. On average, the elimination of adaptation costs contributes a 10.7% increase in expected discounted profit, whereas a relatively larger contribution comes from an increment in the continuation value of 12.4%.

Figure 5: Decomposition of firms' profit change with zero adaptation cost



Finally, Figure 6 shows how firms would switch locations when adaptation costs are subsidized, as follows: zero in every location. The general switching pattern is that, on average, 13.1% of firms in each period would change their original location choices in the absence of adaptation costs. This average change behavior can be further divided into two types: location change, one of which switches from not investing to investing, and the other switches from one location to another. As shown in Figure 6, most switching patterns are driven by the first type; on average, 10.3% of firms in each period would be motivated to invest again if the adaptation costs were completely subsidized. Combined with Figure 5, the profit flow would be likely to be negative in the period when firms switch from not investing, but the future profit (continuation value) is large enough to compensate for the loss in one period, which implies consistent forward-looking behavior in the dynamic process of a firm's FDI location choice.

Figure 6: Location switching patterns with zero adaptation cost

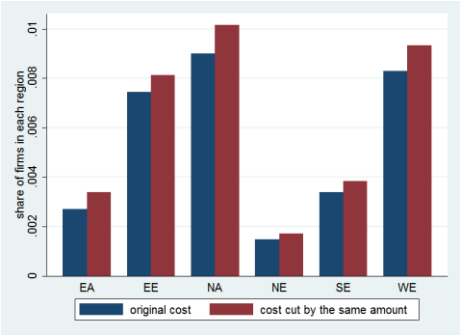


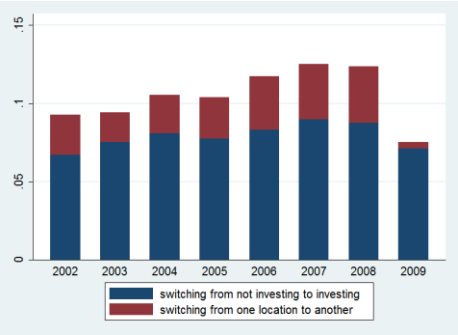
5.3.2Counterfactual (2): all adaptation costs cut by the same amount

Figure 7 shows how firms respond to this policy scenario and the predicted aggregate share of firms investing in each region and switching pattern respectively. In this scenario, all regions begin attracting more firms to their local markets as the average percentage change of firms engaging in FDI are all positive across all regions in Figure 7. However, there is still some variation in the percentage increase among different regions, whereas the difference in

adaptation costs between regions is the same as in the real world. Although Eastern Asia (EA) still has the second largest adaptation costs, a small cost reduction would enable it to enjoy the highest growth rate and attract firms in all regions. However, such a small cut would not make a significant difference in Northern Europe. This also suggests

Figure 7: Counterfactual: all adaptation costs are cut by the same amount





（a）Region (b) Switching Pattern

Note: EA denotes countries of China and Hong Kong located in Eastern Asia. EE denotes countries of Poland, Czech Republic, Hungary, and Slovak Republic located in Eastern Europe. NA denotes countries of United States and Canada located in North America. NE denotes countries of Denmark, Finland, Norway, and Sweden located in Northern Europe. SE denotes countries of Italy, Spain, Greece, and Portugal located in Southern Europe. WE denotes countries of France, Austria, Switzerland, Belgium, Ireland, Luxembourg, Netherlands and Great Britain located in Western Europe.

countries in Eastern Asia (EA) are relatively more attractive for investment between those two regions, in the sense that firms can find a better location for FDI to maximize their expected discounted profits. Under this counterfactual, countries within Northern America (NA) and Western Europe (WE) remain more attractive than others based on the absolute share of firms investing in each region. This implies that location attributes in Eastern Asia (EA) are still insufficient to compensate for the largest adaptation costs.

The right subfigure in Figure 7 presents the location-switching pattern for FDI if adaptation costs are cut everywhere by the same amount. The general share of firms that switch locations is 10.5%, which is approximately 3% less than under the first counterfactual. The decomposition shows that the major change would also be switching from not investing to investing at approximately 7.9% on average over time. A similar switching pattern seems to suggest that intertemporal considerations may be the driving force for location switching. Thus, firms are indeed forward-looking to pursue long-run profits from investing in certain locations. A reduction in adaptation costs by the same amount reduces the benefits of state dependence. Therefore, firms are encouraged to invest in a broad range of countries. In addition, a better match exists between a larger set of host countries. The increase in expected discounted profit, on average across all firms and over time, would be 0.9% in this counterfactual experiment.

6.Conclusion

We develop a dynamic structural model that characterizes firms' decisions regarding when and where to engage in FDI. It embodies uncertainty, observed and unobserved firm heterogeneity in the profit function of FDI, and firms' heterogeneous adaptation costs. We estimate the model based on unique plant-level data on FDI from all German non-manufacturing firms using a newly developed methodology based on an empirical industrial organization. After recovering the adaptation costs, we use them to conduct a counterfactual

FDI promotion policy analysis.

This study focuses on adaptation costs, which strongly affect firms' sequential FDI location choice patterns. The estimation results suggest that these adaptation costs vary across locations and range from 0.9% to 22.4% of the expected discounted profits across all German firms. Consequently, firms do not engage in FDI in new locations unless the expected discounted profit is sufficiently large to compensate for the adaptation costs. They also tend to invest even when their current net profit is negative, thus avoiding the adaptation costs of starting a new business in foreign markets when economic conditions improve. Therefore, history and expectations are crucial for firms to engage in FDI sequentially.

Policy experiments on FDI promotion suggest that a reduction in adaptation costs contributes to an increase in firm profits through two channels. The first channel is the exact amount of increase directly from cost reduction, and more importantly, the second channel is a better matching process between firms and location, which generates the majority of the increment in firms' profits.

References

Alfaro, L. and M. X. Chen (2018). Selection and market reallocation: Productivity gains from multinational production. American Economic Journal: Economic Policy 10 (2),

Alguacil, M., J. Mart´ı, and V. Orts (2023). Firms' characteristics and their international location strategy: Micro-level evidence from european countries. International Review of Economics & Finance 83, 97–113.

Antr`as, P. and S. R. Yeaple (2014). Multinational firms and the structure of international trade. Handbook of international economics 4, 55–130.

Arcidiacono, P. and P. B. Ellickson (2011). Practical methods for estimation of dynamic discrete choice models. Annu. Rev. Econ. 3 (1), 363–394.

Aw, B., Y. and Y. Lee (2008). Firm heterogeneity and location choice of Taiwanese multinationals. Journal of International Economics 75, 167–179.

Barkema, H., J. Bell, and J. Pennings (1996). Foreign entry, culture barriers and learning.
Strategic Management Journal 17, 151–166.

Barrios, S., H. Huizinga, L. Laeven, and G. Nicod`eme (2012). International taxation and multinational firm location decisions. Journal of Public Economics 96 (11-12), 946–958.

Berry, S., J. Levinsohn, and A. Pakes (1995). Automobile prices in market equilibirum.
Econometrica 63 (4), 841–890.

Berry, S., J. Levinsohn, and A. Pakes (2004). Differentiated products demand systems from a combination of micro and macro data: The new car market. Journal of Political Economy 112 (1), 68–105.

Carr, D. L., J. R. Markusen, and K. E. Maskus (2001). Estimating the knowledge-capital model of the multinational enterprise. The American Economic Review 91 (3), 693–708.

Chamberlain, G. (1980). Analysis of covariance with qualitative data. Review of Economic Studies 47 (1), 225–238.

Chen, M. X. and C. Lin (2020). Geographic connectivity and cross-border investment: The belts, roads and skies. Journal of Development Economics 146, 102469.

Chen, X. and M. Moore (2010). Location decision of heterogenous multinationals firms. Journal of International Economics 80, 188–199.

Chintagunta, P., E. Kyriazidou, and J. Perktold (2001). Panel data analysis of household brand choices. Journal of Econometrics 103 (1), 111–153.

Das, S., M. J. Roberts, and J. R. Tybout (2007). Market entry costs, producer heterogeneity, and export dynamics. Econometrica 75 (3), 837–873.

Davidson, W. (1980). The location of foreign direct investment activity: Country characteristics and experience effects. Journal of International Business Studies 11 (2), 9–22.

Delios, A. and W. Henisz (2003). Political hazards, experience, and sequential entry strate gies: The international expansion of Japanese firms, 1980¨c1998. Strategic Management Journal 24, 1153–1164.

Egger, P. and H. Winner (2005). Evidence on corruption as an incentive for foreign direct investment. European journal of political economy 21 (4), 932–952.

Gowrisankaran, G. and M. Rysman (2012). Dynamics of consumer demand for new durable goods. Journal of Political Economy 120, 1173–1219.

Grossman, G. M., E. Helpman, and A. Szeidl (2006). Optimal integration strategies for the multinational firm. Journal of International Economics 70 (1), 216–238.

Gumpert, A., J. R. Hines Jr, and M. Schnitzer (2016). Multinational firms and tax havens. Review of Economics and Statistics 98 (4), 713–727.

Heckman, J. (1981). Heterogeneity and state dependence. Studies in Labor Markets, 91–139.
Helpman, E., M. Melitz, and S. R. Yeaple (2004). Export versus FDI with heterogeneous firms. American Economic Review 93 (1), 300–316.
Hendel, I. and A. Nevo (2006). Measuring the implications of sales and consumer inventory behavior. Econometrica 74 (6), 1637–1673.
Honor´e, B. E. and E. Kyriazidou (2000). Panel data discrete choice models with lagged dependent variables. Econometrica 68 (4), 839–874.
Johanson, J. and J. Vahlne (1977). The internationalization process of the firm-a model of knowledge development and increasing foreign market commitments. Journal of Interna tional Business Studies 8 (1), 23–32.
Jones, J. M. and J. T. Landwehr (1988). Removing heterogeneity bias from logit model estimation. Marketing Science 7 (1), 41–59.
Kohlhase, S. and J. Pierk (2020). The effect of a worldwide tax system on tax management of foreign subsidiaries. Journal of International Business Studies 51, 1312–1330.
Li, S. (2018). A structural model of productivity, uncertain demand, and export dynamics. Journal of International Economics 115, 1–15.
Loncan, T. (2021). The effects of project scale on fdi location choices: Evidence from emerging economies. Management International Review 61 (2), 157–205.
Mart´ı, J., M. Alguacil, and V. Orts (2017). Location choice of spanish multinational firms in developing and transition economies. Journal of Business Economics and Manage ment 18 (2), 319–339.
McFadden, D. (1999). Computing willingness to pay in random utility models. Trade, Theory and Econometrics: Essays in honour of John S. Chipman 15, 253–274.
Morales, E., G. Sheu, and A. Zahler (2015). Extended gravity. The Review of Economic Studies.
Morales, E., G. Sheu, and A. Zahler (2019). Extended gravity. The Review of economic studies 86 (6), 2668–2712.
Nosal, K. (2012). Estimating switching costs for medicare advantage plans. working paper (University of Mannheim).
Roberts, M. and J. Tybout (1997). The decision to export in Colombia: an empricial model of entry with sunk costs. American Eonomic Review 87, 545–564.
Shaver, J., W. Mitchell, and B. Yeung (1997). The effect of own-firm and other-firm experience on foreign direct investment survival in the United States, 1987-92. Strategic Management Journal 18 (10), 811–824.
Shcherbakov, O. (2016). Measuring consumer switching costs in the television industry. The RAND Journal of Economics 47 (2), 366–393.
Ting, A. and S. J. Gray (2019). The rise of the digital economy: Rethinking the taxation of multinational enterprises. Journal of International Business Studies 50, 1656–1667.
Tintelnot, F. (2017). Global production with export platforms. Quarterly Journal of Economics.
Tomiura, E. (2007). Foreign outsourcing, exporting, and FDI: A productivity comparison at the firm level. Journal of International Economics 72 (1), 113–127.
Wang, X., C. Zhang, and Z. Zhang (2019). Pollution haven or porter? the impact of environmental regulation on location choices of pollution-intensive firms in china. Journal of environmental management 248, 109248.
Yeaple, S. R. (2009). Firm heterogeneity and the structure of U.S. multinational activity. Journal of International Economics 78, 206–215.
Zhu, Y., D. Sardana, and R. Tang (2022). Heterogeneity in ofdi by emnes: Drivers and trends of Chinese and Indian firms. International Business Review 31 (6), 102013.

Appendix

A Mixed Conditional Logit Model

Table 7: Results of mixed conditional logit model

	S1	S2	S3	S4	S5	S6	S7
Mean							
gdp	0.1198**	0.1556**	0.1603***	0.0710	1.0503**	1.0475**	1.0024**
	(0.0504)	(0.0606)	(0.0597)	(0.1737)	(0.5163)	(0.5084)	(0.4904)
gdppc	-0.0134	-0.0286**	-0.0305***	-0.0357**	-0.0172	-0.0155	-0.0147
	(0.0098)	(0.0112)	(0.0112)	(0.0143)	(0.0460)	(0.0438)	(0.0384)
growth rate	0.0747***	0.0767***	0.0791***	0.0772***	0.0671*	0.0685**	0.0704**
	(0.0204)	(0.0209)	(0.0219)	(0.0203)	(0.0343)	(0.0340)	(0.0292)
labor cost	-0.0130	-0.0048	-0.0034	-0.0016	0.0076	0.0095	0.0154
	(0.0125)	(0.0123)	(0.0120)	(0.0160)	(0.0168)	(0.0125)	(0.0161)
tax rate	-2.4000***	-3.0526***	-3.0149***	-3.2250***	-0.7699	-0.7080	-0.9004
	(0.6530)	(0.7036)	(0.7002)	(0.9753)	(1.5121)	(1.5355)	(1.3508)
unempt	0.0298**	0.0328***	0.0304**	0.0291*	0.0390***	0.0371***	0.0426***
	(0.0119)	(0.0120)	(0.0118)	(0.0151)	(0.0117)	(0.0119)	(0.0144)
CI	0.1070	0.1114	0.1748**	0.3287***	0.0474	0.1042	0.2017**
	(0.0701)	(0.0710)	(0.0734)	(0.0841)	(0.0638)	(0.0673)	(0.0783)
experience-country	2.4282***	2.3869***	4.0643***		2.4009***	3.9562***	
	(0.2866)	(0.2859)	(0.5213)		(0.2823)	(0.4583)	
experience-region				4.3907***			4.2812***
				(0.0486)			(0.5484)
experience-country*CI			-0.2347***			-0.2206***	
			(0.0459)			(0.0399)	
experience-region*CI				-0.3023***			-0.2932***
				(0.0486)			(0.0483)
C FE	✓	✓	✓	✓	✓	✓	✓
C FE*sector FE		✓	✓	✓			
SD							
C FE	✓	✓	✓	✓			
gdp					0.0025	0.0025	0.0025
$-L$	-7549.85	-7484.30	-7452.69	-7740.97	-7985.68	-7513.97	-7726.99

"gdp" and "gdppc" denote Gross Domestic Product (GDP) and GDP per capita respectively. "growth rate" denotes annual percentage of growth rate of GDP at market price based on constant local currency. "labor cost" denotes hourly wages in the manufacturing sector in US $. "tax rate" denotes the average tax on income, profits, and capital gains. "unemployment" denotes the share of the labor force that is without work but available for and seeking employment. "CI" denotes corruption perceived index. "experience-country" is an indicator, which equals to 1 if the firm invested in this specific country before period t, otherwise 0. "experience-region" is also an indicator and it equals to 1 if the firm invested in at least one country within the region before period t, otherwise equals 0. "C FE" and "sector FE" denote country fixed effect and sector fixed effect, respectively. Firm heterogeneity Fij in equation (1) is modeled to follow independent normal distribution, i.e., Fij ~ N (μj, σj). The associated results are from column S1-S4. For robustness check, we alternatively assume the firm heterogeneity is captured by their ability of generating various profit given the same market size (gdp). Thus we estimate a random coefficient for market size in column S5-S7. In brief, the coefficient for experience in both country and region are significantly positive in all specifications. ***, ** and * denote significance at the 1%, 5% and 10%, respectively.

B Tractable Specification for Value Function

The curse of dimensionality in the discrete choice model above renders dynamic programming approach intractable. To make the original value function solvable for estimation, we first split the state variable →nit into two variables →sit and Nit, where →sit = {si1t, . . . , siJt} with

$$s_{ijt} = \mathbb{1}_{(n_{ijt}>0)}, N_{it} = \sum_j n_{ijt}$$

The key information about which countries a firm has invested in before this period is well preserved by the vector →sit and the variation in this variable helps to identify the adaptation costs in the model. The state variable Nit retains the information of the total number of affiliates in all locations owned by firm i in period t, but loses information about the exact number of affiliates in each location. Therefore, we assume that diminishing returns occur at the aggregate level. Specifically, firms that already have numerous affiliates are less likely to invest in any location, regardless of the distribution of the distribution of →nit across the locations. The estimated parameter α will indicate the restrictiveness of this assumption. That is, if the estimation results show that α is positive and significant, then diminishing returns at the aggregate level indeed exist and effectively affect firms' investment behavior. Based on this assumption, the deterministic profit flow can be written as fi(X→ jt, nijt) = fi(X→ jt, Nit).

The profit flow from existing subsidiaries can be approximated using the new state variables as follows:

$$\sum_{j=1} n_{ijt} f_i(\vec{X}_{jt}, n_{ijt}) = N_{it}\psi_i(\vec{X}_t, \vec{s}_{it}, N_{it})$$

$$\psi_i(\vec{X}_t, \vec{s}_{it}, N_{it}) = \frac{\sum_{j\in\{j:s_{ijt}=1\}} f_i(\vec{X}_{jt}, N_{it})}{\sum_{j\in\{j:s_{ijt}=1\}} 1}$$

where ψi(X→ t, →sit, Nit) represents the mean profit flow from existing subsidiaries across all countries firm i invests in period t. Thus, the total profit flow from existing subsidiaries equals the product of Nit and ψi(X→ t, →sit, Nit).

Given the new state variables →sit−1, Nit, we define the location-specific per-period profit flow πijt (j = 0, 1, . . . , J) from the new subsidiary as follows:

$$\pi_{ijt} = f_i(\vec{X}_{jt}, N_{it}) - \eta_j \mathbb{1}_{(s_{ijt-1}=0)} + \varepsilon_{ijt} \quad (6)$$

$$f_i(\vec{X}_{jt}, N_{it}) = \bar{\pi}_{jt} + \sum_k \sum_r \tilde{\alpha}_{kr} z_{irt} x_{jkt} - \alpha N_{it} \quad (7)$$

$$\bar{\pi}_{jt} = \sum_k \bar{\alpha}_k x_{jkt} + \xi_{jt} - \alpha_I I_t \quad (8)$$

where π¯jt denotes the mean profit constant for all firms. Thus, the profit flow (πijt) from the new subsidiary set up by firm i in location j in period t can be decomposed into two parts: one is π¯jt, a constant for any firm and the other varies according to the firm's experience (sijt−1), characteristics (zirt), and the total number of subsidiaries (Nit),as well as an idiosyncratic profit shock εijt. Specifically, we only interact with firms' observed and unobserved market size characteristics in the estimation section. If firm i does not engage in FDI in period t, then it will obtain πi0t, where πi0t = εi0t.

Regarding the experience vector →sit−1, we focus on regional experience rather than country-specific experience. We group all 24 locations into six regions as defined above.

This implies that firms do not need to keep track of experience in each country, but only at the regional level because previous empirical evidence established that regional and country-specific experiences have similar positive effects on reducing adaptation costs. Thus, regional experiences are transitive across countries within the same region. Consequently, the cardinality of →sit−1 decreased from 224 to 26. The grouping method reduces the state space drastically. However, it implicitly assumes that adaptation costs are constant across coun- tries within regions.

To deal with the exogenous information set Ωt, we borrow the concept of a logit inclusive value (δit) to collapse a high-dimensional vector into a scalar.47 Owing to the iid type-I extreme value distribution of εijt, the inclusive value has the following closed-form solution:

$$\begin{aligned}\delta_{it}(\vec{s}_{it-1}, N_{it-1}, \Omega_t) &= E \max\{\delta_{i1t} + \varepsilon_{i1t}, \ldots, \delta_{iJt} + \varepsilon_{iJt}\} \\ &= \ln\Big(\sum_{j=1,\ldots,J} exp(\delta_{ijt}(\vec{s}_{it-1}, N_{it-1}, \Omega_t))\Big)\end{aligned}$$

where

$$\delta_{ijt}(\vec{s}_{it-1}, N_{it-1}, \Omega_t) \equiv \pi_{ijt} + N_{it}\psi(\vec{s}_{it}, N_{it}, \Omega_t) - \varepsilon_{ijt} + \beta E[V_i(\vec{\varepsilon}_{it+1}, \vec{s}_{it}, N_{it}, \Omega_{t+1})|\Omega_t, \vec{s}_{it-1}, N_{it-1}]$$

δijt denotes the choice-specific value function, that is, the value firm i can obtain if it is forced to set up a new subsidiary in location j in this period. Intuitively, the inclusive value δit(→sit−1, Nit, Ωt) captures the expected value of a firm's best location for FDI among all available locations. This provides a summary of location attributes and the selection of all possible countries to enter, considering adaptation costs and an infinite-horizon future value. Instead of keeping track of all detailed location attributes in every country, firms can equivalently focus on sufficient summary statistics δit under certain assumptions. The evolution of δit can capture only the overall pattern; that is, Thus, all else being equal, the logit inclusive value increases as the market size increases in all countries. However, if, for example, location attributes evolve differently, a change in the logit-inclusive value does not provide any information on which country evolves better.48 This required additional assumption is called the inclusive value sufficiency (IVS) assumption.

$$P(\delta_{it+1}|\Omega_t, a_{it}) = P(\delta_{it+1}|\delta_{it}, a_{it})$$

IVS assumption implies that, given the same action choice, the current inclusive value provides all relevant information about the marginal distribution of the inclusive value in the next period. Consequently, firms do not need to form expectations for each variable. in the information set Ωt but can simply focus on the inclusive value of the scalar variable. With this IVS assumption and all reductions of the state space, the value function can be equivalently written as

$$V_i(\vec{\varepsilon}_{it}, \vec{s}_{it-1}, N_{it-1}, \psi_{it}, \delta_{it}) =$$
$$\max_{a_{it}\in\{0,1,\ldots,J\}} \sum_j \pi_{ijt} \mathbb{1}_{(a_{it}=j)} + N_{it}\psi_{it} + \beta E[EV_i(\vec{s}_{it}, N_{it}, \psi_{it+1}, \delta_{it+1})|\vec{s}_{it-1},, N_{it-1}, \psi_{it}, \delta_{it}] \tag{9}$$

where the expected value function $EV_i(\vec{s}_{it-1}, N_{it}, \psi_{it}, \delta_{it})$ is given by

$$EV_i(\vec{s}_{it-1}, N_{it-1}, \psi_{it}, \delta_{it}) = \int V_i(\vec{\varepsilon}_{it}, \vec{s}_{it-1}, N_{it-1}, \psi_{it}, \delta_{it}) dF(\vec{\varepsilon}_{it})$$
$$= \ln\left[exp\big(N_{it}\psi_{it} + \beta E[EV_i(N_{it}, \vec{s}_{it}, \psi_{it+1}, \delta_{it+1}|\delta_{it}, \psi_{it}, \vec{s}_{it-1}, N_{it-1})]\big) + exp(\delta_{it})\right]$$

Given their forward-looking behavior, firms must form expectations of all state variables. First, the evolution of the experience state $\vec{s}_{it}$ is as follows:

$$\vec{s}_{it} = \begin{cases} s_{ijt} = 1, s_{i-jt-1} = s_{i-jt-1}, & \text{if } a_{it} = j; \\ \vec{s}_{it-1}, & \text{if } a_{it} = 0. \end{cases}$$

If firm i selects location j for FDI in period t, that is, ait = j, then sijt = 1 and all the others remain the same.
Second, the evolution of the total number of subsidiaries Nit follows

$$\text{Nit} = \text{Nit}-1 + 1(\text{ait}/=0)$$

We focus only on the location choice for FDI and abstract from the decision to set the optimal number of subsidiaries. Therefore, we assume that firms always choose one subsidiary unit, conditional on investing in this period.49
Third, the evolution of the mean profit flow from existing subsidiaries ψit is where belief shock νit is assumed to follow a normal distribution N (0, σ2). The evolution of ψit indicates this change in the profit portfolios of existing subsidiaries. If a firm selects an outside option in the current period, then the change in ψit only reflects the exogenous variation in location attributes in the countries in which the firm invested. This exogenous change in mean profit flow from existing subsidiaries is captured by parameter γ1i. However, if a firm engages in FDI in one location with better economic development in this period, the mean profit flow will shift upward compared to when the firm does not make any investment or selects other locations. This difference is captured by γ2i. The mean value of the belief shock is 0. This implies that the firms have rational expectations. All parameters in this equation vary across firms to account for heterogeneity.
Finally, the evolution of the inclusive value δit is

$$\delta_{it+1} = \begin{cases} \rho_{0i}^{out} + \rho_{1i}^{out}\delta_{it} + \nu_{it}^{out} & \text{if } a_{it} = 0; \\ \rho_{0i}^{old} + \rho_{1i}^{old}\delta_{it} + \nu_{it}^{old} & \text{if } a_{it} = j,\ s_{ijt-1} = 1; \\ \rho_{0i}^{new} + \rho_{1i}^{new}\delta_{it} + \nu_{it}^{new} & \text{if } a_{it} = j,\ s_{ijt-1} = 0; \end{cases} \tag{11}$$

where we assume that the shock νit on belief follows a normal distribution N (0, σ2). We omit the superscripts of νit to save notation. However, the associated distribution varies

according to the different types of actions, as in equation (11). The evolution of the logit inclusive value explicitly depends on firm i's current choice ait and the firms' characteristics according to equation (11). If firm i selects the outside option, the evolution of δit captures only information on exogenous changes such as variations in location attributes and associated with the continuation values. If firm i selects an old location to engage in FDI during this period, then the evolution of δit contains information on exogenous and endogenous changes in Nit, for example, Nit+1 = Nit + 1. Finally, if firm i chooses new location j for FDI, then δit+1 should reflect a reduction of the adaptation cost in location j, which implies that the best choice in the next period should be higher than the current choice of old lo- cations or the outside option, assuming that everything else is equal. Therefore, parameter ρ1i in equation (11) varies among different types of actions: choosing an outside option, choosing an old location, or choosing a new location to invest in. As in Equation (10), firms have rational expectations regarding the evolution of inclusive values. The associated belief parameters differ by firm.

Let the value of choosing the outside option, After integrating out the unobserved idiosyncratic profit shock, the optimal policy function Pijt, the probability of firm i choosing location j to engage in FDI in period t, conditional on its attributes is

$$P_{ijt}(\vec{s}_{it-1}, N_{it}, \psi_{it}, \delta_{it}|z_{i1}, z_{i2}) = \int \mathbb{1}\left(\delta_{ijt} + \varepsilon_{ijt} > \delta_{ikt} + \varepsilon_{ikt}, \forall k \neq j,\right) dF(\vec{\varepsilon}_{it})$$

$$= \frac{exp(\delta_{ijt})}{exp(\delta_{i0t}) + exp(\delta_{it})}$$

With all the above reductions in state space, we can eventually estimate a tractable dynamic discrete choice model. The details of the estimation are presented in the following section.

C The Estimation Procedure

The estimation method in this study closely follows those used by Nosal (2011), Shcherbakov (2016), and Gowrisankaran and Rysman (2012), which involves three levels of optimization. The basic idea is to nest solving a dynamic programming (DP) problem inside the location share inversion of Berry, Levinsohn and Pakes (1995).

The inner loop solves the firms' DP problem in Equation (9) for each firm type, and computes the predicted aggregate location share. The middle loop updates the mean profit flow $\bar{\pi}$ until the predicted location shares match the observed ones. The outer loop search over the parameter space to maximize the likelihood function.

C.1 Inner Loop

We set the annual discount factor β equal to 0.9 to solve the DP problem in the inner loop.5To obtain a fixed point for the Bellman equation: (9), we need to discretize the continuous logit inclusive value (δit) and ψit. The state-space dimensions for the variable δit are divided into 30 grid points and 20 grids for ψit. Nit = {0, . . . , 9} Similarly, observed firm's characteristics size zi1 is discretized into three types: small, medium, and large based on quantiles from the data.52 Thus, there are six types of firms: three observed types (size)

The discount factor β is generally not identified in dynamic discrete choice models. Thus, we selected a value of 0.9, which is commonly used in the literature. As discussed in the previous section, Nit is associated with the number of unit multiplied by two unobserved types (productivity). Together with the state variable, →sit and Nit, there are 64 × 30 × 20 × 10, 384000 grid points in the Bellman equation to solve for each firm type. The value function Vi(→sit, Nit, ψit, δit) is then defined discretely for each grid point, and its value is approximatedas by linear interpolation when the arguments fall between grid points.

The inner loop determined the joint fixed points using several equations. This determines

the value function, which is a fixed point of the Bellman equation. It determines the choice-specific value functions δijtfor all j and the logit inclusive value δit that satisfy their recursive definition, respectively). Finally, we find the firm's belief parameters γi, ρi, σi that are stable during the iteration. To begin the inner loop, the initial value estimates for the above variables are necessary. As the expectation of the value function is part of the expressions δit and ψit, integration along the dimensions of these state variables was achieved by simulation.53 Once the expected value function has been computed, we can easily obtain δijt for each location j and use it to update the logit the inclusive value δit. Then, δit is regressed on δit−1 to obtain new ρi, σ2i and regress ψit on ψit−1 to obtain the new γi and σ1i. Because both δit and ψit are functions, of the endogenous state variables (→sit, Nit) and exogenous location attributes, we can select the realized value in different state (→sit, Nit) to nonparametrically identify the belief parameters for the corresponding action choices.

After joint convergence is achieved, we can obtain the conditional choice probabilities Pijt. The Pijt for all j and t, is used to predict the location share of firms that choose to enter each country, and then pass it on to the middle-loop estimation.

C.2 Middle Loop

The middle loop is an application of the Berry, Levinsohn and Pakes (1995) inversion. They proved that one-to-one mapping exists between the the average profit flow $\bar{\pi}_{jt}$ and location share χjt. For ease of computation, we divide the main parameters into two mutually exclusive sets of parameters, the linear parameter vector Θ1 which enters only the mean profit flow $\bar{\pi}_{jt}$ and nonlinear parameters are Θ2 = {α, α˜1, α˜2, λ, ηj, j = 1, . . . , 24};

$$\chi_{jt} = \hat{\chi}_{jt}(\bar{\pi}_{jt}, \forall j|\Theta), \forall j$$

where χjt denotes the predicted share of firms choosing location j in period t for FDI. This is a function of average profit flow $\bar{\pi}_{jt}$ in all locations as well as the parameter Θ, which is passed from the outer loop. To solve the above system of equations, Berry, Levinsohn and Pakes (1995) provided a computational device to aid in are concentrated in $\bar{\pi}_{jt}$. Where is the updated average profit flow, which is guaranteed to converge because ofcontraction mapping. Given the new average profit flow, we update predicted the location share through an inner loop. This implies that the convergence of the middle loop is the joint convergence of the middle and inner loop. Gowrisankaran and Rysman (2012) suggest to iterate inner and middle loop interchangeably until convergence in both stages to save computation time. Once the average profit flow converges, the linear parameter Θ1 can be represented as of the nonlinear parameters Θ2.

C.3 Outer Loop

The outer-loop search over a set of nonlinear parameters (Θ2) to maximize the likelihood function is

$$\hat{\Theta}_2 = arg \max_{\theta_2} \{ \sum_i \sum_t \sum_j \mathbb{1}_{(a_{it}=j)} \log(\hat{P}_{ijt}(\vec{s}_{it}, N_{it}, \psi_{it}, \delta_{it})) \} \quad (12)$$

When convergence is reached in both the middle and inner loops, given Θ2, we can obtain the predicted probability Pˆijt(→sit, Nit, ψit, δit) after integrating the unobserved firm attributes zi2t. To construct the objective function, we consider every firm i's state variable in the first period of the sample to be an exogenous given. During optimization, the predicted conditional choice probability Pˆijt must be computed for any given parameter vector. The algorithm terminates when the outer loop reaches its maximum value, and the inner and middle

loops converge simultaneously.

D. Additional tables

Table 8: Summary statistics on non-manufacturing and non-financial companies in Germany from 2002 to 2009

	Mean	Std	Min	25%	50%	75%	Max
Total revenue	1870.82	8459.73	-0.02	13.61	45.29	245.36	87325.00
Total asset	2837.58	16285.52	0.00	15.81	48.23	237.12	262964.00
Number of employees	15.35	58.17	0.001	0.14	0.43	3.02	475.10
Profit	50.66	642.79	-24587.00	-1.22	0.60	5.77	8568.00

Note: Total revenue, total asset and profit are in millions of dollars. Total number of employees is in thousands. Source: Bundesbank, Compustat.

Table 9: 2003 FDI Regulatory Restrictiveness Index

Country Name	Country Code	FDI Index	Rank among OECD countries
Luxembourg	LUX	0.015	1
Netherlands	NLD	0.037	2
Ireland	IRL	0.053	3
Denmark	DNK	0.125	18
Japan	JPN	0.139	20
Norway	NOR	0.179	24
Sweden	SWE	0.182	25
Finland	FIN	0.236	28
Korea, Rep.	KOR	0.276	30

Notes: The FDI Regulatory Restrictiveness Index (FDI Index) measures statutory restrictions on foreign direct investment across 22 economic sectors. This index is on a scale from 0 (open) to 1 (closed). The FDI index we used includes tertiary sectors, with the exception of financial services, banking, insurance and other finance sectors. The rank among OECD countries is based on FDI index and calculated by the authors. Source: OECD's statistical database.