

Foreign direct investment of German companies during globalization and ‘deglobalization’ periods from 1873 to 1927

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Based on firm-specific data on foreign direct investment of German companies from 1873 to 1927, we study firm characteristics that caused FDI, preferred host countries, and whether FDI was successful in terms of enhancing corporate profitability. Large companies with high profitability that were created relatively late during Germany’s growth success period conducted more FDI. Market size and similarity of the respective host country triggered horizontal FDI. However, wage gaps and differences in human capital stimulate FDI flows; hence, we uncover that incentives for vertical FDI existed, and Krugman’s (1996) ‘slicing up the value chain’ is not a peculiarity of the globalization period of the last decades.

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1. Introduction

There are many terms for vertical foreign direct investments (FDI) like ‘slicing up the value chain’ coined by Krugman (1996), fragmentation (see Jones and Kierzkowski, 1990) or outsourcing – but regardless how one calls it, shifting production to low wage countries threatens especially the wages and employment of unskilled labor in developed nations. Empirical evidence based on data covering the last 20 to 25 years is ambiguous, as Carr, Markusen and Maskus (2001) confirmed vertical and horizontal FDI, whereas Davies and Head (2003) did not find vertical FDI. Henceforth, evidence for vertical FDI in the recent phase of globalization is puzzling – but what can we learn from the first phase of globalization and the ‘deglobalization’ period in the 1920s on this? Did incentives for vertical FDI exist long before theories and debates about the same emerged? Which companies conducted FDI, and was it successful?

In our paper, we study FDI streams during the period 1873-1927 undertaken by German companies. Working with micro-level data on 948 individual FDI transactions of 377 joint stock companies, as well as a control group of 556 joint stock companies without FDI, we try to answer these questions. In particular, we work on a disaggregated level to reveal company characteristics that stimulated entering foreign markets. In a second step, we aggregate individual FDI decisions to a panel of country level investment streams. We apply an extended knowledge-capital model to identify country characteristics that attracted FDI and to uncover the nature of FDI streams. Based on firm-level data, we finally analyze the success of FDI taking into account the inherent endogeneity problem, as successful firms undertake more often FDI, and FDI in turn can make companies more successful.

Theoretical models for horizontal FDI focus on the trade-off between economies of scale and transportation costs, which suggest that in the absence of transportation costs firms

would prefer producing in one factory and exporting goods to foreign markets.¹ As transportation costs were relatively high from 1873 to 1927, we would expect a strong incentive to conduct horizontal FDI by producing in host countries to meet local demand. Due to limited data availability, we cannot estimate a translog cost function to determine economies of scale; however, by regressing returns on equity ROE (as a measure of profitability) on firm size and squared firm size, we obtain a proxy for economies of scale. Cost functions are U-shaped suggesting an optimal level of firm size. We find a similar pattern for returns on equity; hence, firms that exceed the optimal firm size do not benefit from extending their production. Accordingly, large companies have a higher tendency to conduct horizontal FDI.

In contrast, vertical FDI is driven by differences in factor intensities and factor prices suggesting that companies shift parts of the production process, which are not skill intensive, into countries with low wages for unskilled labor.² If countries with a high wage gap, namely lower real wages compared to Germany, and low relative skill levels (measured by our human capital proxy) attract FDI, we can regard these investments as being of vertical nature. Markusen (2002) combined both theoretical approaches into the knowledge-capital (KC) model, which was empirically tested and modified by Braconier, Norbaeck, and Urban (2005) and Davies (2004). By aggregating our firm level FDI data, we apply a modified KC model to explain FDI across countries.

Our paper is organized as follows: the literature review stresses the current debate concerning horizontal and vertical FDI, globalization periods, and the success of FDI and multinational enterprises; the third section highlights our data collection efforts and shows first descriptive findings; the fourth section presents our empirical findings regarding the

¹ Helpman (1984) and Helpman and Krugman (1985) developed the first theoretical models that explain horizontal FDI.

² We refer to Markusen (1984) and Markusen and Venables (1998).

following three questions: (1) which companies conducted FDI? (2) Was it horizontal or vertical FDI? (3) Was FDI successful? Finally, we conclude and discuss our findings.

2. Literature review

A large number of factors have been studied as potential determinants of FDI. Apart from the motivation to exploit different factor prices or to access markets known as vertical and horizontal FDI, respectively, the more prominent determinants of FDI can be classified as those (a) created by government activities (taxation, protectionism), (b) chain migration of FDI into similar regions and countries, and (c) the attempt to internalize the profit effects of brand names and proprietary knowledge.

(a) Taxation as FDI determinant is, of course, a very attractive field of study, because it might allow direct policy interventions to stimulate foreign investment. However, the results for this factor have been somewhat inconclusive until now. Maskus (1998b) and Blonigen and Davies (2000) actually found that FDI flows are sensitive to tax regimes and other state interventions, whereas Brainard (1997) argued that the taxation strategy of host countries does not discourage FDI. Other interventions might also have ambivalent effects on FDI, for example protectionism: protectionism might be negative for trade with one's affiliate and re-exports (and it might be a proxy for illiberal economic policy in general), but the market access motivation might actually be reinforced by protectionist policies, at least of rich and large countries. Furthermore, changes in the exchange rate regimes and other macroeconomic change also affect FDI (see Blonigen 1997).

(b) The histories Coca Cola or Daimler Benz stand for famous brand names that have been marketing successes in many countries, and Kodak or Siemens were similarly able to exploit proprietary knowledge using FDI, in many countries of the world. Among others, the study by Brainard (1997) demonstrated the strength of those factors for U.S. multinationals

(MNE). Patent rights in the host country also play a role for innovation-intensive MNEs (Maskus 1998).

(c) Another interesting field is the chain migration of firms into similar environments. For example, Japanese firms tend to cluster together in U.S. regions (see Head, Ries, and Swenson 1995). Those agglomerations provide some information processing advantages, and in the case of similar skills demanded on the labor market, there might also be clusters of similar producers in some regions (the Silicon Valley effect).

We now turn to the literature on the main motivations of FDI: factor price differences and market access. The traditional view of capital flows is that investments from capital abundant countries should mostly flow to economies that have low capital intensity and are “rich” in other factors such as unskilled labor or natural resources, unless capital flows are substituted by movements of goods (i.e., exports) or labor (migration). In contrast, most empirical studies found that the largest share of FDIs usually move from one rich, high-wage country to another rich, high-wage country. Hence, another set of theoretical models evolved that were better able to explain the empirical facts. The probably most prominent model is currently the knowledge-capital-model of the multinational enterprise (see, among others, Markusen 1984, 2002, Carr et al. 2001). This model assumes that the assets of knowledge-based firms can be used in many types of economies, including rich and human capital-intensive countries. It comprises as special cases the “vertical” and the “horizontal” strategies: the horizontal strategy means that production processes are placed via FDI in countries that are very similar in human capital intensity to the headquarter economy. The main motivation is to gain market access more easily, by moving production into the proximity of foreign consumers. Economies of scale cannot be exploited by this strategy, but transport costs are lower. In empirical studies, GDP of the target economy should be a strong indicator for the horizontal strategy, as it might indicate market potential.

Quite contrary, the “vertical” strategy of FDI follows the idea that the stages of the production process are sliced up vertically, and each stage of production takes place where the factor costs are lowest: simple stages of production are relocated to low-wage, low-human capital countries, and human capital intensive processes take place in high-wage countries, for example the headquarter economy. Intermediate products are moved between the countries. The empirical implication would be that GDP of the host country should not matter much, and similarity of GDP, wages or human capital measures should actually have a negative sign, as similarity represents the differences between economies that are exploited by a vertical MNE. The knowledge-based model of the MNE nests both models, and it predicts that companies employ the vertical or horizontal strategy, whichever might be most suitable for a given situation.

Most empirical studies for the last few decades tend to confirm the horizontal strategy as the more dominant strategy. But there is also some evidence for the vertical one, especially from interviews with central European firms that aim at using the wage differential between Central and Eastern Europe to slice up their production chain.

Most studies so far used aggregated data, whereas firm level data studies on the knowledge-based model have been only performed for the U.S., Sweden, and Germany during the last two decades. Especially long-run studies that could make use of the special feature of the knowledge-based model – that behavior should be determined by varying economic environments – are lacking so far.

One interesting recent study on Germany compares results at the firm level and at the aggregated level (see Buch et al. 2005). The authors mobilized a very large panel dataset that was recorded at the *Bundesbank* and compared aggregate and individual adjustments to target country GDP, and similarity. On the aggregated level, an additional percent of GDP results in almost 1 percent additional FDI. This can be decomposed into (a) the increase of the number of affiliates and (b) a higher investment per affiliate. Buch et al. (2005) found that the

investment per affiliate accounts for about one third of additional FDI volume, whereas additional affiliates account for the remaining two thirds (assuming no omitted variable and measurement error problems in their regressions). The authors also uncovered that similarity of GDP in the host country and Germany (which is the only headquarter economy in this study) has a positive influence on the size of the investment and sales per affiliate, whereas protectionism has a negative influence.

In sum, most of the recent literature stresses the “horizontal”, market access motivation as the strongest determinant of FDI, although vertical cost-saving motivations play a role in some situations (especially where factor price differences are only separated by relatively open borders, such as within the EU, or between the U.S. and Mexico). Other motivations of FDI are taxation (although results are yet inconclusive), protectionism, chain migration of firms, brand name and proprietary knowledge effects.

3. Data

We use a new database to investigate the determinants and success of FDI in the period 1873-1927 on firm and country level. It is a unique database for the following reasons: first, our database provides 948 individual FDI transactions of 377 joint stock companies, as well as a control group of 556 joint stock companies without FDI. The FDI data were drawn from the ‘Handbuch der deutschen Aktiengesellschaften’ (various issues). Second, the database contains also firm specific information on total assets, common equity, profits, investment accounts, year of foundation of the company, and industry dummies. And finally, as only a few papers on FDI (for example Buch et al., 2005, and Wagner and Schnabel, 1994) analyzed recent micro data, we stress that this is the first approach to investigate German FDI data in the first globalization period with econometric methods. Buch et al. (2005) pointed at the limitations of studies that only focus on macroeconomic or aggregated data, as they did not allow assessing firm-specific characteristics and incentives for FDI.

Our analysis includes all joint stock companies listed on German stock exchanges and documented in the 'Handbücher der deutschen Aktiengesellschaften' of the selected years that undertook FDI. To reveal company characteristics that made FDI more likely, we need a reference sample consisting of companies without FDI. Thus, we add a randomly chosen control group in the period of interest. Generally, we have information about the year, the destination (town and country), the industry, and the amount of investment of the respective FDI transaction. When focusing on the type of FDI provided by the 'Handbücher der deutschen Aktiengesellschaften', FDI in the form of holdings, agencies, and affiliates dominated. Due to the fact that the complete set of information is not available for all companies, we cannot include all variables into our regressions without a considerable loss of observations.

Summing up, the dataset provides information on German FDI in 55 countries and 37 industries. The 10 most important countries were by far Austria-Hungary (current borders, after WWI: Austria and Hungary) and UK, followed by France, USA, Italy, Russia (SU after WWI), Poland (before WWI: part of neighbor empires), Switzerland, Netherlands, and Czech Republic (before WWI: part of Austria-Hungary). Figure 1 plots the relative importance of specific industries regarding FDI. We observe a particular high number of FDI in the electrical and machinery industry with a share of about 40% of all FDIs, followed by the chemical and metal processing industry. None of the remaining industries accounted for more than 5.6% of all FDI.³

The end of the 19th century and the beginning of the 20th century marked a period of expanding demand, growth in productive capacity and rising exports in Germany. Germany became one the leading industrial countries and has taken a pioneering role especially in the chemical, electrical, and engineering industry until WWI (see Henderson 1973, p.173).

³ We account for the four most active industries concerning FDI by including dummy variables into our regression models.

Inventions such as the dynamo and the electrical bulb were as important to the electrical industry as synthetic dyes to the chemical industry or the development of steam engines to the engineering industry. Relatively new companies, such as AEG or Siemens, had achieved industrial success. The fastest-growing electro-technical firm AEG for example, invested 37 times abroad from 1873 to 1927. AEG did its first FDI in UK in 1892, soon after Emil Rathenau acquired a license for Edison's patents on lamps and the foundation of AEG in 1887 (see Pohl 1988). Growing competition, especially in those successful industries, required diversification and consequently triggered more and more FDI.

In the following regressions, we also include as potential determinant of FDI a macroeconomic human capital measure. Our proxy for human capital is partly based on patent statistics published by the German patent authorities. To distinguish between important and unimportant patents, we follow Labuske and Baten (2005, 2006) and Streb et al. (2006) and concentrate only on patents that were prolonged for at least ten years (so called high-value patents). This is possible for foreign patents in Germany, because Germany had the highest patent fee among a group of 60 countries between 1850 and 1999. For one-year patent protection the German Patent authority charged an annual patent fee at the beginning of each year. In order to extend the validity of the patent, the patentee had to pay an increasing renewal fee. The patentee only renews the patent if the present value of expected future returns of the patented invention exceeds the present value of future costs. Labuske and Baten (2006) constructed a measure for technical human capital that is the equally weighted average of primary school enrolment rates and adjusted patents. To generate the adjusted patents, they saved the residual from a regression on distance and German language. This adjustment accounts for the fact that neighboring countries with the same cultural background tended to have more patents in Germany. In order to obtain "enrolment equivalents" in the second step, they saved the predicted values from a regression of enrolment rates on adjusted patent rates. Hence, they obtain an adjusted measure for the innovativeness of a country's industry. In the

third step, Labuske and Baten (2006) calculated the averages between those adjusted patents and primary school enrolment rates.

The definitions of variables and sources used in the empirical part of the paper are summarized in the Appendix in table A.1. To obtain an overview regarding the firm characteristics of companies that conducted FDI and companies that did not, table 1 reports means, standard deviations, minimum and maximum values for firm size, value of investments, return on equity and year of firm creation. Based on group-wise descriptive statistics, we observe that companies with FDI activities tended to be larger, and more profitable (indicated by a higher return to equity ROE).

4. Empirical results

4.1. Which companies conducted FDI?

We first model the decision: “to invest or not to invest” from a business perspective; accordingly, we use firm-level data for the whole period from 1873 to 1927 and analyze individual FDI decisions. Our dataset reports every FDI transaction of the included companies and contains information about a reference sample consisting of firms without FDI. Economies of scale could reduce incentives for horizontal FDI (see Helpman, 1984; Helpman and Krugman, 1985); hence, we take the log of total equity as proxy of firm size to control for size advantages.⁴ As cost curves tend to be U-shaped, we try to identify the optimal firm size beyond which economies of scale vanish due to decreasing returns to scale. Besides the number of employees, we do not have data on inputs, outputs, and prices; hence, we cannot estimate a translog cost function. As a second best proxy, we model the quadratic relationship between returns on equity (ROE) as a measure of firms’ profitability and firm size. Figure 2 plots the fitted values and the actual ROE against firm size. Based on this regression model,

⁴ Note that other proxies like the number of employees would reduce the number of observations considerably due to missing data. In addition, alternative measures are highly correlated with our proxy.

we identify the optimal firm size and define a dummy variable $D_{ec. \text{ of scale}}$ that takes value zero if firms exceed the optimal level of size. If this dummy variable has a negative coefficient in a logit specification with FDI as dependent variable, we would confirm that smaller companies have a lower incentive to conduct FDI, which is in line with models for horizontal motivations. This is certainly a relative rough estimate, given the potentially different production functions across industries, but we can justify this procedure with the fact that two thirds of FDIs are represented by just four industries that are all famous for relatively high optimal firm sizes. Following Helpman (1984) and Helpman and Krugman (1985), we should expect that firms below the optimal level of size benefit from increasing their output and hence tend to conduct less horizontal FDI. Besides the interrelation of firm size and economies of scale, larger companies have easier access to capital markets. Thus, FDI is easier to finance, and cost of capital is lower, which makes FDI more attractive.⁵ Helpman et al. (2004) emphasized the fact that firms conducting FDI are not only larger, but also more efficient and productive than firms that produce for the home market or choose to export. Hence, we include additional factor advantages like companies' efficiency that make FDI more attractive, as these factor advantages create also competitive advantages in foreign markets. We use return on equity (ROE) as a measure of efficiency (profitability) and claim that a higher ROE makes FDI more likely, as companies that are profitable in their home country possess factor advantages when entering foreign markets. Moreover, we use the year of firm foundation to control for firm creation cohorts: did later cohorts conduct more often FDI, or were perhaps earlier cohorts with more experience more likely FDI candidates?

⁵ Tilly (1982) argued that the companies' laws of 1884 and the new exchange law established 1896 favored larger companies. For instance, the law required that the minimum issue volume had to exceed one million Mark. Hence, a larger company had advantages to finance expansion by issuing new shares. The companies' law and the new exchange law mainly determined the legal framework in the pre-1914 period.

We also account for industry effects (denoted j) by using conditional (fixed-effects) logit models. Applying a crude distinction between industries, we obtain four major industries (chemical, electric, machinery, and metal), which were the most active industries in conducting FDI. Refining our distinction further provides 37 different industries. Consequently, we run the following logit model that explains the binary decision concerning FDI during the period 1873 to 1927.

$$\text{fdi}_i = \alpha_j + \beta_1 \log(\text{size}_i) + \beta_2 \text{roe}_i + \beta_3 \text{foundation}_i + \beta_4 \text{D}_{\text{ec. of scale}} + u_i \quad (1)$$

Table 2 shows the regression output for the basic model without industry effects (model 1), the conditional logit model with 37 industries (model 2) and a specification with the four major industries (model 3). Firm size stimulates FDI indicating that economies of scale, easy access to capital markets and other size advantages like market power were relevant for conducting FDI. The dummy variable $\text{D}_{\text{ec. of scale}}$ indicates that firms smaller than the optimal firm size could still benefit from economies of scale in the home market and hence conduct less FDI; however, the coefficient is not statistically significant when we do not control for industry effects (see model 1). Profitability in terms of higher returns on equity made FDI more likely; hence, profitable firms could use their factor advantages to enter foreign markets. The year of foundation, shows a positive significant impact on the probability to conduct FDI. Hence, companies founded later during the German growth success conducted more FDI. This result reflects the dramatic changes in the industrial structure due to technological progress in rising industries such as the chemical industry. To obtain a clearer picture concerning the incentives for conducting horizontal FDI, our second step relies on aggregated data.

4.2. Was it horizontal or vertical FDI?

After clarifying the individual investment decision and showing that firm size is the most important factor for FDI, we try to analyze which macroeconomic factors of the home and

host country enhance FDI. We do this on an aggregated level by analyzing the sum of FDI that flows into different countries. Our estimation strategy is motivated by Carr, Markusen and Maskus (2001), Markusen and Maskus (2001, 2002), and Blonigen, Davies, and Head (2003) that applied gravity equations and the knowledge-capital model to macro-level data on FDI.

Based on gravity models and the extension with skill measurers (knowledge-capital model), we state that FDI streams among countries can be explained by the following variables: (1) the sum of log GDP (host and home country) represents the gravity component, which underlines that larger countries attract more FDI. (2) The dispersion index (squared difference of home and host country's log GDP) highlights whether home and host countries are of similar size. Similarity of GDP leads to larger FDI streams between the two countries. (3) The distance parameter (km between the capitals of the home and host country) is a common proxy for transportation costs and cultural differences. Adjacent countries tend to trade more due to low transportation costs, similar culture and familiar regulatory frameworks (i.e. legal system). (4) We also include the official language of the host country to account for cultural aspects. (5) To account for skill differences, we use a human capital indicator, which is an equally weighted sum of primary school enrolment rates and the number of patents that firms of the respective host country hold in Germany (see Labuske and Baten, 2005, 2006). This macro-level proxy provides a better measure for skills in an economy compared to input-oriented measures like the number of scientists per 1000 workers (see Carr, Markusen, and Maskus, 2001). As Germany can be regarded as skill abundant country, a high skill level in a host country suggests that the host country is more similar compared to Germany. If similarity in human capital triggers higher FDI flows, vertical FDI and outsourcing could be excluded.⁶

⁶ As our human capital indicator is the equally weighted average of primary school enrolment rates and patents of foreign firms in Germany, we cannot determine the same measure for Germany itself. Hence, to discuss

Our variable denoted *humancap* measures the difference between the 75 percentile in the human capital proxy and the value of the proxy in the respective host country. If the variable *humancap* exhibits positive values, host country's human capital proxy is below the 75 percentile. The log investment stream (based on individual FDI) serves as dependent variable, which we observe on a firm level. Yet, we have only 376 underlying observations (that we can aggregate to country level), because the investment stream was not always reported when companies conducted FDI.⁷ Accordingly, we aggregate FDI over all companies to form pairs of home and host countries. The following regression equations are used for our gravity and knowledge-capital models.

$$\log(\text{invest}_f) = \alpha_j + \beta_1(\ln(\text{GDP}_f) + \ln(\text{GDP}_{\text{Home}})) + \beta_2(\ln(\text{GDP}_f) - \ln(\text{GDP}_{\text{Home}}))^2 + \beta_3\text{distance}_f + \beta_4\text{language}_f + u_f \quad (2)$$

$$\log(\text{invest}_f) = \alpha_j + \beta_1(\ln(\text{GDP}_f) + \ln(\text{GDP}_{\text{Home}})) + \beta_2(\ln(\text{GDP}_f) - \ln(\text{GDP}_{\text{Home}}))^2 + \beta_3\text{distance}_f + \beta_4\text{language}_f + \beta_5 \cdot \text{humancap}_f + u_f \quad (3)$$

We could extend the standard model by inserting wage differences, as lower wages in host countries might trigger vertical FDI, for firms can reduce costs by shifting their wage intensive production to a labor abundant country.⁸

$$\log(\text{invest}_f) = \alpha_j + \beta_1(\ln(\text{GDP}_f) + \ln(\text{GDP}_{\text{Home}})) + \beta_2(\ln(\text{GDP}_f) - \ln(\text{GDP}_{\text{Home}}))^2 + \beta_3\text{distance}_f + \beta_4\text{language}_f + \beta_5 \cdot \text{humancap}_f + \beta_6(\ln(\text{wage}_{\text{Home}}) - \ln(\text{wage}_f)) + u_f \quad (4)$$

Table 3 reports the results for the capital-knowledge models with and without our proxy for human capital differences and wage gaps. The signs are interesting; as it shows that vertical FDI was important at least for some countries.

differences in human capital endowment, we calculate the deviation in the human capital proxy from the maximum of all host countries.

⁷ Balance sheet information could help to overcome this data limitation; however, we cannot distinguish between new FDI and old stakes in foreign enterprises. In spite of 552 balance sheet observations regarding the foreign activities of a company (minority stakes, foreign subsidiaries etc.), we cannot rely on this information.

⁸ We collected real wages for host countries in the respective year of FDI inflows.

The standard gravity model (see model 1) with the sum of GDP, dispersion factor, distance, and common language dummy has explanatory power in our country panel. We confirm the presence of FDI motivated by horizontal strategies: large and rich host countries attract more FDI than the ones with smaller GDP. Distance has a negative impact on FDI in one of the three specifications, hence it is not a robust predictor once cultural and institutional similarities are accounted for, as we do with the language dummy. Common language is highly significant and of substantial explanatory power in our regressions. To account for vertical FDI driven by human capital differences and wage gaps, we reveal that vertical FDI was relevant for some countries that had lower wages compared to Germany (see model 3). Differences in human capital, however, did not cause higher inflows of FDI (see model 2 and 3). Hence, wage gaps were the driving force for vertical FDI. To illustrate our findings, figure 3 plots the percentage of vertical FDI suggested by model 3 against the difference in human capital and wage gaps. The three countries that exhibited the highest estimated vertical (conditional) FDI are India (11.5%), Japan (9.8%), and Turkey (9.7%), of course conditional on the other factors included. Countries more similar to Germany, such as France, show a low figure of estimated vertical FDI, namely 0.4%. Accordingly, we confirm vertical FDI – but we also stress that horizontal FDI driven by access to foreign markets was predominant. Nevertheless, the alleged first emergence of vertical FDI and outsourcing in the second phase of globalization seems to be doubtful in light of our results.

4.3. Was FDI successful?

Our logit and conditional logit models reveal that firms with higher return on equity conduct more FDI. However, there might be an endogeneity problem in this relationship: FDI might also lead to higher returns on equity. There are at least two approaches that could solve the problem of endogeneity of FDI and firm performance, namely a two-step approach and a

modified vector autoregressive model. The two-step approach is rather simple, but affects statistical inference, as error-terms in the second step depend on the precision of the first step. The first step could be a dynamic probit model that allows serial dependency of FDI, which reflects that FDI becomes more likely if the company has already conducted FDI before. As we can only observe whether a company undertakes FDI or not, the underlying decision process can be regarded as unobserved.

Based on a dynamic probit model, we could estimate the probability that company i executes FDI in period t . Following ROC analysis, a cut-off rate can be justified, which yields expected and unexpected FDI. The second step would insert unanticipated FDI into the regression framework (5); thus, only exogenous FDI influences ROE. Note that λ denotes a vector with additional exogenous variables like firm size. This procedure, however, has several pitfalls, namely the error-terms of the second step are contaminated and determining an appropriate cut-off rate is a tricky issue.⁹

$$ROE_i = \alpha + \beta_1 FDI_i + \beta_2' \lambda + u_i \quad (5)$$

VAR models in contrast do not require predefining exogenous variables; hence, they might be an alternative approach. We could write a standard VAR in the following manner assuming the same exogenous variables in both equations

$$\begin{aligned} ROE_{it} &= \alpha_1 + \sum_{j=1}^q \beta_{1j} ROE_{it-j} + \sum_{j=1}^q \gamma_{1j} FDI_{it-j} + \vartheta_1' \lambda + u_{it} \\ FDI_{it} &= \alpha_2 + \sum_{j=1}^q \beta_{2j} ROE_{it-j} + \sum_{j=1}^q \gamma_{2j} FDI_{it-j} + \vartheta_2' \lambda + e_{it} \end{aligned} \quad (6)$$

For continuous and observable variables, OLS or GMM produce reliable estimates – but the variable FDI is binary. As the decision to conduct FDI could be described as a Bernoulli-process (“to invest or not to invest”) with probability p , we cannot insert FDI and ROE into a standard VAR specification. Dueker (2005) proposes a Qual VAR (Qualitative VAR)

⁹ One can avoid determining a cut-off rate by inserting predicted probabilities instead of unanticipated FDI into regression (5); however, the first step still influences the error terms of regression (5).

approach that accounts for the latent variable problem and hence can deal with binary variables.¹⁰ We apply his procedure and specify a Qual VAR; thus, FDI follows a Bernoulli-process, and a logit model that accounts for lagged ROE and other exogenous variables can explain the probability of FDI. Lagged FDI in turn affects ROE as described in model (6). Returns on equity follow a normal distribution as implicitly assumed in standard VAR models; however, we could also allow fat-tails – but our results do not differ. Consequently, our model has the following structure.¹¹

$$\begin{aligned}
 ROE_{it} &\sim N(\mu_{it} | FDI_{it}, \sigma^2) & (7) \\
 E(ROE_{it} | FDI_{it}) &= \alpha_1 + \sum_{j=1}^q \beta_{1j} ROE_{it-j} + \sum_{j=1}^q \gamma_{1j} FDI_{it-j} + \vartheta_1' \lambda \\
 FDI_{it} &\sim \text{Bernoulli}(p_{it} | ROE_{it}) \\
 \text{logit}(p_{it} | ROE_{it}) &= \alpha_2 + \sum_{j=1}^q \beta_{2j} ROE_{it-j} + \sum_{j=1}^q \gamma_{2j} FDI_{it-j} + \vartheta_2' \lambda
 \end{aligned}$$

As the total likelihood of the two-equation system cannot be easily specified, we again follow Dueker (2005), who proposed a Markov-Chain Monte Carlo technique (MCMC).¹² Initial values for parameters can be specified; however, we prefer to sample initial values from priori distributions, namely normal distributions for coefficients and gamma distributions for variance terms.¹³ The Gibbs sampler can handle parameters that should be determined simultaneously – but are actually estimated in a sequential process.¹⁴ All coefficients have a

¹⁰ The latent variable in Dueker (2005) is an indicator variable of recessions, which might improve forecasts of macroeconomic time series.

¹¹ Note that we specify conditional distributions, as the complete likelihood of the two-equations model cannot be easily derived (see Dueker, 2005).

¹² We used Openbugs 2.1.1 to run MCMC models. This software package can be downloaded.

¹³ Note that Openbugs works with precision matrices instead of variance-covariance matrices; hence, one has to invert precision matrices to obtain estimates for variances and covariances.

¹⁴ Note that we can only determine conditional distributions, as the complete likelihood of the two-equation system cannot be determined analytically (see Dueker, 2005). Hence, we treat a simultaneous system as a sequential problem.

flat normal distribution as prior; thus, our Bayesian MCMC approach converges to maximum likelihood estimates. To run the MCMC, we apply a standard Gibbs sampler with 1000 iterations. In order to generate a possibility for comparison with our MCMC estimates, we also run model (6) using OLS and hence treating the model as normal VAR. Based on Hannan-Quinn, Schwarz, and Akaike information criteria, we set the lag number q equal to one. Table 4 contains our results and underlines that FDI does not increase returns on equity; thus, we cannot claim that FDI was generally successful. Our results suggest that FDI was more likely if the company conducted already FDI in previous periods. Besides the serial dependency of FDI, firm size is the only consistent predictor for FDI emphasizing the overall importance of economies of scale for entering foreign markets. To show that our MCMC estimates converge, figure A.1. plots the history of the estimation procedure for every iteration.

5. Conclusion

We have studied a new database on German FDI transactions that were conducted by joint stock companies between the 1870s and late 1920s. We collected data on 377 companies, which conducted almost 1000 foreign direct investments, and added a control group of 556 companies that exhibits the same industry composition. This allowed testing the question: which companies are more likely to perform FDI? Following Helpman et al. (2004) who emphasized the importance of firm size and efficiency for the late 20th century, we find that similar factors were at work in the late 19th and early 20th centuries. We also assessed in more detail whether yet unused economies of scale of smaller companies on the domestic market might have hindered companies to engage in FDI. We find that this was actually a quite important determinant, although the results were only significant in two of three specifications. Companies founded in later years exhibited a higher tendency to invest abroad.

In a second step, we analyzed the destination choice of German companies going abroad. We aggregated individual investment streams by host countries and by the time of investment, which resulted in an unbalanced panel. Our extended capital-knowledge model confirmed the predominant role of horizontal investment strategies already in the late 19th and early 20th century. Interestingly, we also found some evidence for vertical FDI, as wage differential caused FDI inflows. In contrast, differences in human capital did not have a measurable impact presumably because German firms brought their proprietary knowledge with them and hence did not have to rely on human capital of host countries. We also assessed the effect of distance, both geographic and cultural, the latter captured by the proxy common language. It turned out that the same language was by far more important than simple geographic distance, which is certainly an interesting result.

Finally, we addressed the potential endogeneity between profitability and FDI: do firms conduct FDI, because they are already successful on the home market, or is their profitability stimulated by entering foreign markets? Controlling for this dual causality by a Qual VAR approach, we actually find that profitability was not a significant determinant of FDI and vice versa. In contrast, previous FDI was a relatively strong predictor of subsequent FDI, and firm size remained a crucial determinant for FDI also in this specification.

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Table 1. Descriptive Statistics

Joint stock companies ...	Obs.	Mean	Std. Dev.	Min	Max
with FDI					
Foreign direct investment	376	636508.700	1705981.000	1000.000	23700000.000
log(size)	948	15.808	1.541	9.210	20.500
roe	948	0.101	0.224	-0.996	1.759
year of firm creation	948	1893.956	16.546	1825	1927
without FDI					
Foreign direct investment	0	0.000	0.000	0.000	0.000
log(size)	595	14.503	1.349	9.210	19.388
roe	595	0.058	0.297	-3.419	1.242
year of firm creation	594	1895.382	16.328	1816	1927
in electrical industry					
Foreign direct investment	95	1148860.000	1552101.000	2036.000	7374750.000
log(size)	315	16.515	1.753	9.903	18.982
roe	315	0.120	0.090	-0.283	1.008
year of firm creation	315	1898.251	12.222	1871	1927
in machinery industry					
Foreign direct investment	45	7.914	4.344	2.485	14.403
log(size)	302	14.983	1.272	9.210	17.074
roe	302	0.010	0.330	-2.102	0.958
year of firm creation	302	1898.185	16.769	1846	1927
in chemical industry					
Foreign direct investment	53	451707.400	868974.000	1000.000	4000000.000
log(size)	201	14.866	1.259	10.127	17.399
roe	201	0.118	0.226	-0.485	1.673
year of firm creation	200	1893.295	17.292	1835	1923
in metal processing industry					
Foreign direct investment	32	480198.200	707181.600	2000.000	2894477.000
log(size)	184	15.110	1.629	10.309	20.500
roe	184	0.077	0.326	-2.252	1.759
year of firm creation	184	1896	13.856	1844	1927
with FDI in Austria-Hungary					
Foreign direct investment	63	766628.200	1059818.000	2036.000	4766800.000
log(size)	178	15.433	1.424	10.926	20.500
roe	178	0.118	0.215	-0.996	1.759
year of firm creation	178	1893.742	13.864	1862	1927
with FDI in UK					
Foreign direct investment	73	142987.500	249040.900	1000.000	1024590.000
log(size)	126	15.608	1.427	13.122	19.114
roe	126	0.154	0.202	-0.631	1.647
year of firm creation	126	1893.889	14.137	1851	1927
with FDI in France					
Foreign direct investment	33	593384.100	864915.200	8000.000	3214050.000
log(size)	67	15.634	1.424	12.612	18.892
roe	67	0.195	0.315	-0.631	1.759
year of firm creation	67	1893.164	13.257	1856	1922
with FDI in the US					
Foreign direct investment	29	812175.200	2706315.000	5000.000	14700000.000
log(size)	66	15.370	1.199	12.142	18.867
roe	66	0.122	0.158	-0.631	0.643
year of firm creation	66	1891.803	20.435	1824	1923

Table 2. Logit and conditional (fixed-effect) logit models

	(1) Basic model fdi	(2) Industry- effects fdi	(3) Major industries fdi
log(size)	0.605*** (9.97)	0.689*** (10.2)	0.608*** (9.88)
D _{ec. of scale}	-0.383 (-1.51)	-0.614** (-2.22)	-0.507* (-1.93)
roe	0.581** (2.35)	0.833*** (2.97)	0.684*** (2.65)
foundation	0.008** (2.24)	0.015*** (3.43)	0.009** (2.22)
chemical	-	-	0.521*** (2.83)
electric	-	-	-0.137 (-0.73)
machinery	-	-	0.430*** (2.64)
metal	-	-	-0.410** (-2.17)
Constant	-24.355*** (-3.28)	-	-24.916*** (-3.22)
Observations	1542	1492	1542

z statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 3. OLS estimation of gravity models on country level

COEFFICIENT	(4)	(5)	(6)
	country_fdi	country_fdi	country_fdi
sum_gdp	4.159*** (2.97)	5.854** (2.31)	9.369** (2.57)
dispersion	0.024 (0.38)	-0.044 (-0.38)	-0.202 (-1.08)
distance	-0.001 (-1.39)	-0.001* (-1.70)	-0.000 (-0.68)
language	8.213* (1.95)	9.890** (2.13)	13.427*** (2.84)
humancap		3.527 (0.95)	1.171 (0.30)
wagediff			14.611** (2.23)
Constant	-83.178** (-2.64)	-115.438** (-2.30)	-194.449** (-2.65)
Observations	183	178	175
R-squared	0.102	0.107	0.130

Robust t statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

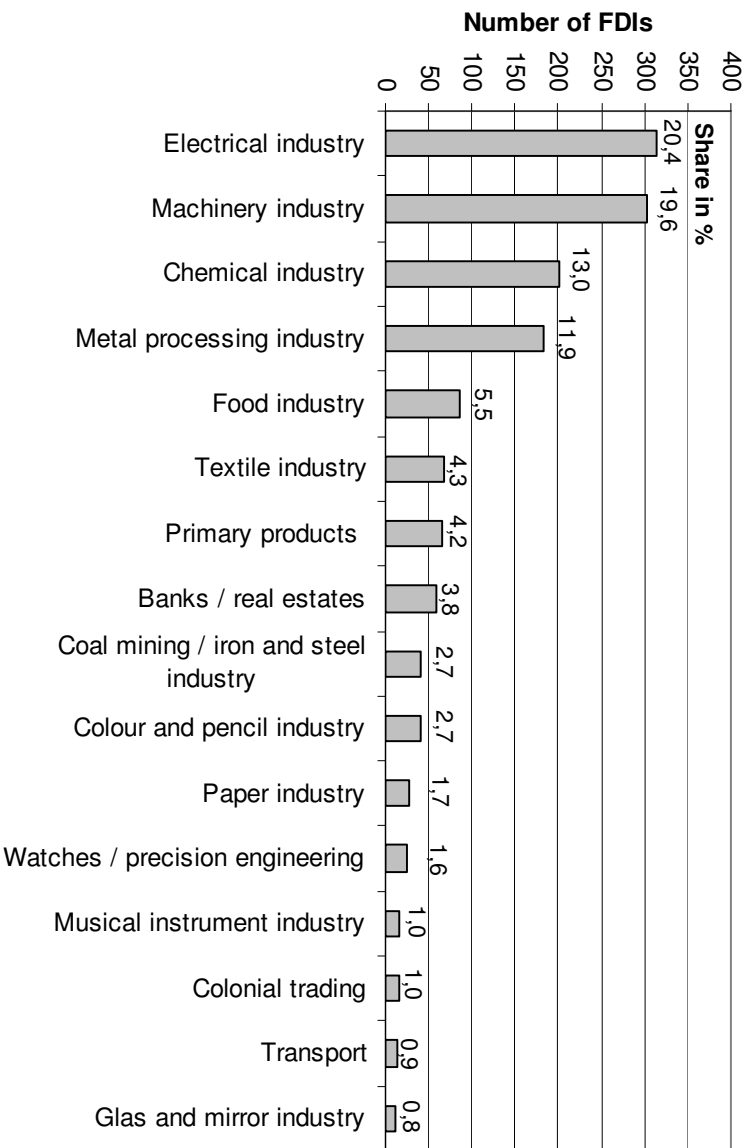
Table 4. VAR model with one lag

COEFFICIENT	OLS		MCMC	
	(7) fdi	(8) roe	(9) fdi	(10) roe
L.fdi	0.435*** (14.2)	0.052** (2.50)	0.433*** (6.23)	-0.0103 (-0.36)
L.roe	-0.057* (-1.66)	0.808*** (35.20)	0.103 (0.38)	0.736*** (31.09)
size	0.009 (1.57)	-0.002 (-0.39)	0.365*** (4.01)	-0.0448 (1.29)
foundation	-0.000 (-0.46)	-0.001** (-2.38)	-0.002** (-2.00)	-0.011*** (-59.12)
chemical	-0.016 (-0.69)	-0.011 (-0.67)	-0.054 (-0.20)	-0.038 (1.48)
electric	-0.025 (-1.10)	0.009 (0.56)	0.088 (0.34)	0.078 (1.61)
machinery	-0.048** (-2.23)	-0.035** (-2.41)	-0.202 (0.93)	-0.033** (-2.00)
metal	-0.075** (-2.40)	0.009 (0.43)	-0.231 (1.09)	0.043 (1.77)
Constant	0.834 (0.94)	1.395** (2.33)	0.0862 (0.30)	34.690*** (673.72)
Observations	610	610	610	610
ROE causal	2.74			
Prob>Chi2	0.0977			
FDI causal	6.270			
Prob>Chi2	0.0123			

z statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 1. The most important industries and their share in total FDI 1873-1927



Data source: 'Handbuch der deutschen Aktiengesellschaften' (1897-1901, 1912, 1927).

Figure 2. Scatter plot of actual ROE and fitted values against firm size

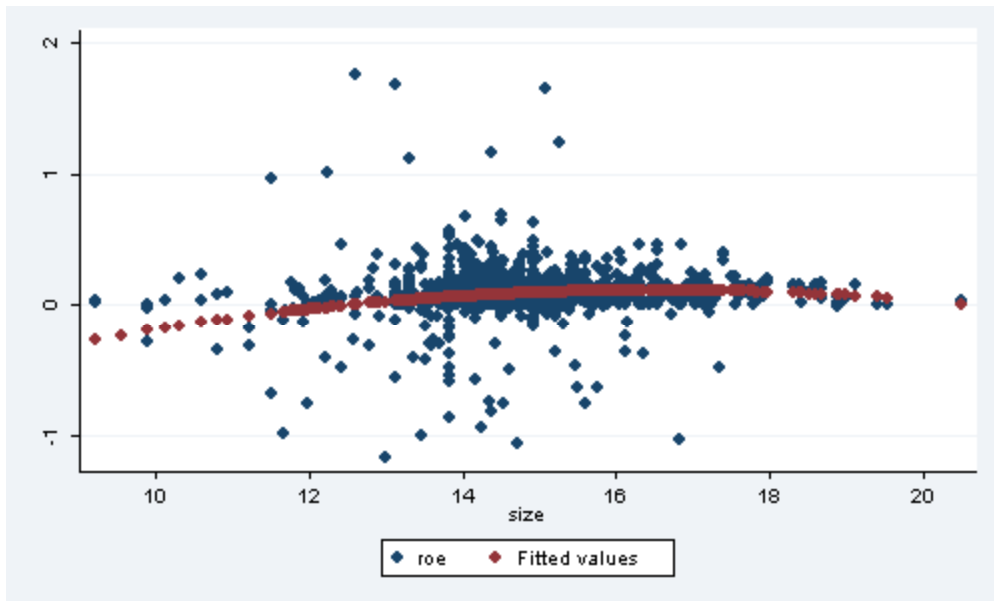
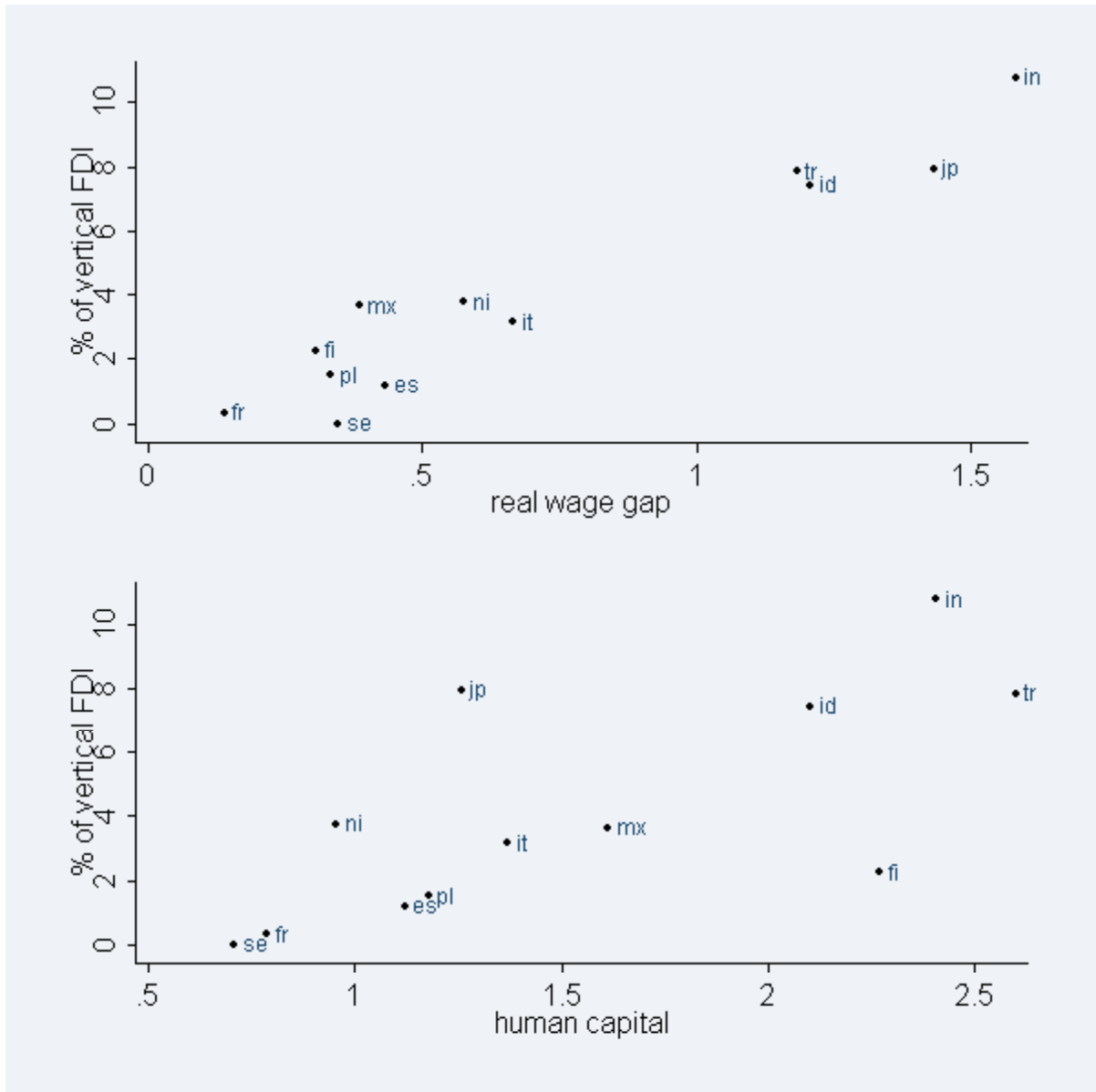


Figure 3. Wage gaps and differences in human capital and vertical FDI



6. Appendix

Table A.1. Variable Definitions and Data Sources.

<i>Endogenous Variables:</i>	
<i>fdi</i>	Dummy variable, 1 = FDI, 0 = no FDI
<i>log (invest)</i>	LN of deflated amount of investment of the respective FDI Data source: 'Handbuch der deutschen Aktiengesellschaften' (1897-1901, 1912, 1927). Amount of investment was deflated, using Hoffmann, W.G. (1965), p.601, col.15.
<i>Exogenous Variables:</i>	
<i>chemical</i>	Dummy variable, 1 = chemical industry, 0 = other industries
<i>dispersion</i>	$(\ln(\text{GDP}_i) - \ln(\text{GDP}_{\text{Home}}))^2$ Maddison, Angus (1995).
<i>distance</i>	Distance between Germany and the country of FDI in km http://www.maclester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/Data/Gravity/dist.txt
<i>Dec_of_scale</i>	Dummy variable, 1=below optimal size (economies of scale still available), 0 = firm exceeds the optimal level of size
<i>electric</i>	Dummy variable, 1 = electrical industry, 0 = other industries
<i>foundation</i>	Year, when joint stock company entered share register Data source: 'Handbuch der deutschen Aktiengesellschaften' (1897-1901, 1912, 1927).
<i>humancap</i>	Measure for technical human capital, see text. Data source: Labuske, K., Baten, J. (2006).
<i>language</i>	Dummy variable, 1 = official language of the host country is German, 0 = other language
<i>machinery</i>	Dummy variable, 1 = machinery industry, 0 = other industries
<i>metal</i>	Dummy variable, 1 = metal working industry, 0 = other industries
<i>patent</i>	Number of patents in the year of FDI Data source: Verzeichnis der von dem kaiserlichen Patentamt im Jahre 1875-1918 erteilten Patente.
<i>roe</i>	Return on equity Data source: 'Handbuch der deutschen Aktiengesellschaften' (1897-1901, 1912, 1927).
<i>log(size)</i>	LN of total equity Data source: 'Handbuch der deutschen Aktiengesellschaften' (1897-1901, 1912, 1927).
<i>sum_gdp</i>	$\ln(\text{GDP}_i) + \ln(\text{GDP}_{\text{Home}})$ Maddison, Angus (1995).
<i>wagediff</i>	$\ln(\text{wage}_{\text{Home}}) - \ln(\text{wage}_i)$ Data source: Williamson, Jeffrey G. (1995).

Figure A.1. Convergence of the MCMC estimation