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Discussion Paper

Deutsche Bundesbank
No 24/2013

Testing the O-ring theory for FDI

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Internet http://www.bundesbank.de

ISBN 978–3–86558–929–3 (Printversion)
ISBN 978–3–86558–930–9 (Internetversion)

Non-technical summary

This paper analyzes which country characteristics determine firms' decisions where to locate production in foreign countries and how this relates to the stage of the production process that shall be placed abroad. Most of today's production processes involve several stages which can be performed simultaneously or sequentially. Firms may split these stages across several countries. These global supply chains are increasingly subject to public debate. Especially policy makers of developing and emerging countries aim at participating in global supply chains and then moving down towards those stages, which yield higher value added (see discussion at the WTO Public Forum 2012, Session 22).[1] Therefore, it is of high relevance for policy makers which country characteristics matter for attracting FDI in more downstream sectors.

In order to analyze global value chains, we apply the idea of Kremer (1993) and Costinot, Vogel, and Wang (2011) to the case of FDI. These papers implement a sequential production process involving several stages which are subject to mistakes. For the product to have full value, all stages have to be completed successfully. Hence, most value can be lost at stages at the end of the value chain. Kremer (1993) and Costinot et al. (2011) find that countries with higher productivities specialize in later stages of production, which Kremer (1993) has called the O-ring theory of economic development. In line with these results, our hypothesis is that firms locate affiliates that produce goods that are positioned at later stages in the production process in countries with lower propensities to making mistakes, i.e., more productive countries.

In order to test this hypothesis, we use firm level panel data for the years 1999 to 2006 on the universe of German multinationals and their activities abroad, which is provided by Biewen, Lipponer, Scholz, and Schultz (2013). In order to capture the affiliate sector's position in a value chain we employ the measure of upstreamness by Antràs, Chor, Fally, and Hillberry (2012). It considers the number of stages at which a sector enters production processes before the final use of a product. Furthermore, we add countries' productivity as a key explanatory variable. We find that a destination country's productivity becomes more important for a firm's investment decision if the affiliate sector is positioned more toward the end of the value chain. Hence, we can confirm the implications of the O-ring theory for FDI. This paper provides a first empirical test of the sorting pattern predicted by Kremer (1993) and Costinot et al. (2011) using data on FDI, which is also relevant from an economic development perspective.

The results are robust as we can show in several robustness checks. In order to make sure that we do not capture market-seeking motives, i.e., that more downstream sectors are located in more attractive markets, we conduct the same estimations including absolute GDP as an additional control. Moreover, we run our basic regression for vertical FDI only. The results remain robust and we even observe an increase in the coefficients. In addition, we control for other sector characteristics, we look at new entrants only and we use an alternative productivity measure. The results remain robust throughout all of these additional tests.

[1] http://www.wto.org/english/forums_e/public_forum12_e/programme_e.htm#session22

Nicht-technische Zusammenfassung

Dieses Papier befasst sich mit der Frage, ob die Ansiedlungsentscheidungen von Unternehmen mit der Position des zu verlagernden Sektors in der Wertschöpfungskette zusammenhängt und von welchen Ländercharakteristika diese Entscheidung beeinflusst wird. Heutzutage findet eine Vielzahl von Produktionsprozessen über mehrere Stufen statt, welche entweder simultan oder sequentiell durchgeführt werden können. Zudem können diese Produktionsstufen in unterschiedlichen Ländern angesiedelt sein. Globale Wertschöpfungsketten sind daher vermehrt Inhalt öffentlicher Debatten. Insbesondere Entwicklungs- und Schwellenländer streben danach, Teil solcher globaler Wertschöpfungsketten zu werden, um sich kontinuierlich hin zu der Produktion solcher Güter mit hoher Wertschöpfung zu entwickeln (siehe die Diskussion auf dem Public Forum der WTO 2012, Session 22).[2] Daher ist es für die öffentlichen Entscheidungsträger in diesen Ländern wichtig zu wissen, welche Standortfaktoren für ausländische Investitionen mit hoher Wertschöpfung entscheidend sind.

Um die Ansiedlungsentscheidungen von Unternehmen empirisch zu untersuchen, übertragen wir die O-Ring Theorie von Kremer (1993) und Costinot et al. (2011) auf ausländische Direktinvestitionen. Die O-Ring Theorie beinhaltet einen sequentiellen Produktionsprozess, der mehrere Stufen umfasst, in denen Fehler gemacht werden können. Damit das Produkt seinen vollen Wert erreicht, müssen alle Produktionsstufen fehlerfrei ausgeführt werden. Daher kann der größte Wertverlust bei Defekten am Ende der Wertschöpfungskette entstehen. Eine Hypothese der O-Ring Theorie ist demnach, dass produktivere Länder sich auf nachgelagerte Stufen der Wertschöpfungskette spezialisieren. Übertragen auf ausländische Direktinvestitionen testen wir die Hypothese, dass Unternehmen Tochterunternehmen in späteren Stufen der Wertschöpfungskette mit höherer Wahrscheinlichkeit in produktiveren Ländern ansiedeln.

Wir testen diese Hypothese mit Firmendaten zu der Gesamtheit deutscher multinationaler Unternehmen für die Jahre 1999 bis 2006 von Biewen et al. (2013). Um die Position eines Sektors in der Wertschöpfungskette zu messen, nutzen wir das Maß von Antràs et al. (2012). Es misst auf welcher Stufe (vor dem Endverbrauch) ein Sektor in andere Produktionsprozesse eingeht. Mit Hilfe eines linearen Wahrscheinlichkeitsmodells schätzen wir den Einfluss der Produktivität eines Landes, der Position des Sektors in der Wertschöpfungskette und einer Kombination der beiden auf die Entscheidung eines Unternehmens, in ein Land zu investieren. Die empirischen Ergebnisse bestätigen die Hypothese. Tochterunternehmen in nachgelagerten Sektoren sind mit höherer Wahrscheinlichkeit in produktiveren Ländern angesiedelt. Damit liefern wir mit diesem Papier einen ersten empirischen Test des Selektionsmusters entsprechend Kremer (1993) und Costinot et al. (2011) anhand von Daten zu ausländischen Direktinvestitionen, das auch aus entwicklungstheoretischer Sicht von großer Relevanz ist.

Die Robustheit der empirischen Ergebnisse wird durch weitere Tests belegt. Um die Attraktivität eines Standortes als Absatzmarkt für nachgelagerte Sektoren als Treiber der empirischen Ergebnisse auszuschließen, schätzen wir unser Modell mit dem absoluten Bruttoinlandsprodukt als weiterer erklärender Variable und nur für vertikales FDI. Außerdem kontrollieren wir für weitere Sektorcharakteristika, schauen uns nur neu eintretende Tochterunternehmen an und nutzen ein alternatives Produktivitätsmaß. Die Ergebnisse bleiben in all diesen Tests robust.

[2] http://www.wto.org/english/forums_e/public_forum12_e/programme_e.htm#session22

Bundesbank Discussion Paper No 24/2013

Testing the O-Ring Theory for FDI[‡]

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Abstract

Modern production processes often involve several sequential stages which are performed in many different countries. This pattern of vertical specialization does not only affect trade between countries but it is also of importance for foreign direct investment (FDI). In this paper, we therefore adopt the idea of Kremer (1993) and Costinot et al. (2011) of a sequential production process which is subject to mistakes to the theory of FDI. Using firm-level panel data on German outward FDI, we show that the affiliate sector's position in the value chain affects the firm's FDI location choice. Affiliates in sectors that are positioned toward the end of the value chain are more likely to be located in more productive countries.

Keywords: Foreign Direct Investment, O-Ring Theory, Upstreamness

JEL classification: F14, F23

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1 Introduction

Most of today's production processes involve several stages which have to be performed sequentially and firms may split them across several countries. Countries, in turn, specialize in particular stages of the production process, which Hummels, Ishii, and Yi (2001) term *vertical specialization*. This type of specialization has constantly grown over the last decades. Hummels et al. (2001) find that it grew by almost 30% between 1970 and 1990.[1] Notably, vertical specialization does not only affect trade flows between countries but it is also of importance for foreign direct investment (FDI). A firm may decide to relocate a production stage to a country that has specialized in this particular stage.

In this paper, we therefore adopt the idea of Kremer (1993) and Costinot et al. (2011) to the case of FDI. They model a sequential production process involving several stages, which are subject to mistakes. For the product to have full value all stages have to be completed successfully. Hence, the highest value can be lost at stages at the end of the value chain. Kremer (1993) termed this the O-ring theory referring to the space shuttle Challenger which broke apart due to a problem of one of its thousands of components, the O-ring. Kremer (1993) and Costinot et al. (2011) find that countries with lower probabilities of making mistakes specialize in later stages of production.[2] In line with these results, our hypothesis is that firms locate affiliates that produce goods that are positioned at later stages in the production process in countries with lower propensities to making mistakes.

To test this hypothesis, we use firm level panel data for the years 1999 to 2006 on the universe of German multinationals and their activities abroad, which is provided by the Biewen et al. (2013). To capture the affiliate sector's position in a value chain we employ the measure of upstreamness introduced by Antràs et al. (2012). It considers the number of stages at which a sector enters production processes before the final use of a product. We compute this measure using input-output tables for Germany from the OECD STAN database for the periods of early 2000 and mid 2000. Furthermore, Costinot et al. (2011) argue that a country's propensity to making mistakes can be approximated by the inverse of a country's total factor productivity (TFP). Therefore, we use a country's TFP to test our hypothesis. Each parent firm faces a 0/1-decision whether to invest in a certain country at a certain time. To capture this in our data, we inflate the dataset over countries and over year for every affiliate the parent firm has once invested in. Using a linear probability model (LPM), we estimate the effect of TFP, the affiliate sector's upstreamness, and an interaction term of the two on the parent firm's FDI location decision while also controlling for parent firm, country and year fixed effects.

The results confirm the O-ring theory for FDI. We find that a destination country's productivity is more important for a firm's investment decision if the affiliate sector is positioned more toward the end of the value chain. We can show that this effect is not only statistically but also economically significant and that it is of about the same size as the effect of a country's productivity as such. To make sure that we do not capture market-seeking motives, i.e., more downstream sectors are located in more attractive markets, we

[1] The countries analyzed are Australia, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, United Kingdom, United States, Ireland, Korea, Taiwan, and Mexico.

[2] Another paper which needs to be mentioned in line with Kremer (1993) and Costinot et al. (2011) is Jones (2008), which also implements a production process that exhibits complementarities.

conduct the same estimations including absolute GDP as an additional control. Moreover, we run our basic regression for vertical FDI only. The results remain robust and we even observe an increase in the coefficients. Furthermore, we control for other sector characteristics, we look at new entrants only and we use an alternative productivity measure. The results remain robust throughout all of these additional tests.

To the best of our knowledge, we are the first to relate the idea of Kremer (1993) and Costinot et al. (2011) to the FDI location decision. Using a production function in which production consists of a number of sequential tasks, all of which have to be successfully completed for the product to have full value, we can explain the attractiveness of certain countries for certain investment projects. More developed countries attract FDI in those sectors which are located at later stages of the production process. As shown by Fally (2012), over the last 50 years there has been a large shift of value added towards more downstream industries, i.e., those located more at the end of the production process. Therefore, we can give a potential explanation for the widening gap of economic development between high-income and low-income countries and how FDI explicitly contributes to this.[3]

Two other papers also combine the concept of complementary production processes and FDI. First, Chang and Lu (2012) introduce risk into a model of whether to conduct FDI by extending the idea of Kremer (1993). The risk of FDI increases with a firm's production technology. The latter is measured in terms of the number of stages, which constitute the production process. Chang and Lu (2012) find that only firms of intermediate technology levels find FDI profitable. Their study focuses on the firm level determinants of the FDI decision whereas our study analyzes the country level determinants of the firm's location decision.

Second, Antràs and Chor (2012) develop a property-rights model of the firm including a similar production function as Kremer (1993). They analyze the optimal allocation of ownership rights along the value chain, i.e., whether the incentives to integrate increase or decrease for earlier or later stages of the value chain. They also test their model empirically. Although the authors apply the same production function of FDI their focus is different. While Antràs and Chor (2012) analyze why only some stages are integrated, we look at why certain affiliates are located in certain countries.

The remainder of this paper is organized as follows. In section 4.2, we present the data used in the estimation and show summary statistics. Section 4.3 explains our empirical strategy. In section 4.4, we then present our estimation results. Section 4.5 discusses our robustness checks. Section 4.6 concludes.

2 Data

2.1 FDI Data

We use firm level data on the universe of German multinationals and their activity abroad, which is provided by the Biewen et al. (2013) in the Microdatabase Direct investment (MiDi). This is a panel dataset for the years 1996 to 2010 of which we consider the

[3] In this respect, our findings are related to Manova and Yu (2012) whose results imply that financially underdeveloped countries may encounter difficulties to progress from low value-added production stages to more profitable ones.

years 1999 to 2006.[4] We only consider German outward FDI. As the reporting thresholds have changed over this period of time, we consider all firms which hold at least 50% of the shares or voting rights of a foreign enterprise, which has a balance sheet total of more than 3 million Euro.[5] These firms are legally required to report to the Deutsche Bundesbank information on the sector, legal form as well as the number of employees and balance sheet information of the foreign affiliate (Biewen et al., 2013). Furthermore, we only consider countries in which at least five affiliates are located. Thereby, we can exclude small countries in which only very few affiliates are located that play a dominant role and therefore may influence country characteristics. Our sample comprises a total of 3919 parent firms holding foreign affiliates in at least one of the 33 host countries and in at least one of the years from 1999 to 2006.[6] The countries included in our estimation sample are listed in Table 10 in Appendix A. With these, we cover 67.5% of total German outward FDI activities.[7]

2.2 Upstreamness Measure

In order to capture at which stage of a production process an affiliate sector is located, we employ the measure of *upstreamness* developed by Antràs et al. (2012). The variable considers the number of stages at which the sector enters into a production process before final use of the resulting product. Antràs et al. (2012) present three approaches which they prove to yield equivalent measures of industry upstreamness. We present one of the approaches to demonstrate the construction of the measure of upstreamness. Considering an open economy, the value of gross output for each industry (Y_i, with $i \in 1, 2, ..., N$) equals the sum of its use as a final good (F_i), its use as an intermediate input to other industries and exports (X_i) minus imports (M_i). The use as an intermediate input is measured as the Euro amount of sector i's output (d_{ij}) needed to produce one Euro worth of industry j's output (Y_j):

$$Y_i = F_i + \sum_{j=1}^{N} d_{ij} Y_j + X_i - M_i.$$

In the input-output tables we do not observe d_{ij} as the data does not distinguish between domestic and international flows of goods. What can be observed is

$$\delta_{ij} = \frac{d_{ij} Y_j + X_{ij} - M_{ij}}{Y_i}.$$

However, to disentangle $d_{ij} Y_i$, we lack information on international inter-industry trade flows, M_{ij} and X_{ij}. Therefore, as in Antràs et al. (2012) we have to assume that the share of industry i's exports (imports) that are used in industry j (be it at home or abroad)

[4] We cannot use more years due to computational limitations.

[5] We also deflate the balance sheet total to make the data comparable over time.

[6] For a more detailed description of the estimation sample refer to Appendix A.

[7] Unfortunately, due to data limitations with respect to country characteristics, the regression sample does not comprise, *inter alia*, the destination countries China and Switzerland as well as the Eastern European countries.

is the same as the share of industry i's output used in industry j. d_{ij} then has to be replaced by

$$\hat{d}_{ij} = d_{ij} \frac{Y_i}{Y_i - X_i + M_i},$$

where the denominator is the domestic absorption of industry i's output.

Hence, we can compute the average position of a sector's output in the value chain as

$$U_i = 1 \cdot \frac{F_i}{Y_i} + 2 \cdot \frac{\sum_{j=1}^{N} \hat{d}_{ij} F_j}{Y_i} + 3 \cdot \frac{\sum_{j=1}^{N} \sum_{k=1}^{N} \hat{d}_{ik} \hat{d}_{kj} F_j}{Y_i} + ..., \tag{1}$$

where the use of the industry's output at different positions in the value chain, starting with final use, is multiplied by their distance from final use plus one and divided by Y_i. Note that $U_i \geq 1$. The interpretation of this measure is straightforward: the larger U_i the more upstream the industry.

We compute this measure using input-output tables for Germany from the OECD STAN database (OECD, 2012) for the periods of early 2000 and mid 2000.[8] Table 1 shows the mean upstreamness over the two periods for several sectors. In order to gain a better intuition for the measure, we present the five least upstream sectors and the five most upstream sectors. Among the five least upstream sectors are two service sectors (hotels and restaurants and the construction sector) as well as the manufacture of textiles, food products, and furniture.[9] The five most upstream sectors are water transport, renting of machinery, other business activities, supporting and auxiliary transport activities, and the manufacture of basic metals.[10]

Figure 2 in Appendix A shows the average upstreamness measure over the two time periods of early and mid 2000 for each sector. The measure of upstreamness ranges from 1.34 to 3.67. An upstreamness measure of 1 would imply that the sector's output is used only in final consumption. The maximum value of about 4 means that the sector's ouput is used in some industries (at least one) as an input in the first stage of a production process involving four stages. Its mean value across the 47 industries in our regression sample is 2.14 with a standard deviation of 0.54. This result is similar to Fally (2012) who finds that production chains involve on average less than two stages. Table 8 in Appendix A shows how the upstreamness variable varies over time. We compare the rankings of the ten least upstream and the ten most upstream sectors over the two time periods early 2000 and mid 2000. As we can see from Table 8, the upstreamness measure varies over time, but the variation is not very strong. Out of the 20 sectors listed, six sectors do not vary in their ranking over time. The rest varies between one to three places. Therefore, if we identify an effect of a sector's upstreamness on the investment probability, it is mainly driven by the variation across sectors and not by the variation of the upstreamness measure over time.

In order to get a first impression on whether our hypothesis, that more upstream affiliates are more likely to be located in less productive countries, holds true, we look

[8] The data for early 2000 is used for the period 1999 to 2002, and mid 2000 is used for 2003 to 2006.

[9] We would have expected the retail sector to be under the five least upstream sectors. However, in the OECD STAN input-output tables the wholesale and retail sector are aggregated. Therefore, the two combined are ranked eighth of the least upstream sectors.

[10] Note that we have excluded activities related to the extraction of natural resources, such as mining. These belong to the most upstream activities.

Table 1: Summary Statistics of Upstreamness Measure

Sector	Upstreamness
Least Upstream Sectors	
Hotels and restaurants	1.3410
Construction sector	1.4041
Manufacture of textiles	1.4792
Manufacture of food products and beverages	1.4792
Manufacture of furniture	1.5596
Most Upstream Sectors	
Water transport	2.9793
Renting of Machinery and Equipment	3.0677
Other business activities	3.0938
Supporting and auxiliary transport activities	3.0969
Manufacture of basic metals	3.6734

The table contains the five least and the five most upstream sectors according to the mean upstreamness measure over the two time periods early 2000 and mid 2000.

at the average upstreamness of affiliates located in different country groups. We categorize countries according to their GDP per capita using the World Bank classification of country incomes (World Bank, 2011). In Figure 1, the country-income group 2 comprises lower-middle income countries, group 3 upper-middle income countries, group 4 high-income OECD countries, and group 5 high-income non-OECD countries.[11] Figure 1 clearly shows that the average upstreamness is lower in more developed countries. As the more developed countries generally are also the more productive ones, this can be taken as first suggestive evidence for our hypothesis.

2.3 Country Characteristics

We seek to analyze whether a country's overall propensity to making mistakes plays a more important role for more downstream industries. Therefore, we need a measure of a country's failure rate. Following the argument of Costinot et al. (2011) that a country's propensity to making mistakes can be interpreted as the inverse of a country's TFP, we use TFP obtained from the World Productivity Database (UNIDO, 2012).[12] In our basic specification we use TFP, *upstreamness*, and an interaction term of the two, i.e.,

[11] Note that our sample does not include low-income countries, i.e., country-income group 1.

[12] The database offers ten-year forecasts of TFP growth which are then used to forecast TFP levels, which we use. Note that TFP level forecasts are calculated for different measures of capital stock. Because of data availability issues (i.e., the number of year-country data points) we use the one based on capital stock calculated in terms of physical efficiency. I.e., capital is assumed to underlie a time-varying depreciation rate. The TFP measure is scaled relatively to the US. See Isaksson (2007) for a detailed technical documentation.

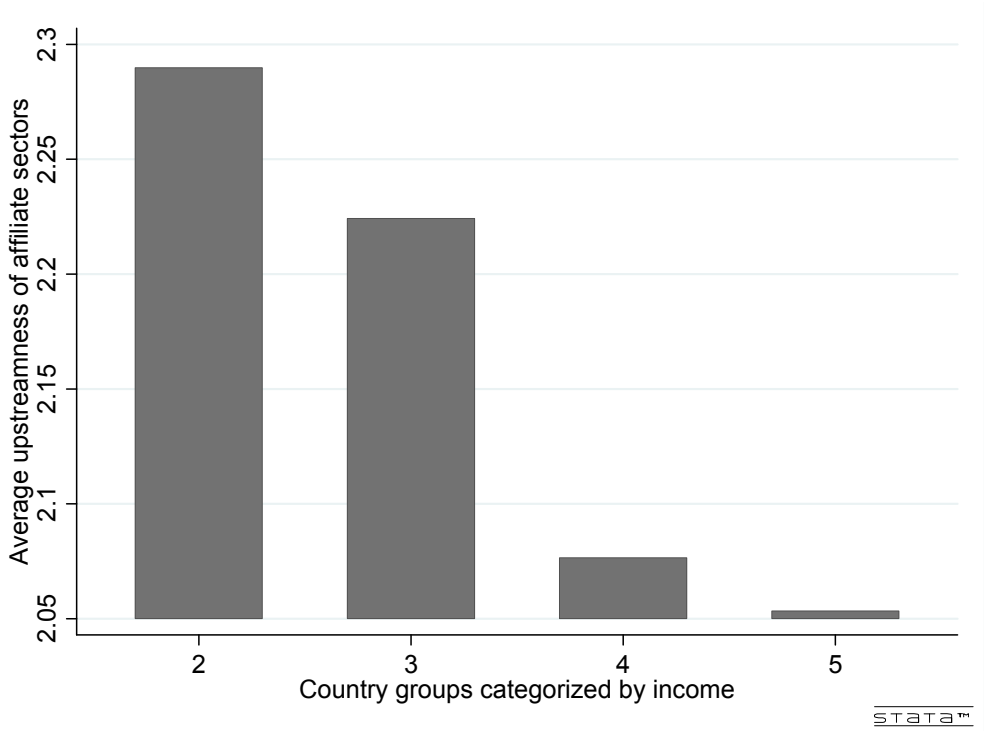

Figure 1: Average Upstreamness of Affiliate Sectors in Different Country-Income Groups

upstreamness∗ *TFP*.[13]

We run the basic specification also controlling for various other country characteristics in order to see whether the effect of the interaction term of *upstreamness* with TFP persists. As a geography measure we use a country's *remoteness*. This variable measures the distance of the host country from all other countries in the world weighted by those other countries' share of world GDP (see Blonigen and Piger, 2011). It captures export-platform motives, i.e., a firm invests in a country to export to other surrounding countries (Ekholm, Forslid, and Markusen, 2007).

To control for factor endowments, we use *average years of schooling*, *average wages*, and *capital intensity*. *Average years of schooling* is obtained from the Barro and Lee (2010) table of educational attainment. We use the measure for male and female persons aged 25 years and older. This data is available in five-year intervals from 1950 to 2010. In order to be able to use the data for our panel analysis, starting with 2000 we replace the missing two years before and after the year for which the data is available with the value of that year. Further, we include *monthly average wages* as a factor-cost measure. The wage dataset was prepared by Harsch and Kleinert (2011) making use of the October Inquiry database of the International Labor Organization (ILO). Average wages may capture conventional cost-saving motives associated with vertical FDI. In order to capture the countries' capital endowment, we calculate *capital intensity* as log physical capital per worker using Penn World Table data following Antràs et al. (2012).

To control for a country's institutional environment, we include the variable *rule of law*

[13]Our measure of TFP is country-specific but does not vary across sectors. We would like to use a country- and sector-specific measure of productivity as we would presume to get even more clear-cut results. However, this data is very limited. The EU Klems data contains a measure of productivity which varies across sectors. Unfortunately, it is only available for six countries.

from the World Bank, which measures contract enforceability and protection of property rights.[14] As a measure of a country's *financial development* we include the ratio of private credit to GDP from Beck, Demirgüç-Kunt, and Levine (2010). In order to control for the fixed cost of setting up a foreign affiliate, we include the variable *market entry*. It is an index computed in five-year intervals since 1970 and annually since 2000. The latest update is published in the 2011 Economic Freedom of the World annual report (Gwartney, Lawson, and Hall, 2011). It measures the performance of countries in terms of the cost of starting a new business. As such, it captures the time (measured in days) necessary to comply with regulations when starting a limited liability company, money costs of the fees paid to regulatory authorities (measured as a share of per-capita income), and funds that must be deposited into a company bank account (measured as a share of per capita income).

In several robustness checks, we include different sector or country level controls and an alternative productivity measure. First, we add absolute GDP obtained from the World Bank to control for market size. Second, we include a dummy variable indicating whether a country has a comparative advantage in a specific sector using data from the WTO trade statistics (WTO, 2012) and following Mayda and Rodrik (2005) who have proposed this measure of comparative advantage. Third, we replace TFP by an alternative measure of productivity. Kremer (1993) focuses in his theoretical model on the skill level of workers. The line of reasoning is that more highly skilled workers are less likely to make mistakes. Therefore, we include a measure of labor productivity, i.e., output per worker, measured as an annual average at the country level, which we obtain from the Total Economy Database (The Conference Board, 2012).

Table 9 in Appendix A summarizes all variables (dependent and explanatory) used in our regressions. Means and standard deviations are also reported. We have sufficient variation in the country characteristics in our estimation sample, which is mostly cross-sectional and not so much over time.

3 Empirical Strategy

The analysis of the effect of a sector's upstreamness on the firm's investment location decision and how this is related to a country's propensity to making mistakes entails an intriguing question: where will the affiliate be located, i.e., are affiliates at later stages of the value chain more likely to be located in countries with higher productivity? In order to find an answer to this question, we estimate a binary choice model. We inflate the dataset such that each firm may invest in each country, in each year, and in each sector it has been observed to invest in at least once before. Due to the inflation of our dataset we have 96% zeros in our data.

Let y_{ijst} be the outcome of firm i in host country j in sector s in year t ($i = 1, ..., N$, $j = 1, ..., J$, $s = 1, ..., S$, and $t = 1, ..., T$). The binary choice model for y_{ijst} is then given

[14] The actual values range from -2.5 (worst governance) to 2.5 (best governance). As the variable is skewed and in order to take the logarithm, we add 2.5 to each value such that it goes from 0 to 5, a higher value implying better governance.

by

$$P(y_{ijst}|.) = \beta_0 + \beta_1 productivity_{jt-1} + \beta_2 upstreamness_{st} + \beta_3 productivity_{jt-1} * upstreamness_{st} + \alpha_i + \eta_j + \delta_t + \epsilon_{ijst}. \quad (2)$$

y_{ijst} is a binary variable taking on the value of 1 if firm i holds an affiliate in sector s in host country j in year t and 0 otherwise. α_i is a time-invariant parent firm-specific effect, η_j is a country fixed effect and δ_t are time dummies. We control for a country's productivity, the sector's upstreamness and an interaction term of the productivity and the sector's upstreamness.

We estimate the investment location decision by specifying $Pr(y_{ijst}|.)$ as a linear probability model (LPM). Hence, we can directly interpret the regression coefficients, even of interaction effects. Using the LPM compared to nonlinear methods such as a random effects probit model has a distinct advantage: it neither requires a distributional assumption regarding the unobserved effect conditional on the covariates nor does it necessitate the assumption of independence of the responses conditional on the explanatory variables and the unobserved effect (Wooldridge, 2010). However, the linear functional form is almost certainly false. Therefore, in order to test the fit of the linear functional form we calculate the share of predicted probabilities below 0 or above 1. In almost all of our regressions this share amounts to about 5%. Accordingly, estimating an LPM seems to be a reasonable choice as it frees us from making other untestable assumptions.

We include all country characteristics lagged once. First, this acknowledges the duration of an investment decision. We assume that it will probably take about one year from the point when the firm considers investing up to the actual effectuation of the investment. Therefore, the country characteristics at the time when the firm decides upon the investment should matter, and not at the time of the realization of the investment. Second, using lags ensures that there are no unobserved year-specific shocks influencing both, the country's characteristics as well as the firm's investment in the country. Additionally, by including firm-, country-, and year-specific effects we can control for various time-invariant unobserved effects.

We exclude those affiliate sectors that are related to agricultural and mining activities. This way, we make sure that our results are not driven by the availability of natural resources, where firms do not exactly face a choice where to locate an affiliate in order to extract or refine these resources.[15]

We use standard errors clustered at the country level. Hence, we account for the fact that the error terms will probably be correlated within a country but not across countries.[16]

[15] We provide a list of the excluded sectors in the description of the estimation sample in the Appendix A.

[16] Cameron and Miller (2010) have pointed out that cluster-robust inference asymptotics are based on the assumption that the number of clusters goes to infinity. In our sample we have 33 clusters. Therefore, we also use bootstrap standard errors proposed by Cameron and Miller (2010) as a finite-sample adjustment. The results do not differ significantly.

4 Results

4.1 Basic Specification

In our basic specification we regress the binary indicator whether a firm has invested in a particular country on the destination country's total factor productivity, on the affiliate sector's position in the value chain, and on an interaction term of the two. This specification follows closely the model of Costinot et al. (2011) where a country's productivity determines the allocation of sectors with respect to their position in the value chain. In addition, we control for year and country fixed effects. As most country characteristics do not vary a lot over time we, thus, control for observed and unobserved time-constant country effects. The results are reported in Table 2. Columns 1 and 2 show the results for our estimation sample of 33 countries with and without including firm fixed effects. Including firm fixed effects, we control for time-constant firm characteristics that presumably have a high explanatory power for the firm's investment location decision. Only about one third of the parent firms in our estimation sample have affiliates in varying sectors. As firm fixed effects, thus, absorb some of the variation across sectors of the upstreamness variable, we also run the regressions without firm fixed effects. Columns 3 and 4 show the results of the same regression for all countries for which we have data on TFP (52 countries). We run the regressions on these different samples because the estimation sample does not include, for example, China and Switzerland for which not all of our country controls are available.

For both samples and with or without including firm fixed effects, we find that firms are more likely to invest in countries with higher TFP. Controlling for firm fixed effects the coefficient becomes slightly smaller but remains positively significant. We also calculate the overall effect of TFP which can be derived from (2) as

$$\frac{\partial P(y_{ijst}|.)}{\partial log(TFP)_{jt-1}} = \beta_1 + \beta_3 upstreamness_{st},$$

at the mean of the upstreamness variable. The overall effect of TFP remains positive but is smaller with a value of 0.0026 for the regression without firm fixed effects in column 1 and remains about the same with a value of 0.0262 for the regression with firm fixed effects in column 2. The overall effect of TFP remains almost unchanged for the regression with firm fixed effects, because we eliminate a lot of variation of the upstreamness variable by including parent fixed effects. In contrast, in the regression without firm fixed effects we keep the full variation of the upstreamness variable across sectors. This explains the difference in the overall coefficients between the regressions with and without firm fixed effects. Keeping the full variation of the upstreamness variable, the overall effect of TFP is smaller. For a sector in an average position in the value chain, TFP only plays a minor role for the firm's investment decision.

Furthermore, affiliate sectors that are located more at the beginning of the value chain are less likely to be invested in (see columns 1 to 4). This result seems to be surprising. As we analyze German outward FDI and Germany is a country with high TFP, more upstream sectors should be more likely located in less productive countries while more downstream sectors should remain in Germany. In addition, it could also be argued that sectors where less value can be lost, i.e., the ones at the beginning of the value

Table 2: The Influence of a Sector's Position in the Value Chain on the FDI Location Decision I

	(1)	(2)	(3)	(4)
Dep. Var.	y_{ijst}	y_{ijst}	y_{ijst}	y_{ijst}
	Estimation Sample		Larger Sample	
log (TFP)	0.0309**	0.0262	0.0152**	0.0148**
	(0.0144)	(0.0161)	(0.0072)	(0.0071)
Upstreamness	-0.0126***	-0.0235***	-0.0070**	-0.0151***
	(0.0044)	(0.0049)	(0.0033)	(0.0037)
Upstreamness*log(TFP)	-0.0133**	-0.0130**	-0.0069**	-0.0068**
	(0.0052)	(0.0061)	(0.0032)	(0.0032)
Firm FE	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Sector FE	No	No	No	No
Observations	674,833	674,833	1,322,007	1,322,007
Countries	33	33	52	52
Parent firms	3,919	3,919	3,920	3,920
R^2	0.0481	0.0500	0.0510	0.0527

The dependent variable is the binary variable y_{ijst}, taking on the value of 1 if a firm has invested in country j in sector s at time t, and 0 otherwise. Columns 1 and 2 include the basic regression for the estimation sample. Columns 3 and 4 include the basic specification for the larger sample of 52 countries. In all of the regressions we control for country and year fixed effects. We estimate the regressions with and without firm fixed effects. Standard errors clustered at the country level are given in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

chain, are more likely to be relocated as monitoring them is less crucial. However, in line with Antràs and Chor (2012) one could then argue that these stages may rather be outsourced than being kept within the firm, which is something we cannot observe in our data. Furthermore, an intuition for the negative coefficient may be that more upstream sectors such as the manufacture of basic metals entail large initial fixed investment costs, which could reduce the likelihood of investing at all. The overall effect of upstreamness, evaluated at the mean of TFP, is also negative.

For the interaction of upstreamness and TFP the theoretical intuition is clear. Following Costinot et al. (2011), more upstream sectors should be located in less productive countries. In our estimation, we can confirm this hypothesis. The interaction term of upstreamness and TFP is negatively significant for both samples with or without firm fixed effects. This implies that the more upstream an affiliate sector, the less a destination country's productivity matters for the investment decision. Putting it differently, a destination country's productivity becomes more important for a firm's investment decision if

the affiliate sector is positioned more toward the end of the value chain. Hence, we find the O-ring idea to be confirmed for FDI: the more upstream an affiliate sector, the less the productivity of a destination country appears to matter for the decision whether to invest. One might argue that there could be skill spillovers between a parent and its affiliate. Consequently, the host country's productivity should be less important. Nevertheless, we find a country's productivity to be important and even more so for more downstream affiliates. Hence, the effect of a country's productivity on its sectoral specialization may be even stronger for domestically owned firms.

Including firm fixed effects does not alter our results. The signs and significance levels remain unchanged. Only the size of the coefficients varies, but not significantly. Interestingly, controlling for firm fixed effects increases the R-squared by less than 1 percentage point. Hence, time-constant firm characteristics seem to matter less for the decision where to locate an affiliate than we would have expected.

The results are the same for the two samples, except for the size of the coefficients which is smaller in the larger sample including 52 countries. However, the signs of the coefficients remain unchanged and the explanatory variables are still significant.

Table 3: Economic Significance

Dep. Var.	(1) y_{ijst}	(2) y_{ijst}
log(TFP)	0.0651**	0.0606*
Upstreamness	-0.0339***	-0.0633***
Upstreamness*log(TFP)	-0.0628**	-0.0614**

The table contains the *beta coefficients* of columns 1 and 2 of Table 2. *** p<0.01, ** p<0.05, * p<0.1.

These effects are not only statistically but also economically significant. In order to discuss economic significance and to be able to compare the coefficients we calculate *standardized coefficients*, also called *beta coefficients*. Table 3 gives the *beta coefficients* of our basic specification in columns 1 and 2 of Table 2. An increase in TFP by one standard deviation significantly increases the investment probability by about 0.06 standard deviations. If the affiliate sector moves one standard deviation up the value chain, the firm's investment probability decreases by about 0.03 to 0.06 standard deviations. Finally, an increase in the interaction term of TFP and upstreamness by one standard deviation decreases the investment probability by about 0.06 standard deviations. Hence, for the firm's investment location decision the effect of TFP interacted with the affiliate sector's position in the value chain is as important as the effect of TFP itself.

4.2 Controlling for the Number of Affiliates

Following the theory of Costinot et al. (2011), an increase in country j's productivity should make country j more attractive for investments in more downstream sectors. Take the example of three countries: country 1, country 2, and country 3. Country 1 is the most productive, country 2 is less productive, and country 3 is least productive.

If country 3's productivity increases, the most upstream affiliate sectors in country 2 may be relocated to country 3. This leads to a decrease in the average upstreamness measure of both, country 2 and country 3. Hence, in country 3 the productivity increase has induced a decrease in the average upstreamness of the sectors located in country 3. However, the average upstreamness has also decreased in country 2 while country 2's productivity has remained the same. Therefore, we also control for the number of affiliates per country.[17] This should increase the coefficient of the interaction term as those changes in the average upstreamness caused by an exit of the most upstream sectors are accounted for separately.

Indeed, we find our results to remain stable and our coefficients to increase slightly (see columns 1 and 2 of Table 4). Affiliates in more downstream sectors are more likely to be located in more productive countries. The number of affiliates as such has a positive significant effect on the investment probability. Affiliates seem to be located in countries where already other affiliates are located. This may hint at agglomeration effects.

4.3 Additional Country Controls

In columns 3 and 4 of Table 4, we insert additional country characteristics as covariates in our baseline regression: in addition to TFP, upstreamness and the interaction term between the two, we now also control for a country's endowment with human capital *(average years of schooling)* and with physical capital *(capital intensity)*, the labor cost in a country *(average wages)*, the cost of *market entry*, the GDP-weighted distance of the destination country from all other countries in the sample *(remoteness)* as well as a set of factors capturing a country's institutional development *(rule of law, financial development)*.[18]

Except for TFP which becomes insignificant, we find that in our set of original covariates neither the significance levels, nor the sign of the coefficients is altered by adding the additional variables. Only the coefficients' magnitude decreases slightly compared to our regression results in columns 1 to 4 in Table 2 and columns 1 and 2 in Table 4. Looking at the new regressors, we see that only financial development significantly influences the investment decision. Firms are more likely to invest in countries that are more financially developed. A potential reason for the insignificance of most of the country characteristics may be that most of the variables are highly correlated. Nonetheless, controlling for other country characteristics the affiliate sector and the country's TFP still seem to be the drivers of the FDI location choice.

[17] Note that we only control for the number of German affiliates per country. This is the relevant category as the average upstreamness is also based on German affiliates.

[18] Note that when including these additional country characteristics, we have to leave out the country fixed effects due to the new covariates' insufficient variation over time.

Table 4: The Influence of a Sector's Position in the Value Chain on the FDI Location Decision II

	(1)	(2)	(3)	(4)
Dep. Var.	y_{ijst}	y_{ijst}	y_{ijst}	y_{ijst}
	Estimation Sample		Estimation Sample	
log (TFP)	0.0276**	0.0257*	0.0561	0.0569
	(0.0121)	(0.0141)	(0.0405)	(0.0417)
Upstreamness	-0.0126***	-0.0236***	-0.0128***	-0.0238***
	(0.0044)	(0.0049)	(0.0044)	(0.0050)
Upstreamness*log(TFP)	-0.0134**	-0.0130**	-0.0139**	-0.0133**
	(0.0053)	(0.0062)	(0.0052)	(0.0061)
Affiliate Number	0.0184***	0.0193***		
	(0.0043)	(0.0044)		
Average Schooling			-0.0039	-0.0037
			(0.0060)	(0.0060)
log (wage)			0.0219	0.0206
			(0.0222)	(0.0216)
Market entry			-0.0018	-0.0024
			(0.0038)	(0.0030)
log (remoteness)			-0.0416	-0.0411
			(0.0248)	(0.0245)
Rule of Law			-0.0179	-0.0170
			(0.0156)	(0.0147)
log (Fin. Dev.)			0.0257*	0.0259*
			(0.0141)	(0.0141)
log (Capital Intensity)			-0.0130	-0.0134
			(0.0171)	(0.0173)
Firm FE	No	Yes	No	Yes
Country FE	Yes	Yes	No	No
Year FE	Yes	Yes	Yes	Yes
Sector FE	No	No	No	No
Observations	674,833	674,833	674,833	674,833
Countries	33	33	33	33
Parent firms	3,919	3,919	3,919	3,919
R^2	0.0478	0.0497	0.0165	0.0174

The dependent variable is the binary variable y_{ijst}, taking on the value of 1 if a firm has invested in country j in sector s at time t, and 0 otherwise. Columns 1 and 2 contain the basic specification including the number of affiliates. Columns 3 and 4 include the basic specification controlling for other country characteristics. In all of the regressions we control for country and year fixed effects (except for columns 3 and 4, where we do not control for country fixed effects). We estimate the regressions with and without firm fixed effects. Standard errors clustered at the country level are given in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5 Robustness Checks

5.1 Closing the Market-Seeking Channel

In a first robustness check, we test whether our results are driven by market-seeking arguments. The idea is that more downstream sectors are located in more attractive markets which are generally also the more productive ones. Therefore, we rerun our basic regression including a country's absolute gross domestic product (GDP) as a covariate in a first test and analyze only vertical FDI in a second test. First, affiliates are more likely to be located in richer countries if the location decision is driven by market-seeking arguments. Hence, absolute GDP should control for this channel. Second, vertical FDI is by definition not driven by market-seeking motivations but can be explained by cost-saving arguments, i.e., the search for the most cost-efficient production location. Thus, if our results still hold for vertical FDI only, it can be argued that they are not driven by the market-seeking channel.

Columns 1 and 2 of Table 5 report the results when including absolute GDP as an additional control. Our results remain robust. TFP has a positive effect on the investment probability. The more upstream a sector is, the lower the investment probability is. Most importantly, the more downstream the affiliate the more likely the firm is to invest in more productive countries. The size of the coefficients also remains about the same. Absolute GDP is not significant. We would have expected it to be positively significant. Presumably, the variation over time is not sufficient to identify a significant effect as we control for country fixed effects in our regressions. This stresses the validity of our results, as controlling for country fixed effects seems to rule out omitted variable bias, such as absolute GDP influencing TFP and the firm's probability to invest in a country.

The regression results for vertical FDI only are shown in columns 3 and 4 of Table 5. We define vertical FDI as those investments where the parent firm's sector differs from the affiliate's.[19] We find our results to remain robust. Moreover, the coefficients actually increase. Hence, for vertical investments a country's TFP is more important if the sector of the investment project is more downstream.

5.2 Controlling for Other Sectoral Characteristics

One objection to including upstreamness as the only sectoral characteristic may be that this way our results capture various sectoral factors and may, thus, be explained by different theories. Hence, we do two things to alleviate this concern. First, we include a variable that indicates whether country j has a comparative advantage in sector s. We construct this measure following Mayda and Rodrik (2005) who term it *revealed comparative advantage*. The comparative advantage variable is an indicator variable and defined as follows

$$CA_{sj} = \begin{cases} 1, & \text{if } M_{sj} - X_{sj} - \lambda M_{sj} < 0, \\ 0, & \text{if } M_{sj} - X_{sj} - \lambda M_{sj} > 0 \text{ or non-tradable sector.} \end{cases}$$

[19] Due to a lack of data we cannot use the standard identification of vertical FDI where, in addition to the different parent and affiliate sectors, we would also control for trade flows from the affiliate to the parent.

Table 5: Robustness Check: Excluding Market-Seeking

	(1)	(2)	(3)	(4)
Dep. Var.	y_{ijst}	y_{ijst}	y_{ijst}	y_{ijst}
	Estimation Sample		Ver. FDI	
log (TFP)	0.0327**	0.0258	0.0553**	0.0660**
	(0.0160)	(0.0168)	(0.0248)	(0.0305)
Upstreamness	-0.0126***	-0.0234***	-0.0296***	-0.0398***
	(0.0044)	(0.0049)	(0.0081)	(0.0079)
Upstreamness*log(TFP)	-0.0133**	-0.0129**	-0.0227**	-0.0269**
	(0.0052)	(0.0061)	(0.0087)	(0.0112)
log(Absolute GDP)	0.0029	-0.0070		
	(0.0036)	(0.0061)		
Firm FE	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Sector FE	No	No	No	No
Observations	674,833	674,833	338,342	338,342
Countries	33	33	33	33
Parent firms	3,919	3,919	2,348	2,348
R^2	0.0481	0.0501	0.0520	0.0529

The dependent variable is the binary variable y_{ijst}, taking on the value of 1 if a firm has invested in country j in sector s at time t, and 0 otherwise. In columns 1 and 2 we run the basic regression including *log(Absolute GDP)*. In columns 3 and 4 the basic regression is run for vertical FDI only. In all of the regressions we control for country and year fixed effects. We estimate the regressions with and without firm fixed effects. Standard errors clustered at the country level are given in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

λ is an adjustment factor which should take into account the existence of overall trade imbalances. Mayda and Rodrik (2005) define it as:

$$\lambda = \frac{\sum_s (M_s - X_s)}{\sum_s M_s}.$$

The adjustment factor illustrates by which fraction imports would have to be reduced or increased in order to balance the trade account. λ is negative for countries with a trade surplus and positive for those with a trade deficit. Therefore, a sector is defined as a comparative advantage sector if its adjusted net imports are less than zero. The sector is no comparative advantage sector if the adjusted net imports are larger than zero or the sector is non-tradable. We calculate the measure using sectoral trade data from the WTO trade statistics (WTO, 2012).

Columns 1 and 2 of Table 6 report the results when including the comparative advantage measure. Again, our results remain robust. Whether a country has a comparative advantage in a sector does not seem to influence a firm's FDI location decision. Controlling for whether a sector is a comparative advantage sector even increases the coefficients of TFP, upstreamness, and the interaction term of the two.

Table 6: Robustness Check: Controlling for Other Sectoral Characteristics

	(1)	(2)	(3)	(4)
Dep. Var.	y_{ijst}	y_{ijst}	y_{ijst}	y_{ijst}
	Estimation Sample		Estimation Sample	New Entrants
log (TFP)	0.0429**	0.0361**	0.0306**	0.0433***
	(0.0163)	(0.0158)	(0.0144)	(0.0031)
Upstreamness	-0.0164***	-0.0290***		-0.0045***
	(0.0046)	(0.0064)		(0.0012)
Upstreamness*log(TFP)	-0.0178***	-0.0176***	-0.0131**	-0.0063***
	(0.0048)	(0.0049)	(0.0052)	(0.0014)
Comp. adv.	-0.0009	-0.0009		
	(0.0009)	(0.0009)		
Firm FE	No	Yes	No	No
Country FE	Yes	Yes	Yes	No
Year FE	Yes	Yes	Yes	No
Sector FE	No	No	Yes	No
Observations	272,625	272,625	674,833	157,149
Countries	29	29	33	33
Parent firms	3,919	3,919	3,919	3,294
R^2	0.0481	0.0502	0.0545	0.0051

The dependent variable is the binary variable y_{ijst}, taking on the value of 1 if a firm has invested in country j in sector s at time t, and 0 otherwise. In columns 1 and 2 we run the basic regression including *Comp. adv.*. In column 3 the results of the basic regression including sector fixed effects are reported. In column 4 we run the basic regression for new entrants only. In all of the regressions (except for column 4) we control for country and year fixed effects. We estimate the regressions in columns 1 and 2 with and without firm fixed effects. Standard errors clustered at the country level are given in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

Second, we include sector dummies in order to control for time-constant sector characteristics, such as its skill-intensity, and specificity, which can be assumed to be rather constant over time. As upstreamness also hardly varies over time, we exclude the upstreamness variable in this regression. Column 3 of Table 6 shows that the interaction term of upstreamness and TFP remains significantly negative. Therefore, even controlling for other sector characteristics, the link between a country's productivity and a sector's

position in the value chain is a significant explanatory determinant of a firm's FDI location decision.

5.3 New Entrants

Once an affiliate has been set up in a country, it is quite likely that it will remain in that country for a few years. Although we have entry and exit of affiliates in countries over the years, the variation over time is not very large. Therefore, we run our basic specification for new entrants only. This means that we look at the influence of a country's productivity on the initial entry decision for different affiliate sectors. Earlier, we have assumed that the firm decides each year whether to invest in a country if it has not invested in the country before and whether to stay or exit if it already has invested in the country before. Looking only at new entrants implies that we have a cross section. Therefore, we run a LPM without fixed effects.

Column 4 of Table 6 reports the results for the sample with new entrants only. In line with our previous findings, TFP has a significantly positive effect on the initial investment decision. Affiliates in more upstream sectors are less likely to be established in a foreign country. Furthermore, firms are more likely to conduct the initial investment in more upstream affiliates in less productive countries and more downstream affiliates in more productive countries.

5.4 Alternative Measure of a Country's Productivity

In addition to TFP as a measure of a country's productivity, we also use labor productivity (*labprod*), measured as GDP per person employed. Hence, we test the robustness of our results with respect to the productivity measure used.

In Table 7, the results using labor productivity are reported. As TFP, labor productivity has a significantly positive effect on the investment probability. Thus, countries with a higher labor productivity are more likely to attract FDI. Furthermore, the interaction between an affiliate sector's position in the value chain and a country's labor productivity remains significantly negative. Hence, affiliates located at later stages in the value chain are more likely to be placed in countries with a higher labor productivity. One important difference with respect to the results of our baseline specification is that the coefficient of the upstreamness measure is now significantly positive. This implies that investments are more likely to take place in more upstream sectors. As we have argued above, from the German parents' point of view this makes sense as downstream sectors may also remain in Germany. To conclude, the main hypothesis that those sectors that are located at later stages in the production process are more likely to be located in more productive countries can be confirmed irrespective of the productivity measure used.

In summary, our results allow us to make a strong case for the relevance of a sector's position in the value chain for a firm's decision of whether and where to invest. Further, our robustness checks have shown that the results are robust to using various measures of a country's productivity, they are not driven by market-seeking motives, and remain robust when we include other country characteristics.

Table 7: Robustness Check: Alternative Productivity Measure

	(1)	(2)
Dep. Var.	y_{ijst}	y_{ijst}
	Estimation Sample	
log (labprod)	0.0263**	0.0167
	(0.0107)	(0.0107)
Upstreamness	0.1075***	0.0837**
	(0.0265)	(0.0308)
Upstreamness*log(labprod)	-0.0111***	-0.0099***
	(0.0027)	(0.0031)
Firm FE	No	Yes
Country FE	Yes	Yes
Year FE	Yes	Yes
Sector FE	No	No
Observations	674,833	674,833
Countries	33	33
Parent firms	3,919	3,919
R^2	0.0482	0.0501

The dependent variable is the binary variable y_{ijst}, taking on the value of 1 if a firm has invested in country j in sector s at time t, and 0 otherwise. In all of the regressions we control for country and year fixed effects. In column 2 firm fixed effects are included. Standard errors clustered at the country level are given in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

6 Conclusion

The position in the value chain of a production stage matters for the decision of where to set up a foreign affiliate. In our empirical analysis we have shown that a country's productivity, which can also be thought of as a lower propensity to making mistakes, is more important if the affiliate's sector is at a later stage in the production process.

With respect to Kremer (1993) and Jones (2008), our results underline the role of complementary production processes as a potential explanation for pronounced inequalities between countries in terms of development also for FDI. It is not only domestic firms producing more upstream goods in less developed countries but also foreign firms establishing affiliates in upstream sectors in less developed countries and more downstream affiliates in more developed countries. Hence, later stages of production processes are located in more developed countries which again leads to stronger economic growth, as these stages contribute most value added (see Fally, 2012).

Global supply chains are increasingly subject to public debate. Especially policy makers of developing and emerging countries aim at participating in global supply chains and then moving down towards those stages, which yield higher value added (see discussion

at the WTO Public Forum 2012, Session 22).[20] Therefore, it is of high relevance for policy makers which country characteristics matter for attracting FDI in more downstream sectors. This study stresses the importance of becoming more productive in order to attract investment in those sectors which yield a higher value added.

A Appendix

A.1 Description of the Estimation Sample

Our estimation sample comprises all firms that have at least one affiliate, in at least one of the years between 1999 and 2006, and in at least one of the 33 countries listed in Table 10. Hence, we consider only German outward FDI. Furthermore, we exclude indirect FDI from our estimation sample. We only consider countries in which at least 5 affiliates are located. We do not consider holding companies. Furthermore, we exclude all non-firms from the estimation sample, meaning the public sector. As the reporting thresholds have changed over this period of time, we consider all firms which hold 50 percent or more of the shares or voting rights of a foreign enterprise with a balance sheet total of more than 3 million Euro. We also deflate the balance sheet total to make the data comparable over time. Moreover, we exclude those affiliate sectors that are related to natural resources in order to rule out resource driven location decisions. Therefore, we drop those affiliates that are in the following sectors: agriculture, hunting and related service activities; forestry, logging and related service activities; fishing, operation of fish hatcheries and fish farms, service activities incidental to fishing; Mining of coal and lignite, extraction of peat; extraction of crude petroleum and natural gas, service activities incidental to oil and gas extraction; mining of uranium and thorium ores; mining; mining and quarrying, other mining.

We inflate the dataset such that each parent firm for every existing affiliate can invest in every country in every year. Our regression sample contains 47 affiliate sectors. The list of affiliate sectors can be found in Table 11. The number of countries in our sample is limited to 33 due to limited data availability of our country characteristics.

[20] http://www.wto.org/english/forums_e/public_forum12_e/programme_e.htm#session22

A.2 Variation of the Upstreamness Variable

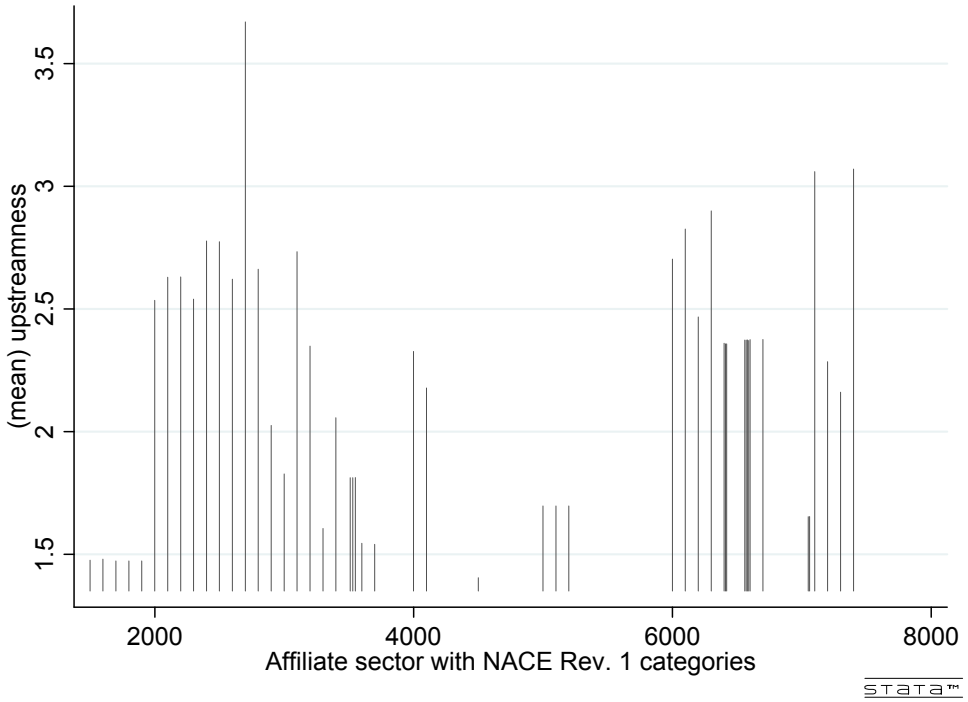

Figure 2: Average upstreamness over early and mid 2000 for each affiliate sector

Table 8: Variation over time of upstreamness variable

Sector	Upstr. early 2000	Ranking	Sector	Upstr. mid 2000	Ranking	Difference
Least Upstream Sectors			*Least Upstream Sectors*			
Hotels and restaurants	1.377689	1	Hotels and restaurants	1.304348	1	0
Construction sector	1.403966	2	Construction sector	1.404301	2	0
Manufacture of food products and beverages	1.46033	3	Manufacture of textiles	1.473903	3	1
Manufacture of textiles	1.471855	4	Manufacture of food products and beverages	1.498023	4	-1
Manufacture of furniture, manufacturing n.e.c.	1.496699	5	Manufacture of furniture, manufacturing n.e.c.	1.622484	5	0
Manufacture of medical, precision and optical instruments	1.552934	6	Housing enterprises	1.650911	6	1
Housing enterprises	1.655782	7	Manufacture of medical, precision and optical instruments	1.66992	7	-1
Wholesale trade and comission trade	1.698581	8	Wholesale trade and comission trade	1.69424	8	0
Manufacture of office machinery and computers	1.726448	9	Building and repairing of ships and boats	1.814354	9	1
Building and repairing of ships and boats	1.80522	10	Manufacture of office machinery and computers	1.954503	10	-1
Most Upstream Sectors			*Most Upstream Sectors*			
Manufacture of other non-metallic mineral products	2.58185	38	Manufacture of wood and wood products	2.653881	38	-2
Manufacture of metal products	2.588107	39	Manufacture of other non-metallic mineral products	2.690833	39	-1
Manufacture of pulp, paper and paper products	2.644286	40	Land transport; transport via pipelines	2.698803	40	2
Manufacture of electrical machinery and apparatus n.e.c.	2.658266	41	Manufacture of chemicals and chemical products	2.713494	41	3
Land transport; transport via pipelines	2.705867	42	Manufacture of metal products	2.773042	42	-3
Manufacture of rubber and plastic products	2.713238	43	Manufacture of electrical machinery and apparatus n.e.c.	2.834763	43	-2
Manufacture of chemicals and chemical products	2.826606	44	Manufacture of rubber and plastic products	2.861197	44	-1
Other business activities	3.012105	45	Renting of equipment and of personal and household goods	3.117577	45	1
Renting of equipment and of personal and household goods	3.01784	46	Other business activities	3.17558	46	-1
Manufacture of basic metals	3.648685	47	Manufacture of basic metals	3.698032	47	0

A.3 List of Dependent and Explanatory Variables

Table 9: List of dependent and explanatory variables

Variable	Description	Mean	Std. Dev.
FDI Dummy	Dummy variable indicating whether a parent firm has invested in a specific sector in a country in a year	0.0414	0.1991
Average Schooling	Variable measuring country's endowment with human capital	9.1501	2.2769
Total Factor Productivity	Variable measuring a country's TFP level relative to the United States	0.6996	0.2463
log Total Factor Productivity	Logarithm of TFP as variable is skewed	-0.4332	0.4190
Wage	Variable measuring factor costs	1954.881	1278.548
log Wage	Logarithm of wage as variable is skewed	7.2317	0.9833
Market Entry	Variable measuring the performance of countries in terms of the cost of starting a new business	7.9044	1.8317
Remoteness	Variable measuring the distance of the host country from all other countries in the world weighted by their share of world GDP	842949.9	265602.4
log Remoteness	Logarithm of remoteness as variable is skewed	13.6008	0.2878
Upstreamness	Variable capturing at which stage of a production process an affiliate sector is located	2.1354	0.5373
Rule of Law	Variable measuring contract enforceability and protection of property rights in a country	3.4664	0.9090
Financial Development	Variable measuring a country's financial development as the ratio of private credit to GDP	0.8832	0.4814
log Financial Development	Logarithm of financial development as variable is skewed	-0.3455	0.7542
Capital Intensity	Variable measuring capital intensity as the log physical capital per worker	1219008	650990.4
log Capital Intensity	Logarithm of capital intensity as variable is skewed	13.7353	0.9062
absolute GDP	Variable measuring a country's absolute GDP	1.01e+12	2.22e+12
Log absolute GDP	Logarithm of absolute GDP as variable is skewed	26.58	1.29
Affiliate Number	Number of German Affiliates in a country in a year	150.79	159.23
Log Affiliate Number	Logarithm of Affiliate Number as variable is skewed	4.43	1.21
Comparative Advantage	Dummy indicating whether a country has a comparative advantage in a sector	0.39	0.49
Labor productivity	Labor productivity measured as output per person employed	36733	15909
Log Labor productivity	Logarithm of Labor productivity as variable is skewed	10.35	0.66

A.4 List of Countries in the Estimation Sample

Table 10: List of Countries in the Estimation Sample

Argentina	Sweden
Australia	Thailand
Austria	Turkey
Belgium	United Kingdom
Brazil	United States
Cyprus	Venezuela
Denmark	
Egypt	*Additional countries (52 sample):*
Finland	Switzerland
France	Morocco
Greece	Tunisia
Hong Kong	Nigeria
India	Kenya
Ireland	South Africa
Israel	Canada
Italy	Guatemala
Japan	Panama
Luxembourg	Columbia
Mexico	Ecuador
Netherlands	Chile
Norway	Uruguay
Pakistan	Iran
Peru	Sri Lanka
Philippines	Indonesia
Portugal	Malaysia
Singapore	China
Spain	Republic of Korea

A.5 List of Affiliate Sectors in the Estimation Sample

Table 11: List of Affiliate Sectors in the Estimation Sample with Nace Rev. 1 categories

1500	Manufacture of food products and beverages
1600	Manufacture of tobacco products
1700	Manufacture of textiles
1800	Manufacture of textile products
1900	Manufacture of leather and leather products
2000	Manufacture of wood and wood products
2100	Manufacture of pulp, paper and paper products
2200	Publishing, printing and reproduction or recorded media
2300	Manufacture of coke, refined petroleum products and nuclear fuel
2400	Manufacture of chemicals and chemical products
2500	Manufacture of rubber and plastic products
2600	Manufacture of other non-metallic mineral products
2700	Manufacture of basic metals
2800	Manufacture of metal products
2900	Manufacture of machinery and equipment
3000	Manufacture of office machinery and computers
3100	Manufacture of electrical machinery and apparatus
3200	Manufacture of radio, television and communication equipment and apparatus
3300	Manufacture of medical, precision and optical instruments, watches and clocks
3400	Manufacture of motor vehicles, trailers and semi-trailers
3500	Manufacture of other transport equipment
3600	Manufacture of furniture, manufacturing n.e.c.
3700	Recycling
4000	Electricity, gas, steam and hot water supply
4100	Collection, purification and distribution of water
4500	Construction
5000	Sale, repair of motor vehicles, retail sale of automotive fuel
5100	Wholesale trade and commission trade
5200	Retail trade
5500	Hotels and restaurants
6000	Land transport, transport via pipelines
6100	Water transport
6200	Air transport
6300	Supporting and auxiliary transport activities; activities of travel agencies
6400	Post and telecommunications
6560	Other credit institutions
6570	Financial leasing
6580	Other financial intermediaries
6590	Investmentfunds
6600	Insurance and pension funding
6700	Activities auxiliary to financial intermediation
7050	Housing enterprises
7060	Other real estate activities
7100	Renting of machinery and equipment without operator and of personal and household goods
7200	Computer and related activities
7300	Research and development
7400	Other business activities

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