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Global Investment Decisions and Patent Protection: Evidence from German Multinationals

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Abstract

This paper investigates the role of patent protection in the global investment decisions of multinational firms. Using comprehensive firm-level panel data of German multinationals, we investigate how changes in a host country's patent protection influence the extensive and intensive margin of foreign direct investment (FDI) decisions. We isolate the effect of patent protection by estimating a difference-in-difference type approach and controlling for an extensive set of fixed effects. At the extensive margin, we find that strengthening patent protection increases the probability of locating a foreign affiliate, whereby the effect is stronger for firms that highly depend on patent protection. The effect depends further on a host country's initial legal and economic development. Given that a parent has established a foreign affiliate, no systematic effects of patent protection are found for the decision on how much to invest in the affiliate at the intensive margin. With regard to the ownership structure, we find that multinationals take into account the risk of intellectual property infringements and increase the ownership share held in the foreign affiliate after strengthening patent protection.

Keywords: Intellectual property rights, patent protection, foreign direct investment, multinationals

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1. Introduction

The protection of intellectual property rights has been an important issue on the international policy agenda. The Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) has raised the concern in the political and economic debate that stronger intellectual property rights (IPR) can slow down economic progress in developing countries by restricting the ability of domestic firms to imitate and benefit from advanced technologies of foreign firms. However, the proponents of stronger IPR argue that this disadvantage could be partially offset by benefits that arise from increasing investments of multinational enterprises. Stronger IPR could encourage multinationals to expand their scale of operations and increase the local manufacture of technologically sophisticated goods (Branstetter et al., 2011).

For IPR reforming countries, the question whether a strengthening of local IPR protection can attract new foreign investors or stimulate the expansion of existing investments is of high importance for assessing the costs and benefits of IPR reforms. The aim of the present paper is therefore to empirically examine the second argument, i.e., whether IPR protection affects the global investment decisions of multinationals. We thereby focus on patent law and contribute to a better understanding of how strengthening patent protection affects inward FDI in reforming countries. Using a firm-level panel dataset on the universe of German outward FDI, we investigate individual firm-level investment decisions at the extensive and intensive margins. At the extensive margin, we explore the impact of patent protection on the decision where to locate a foreign affiliate. At the intensive margin, we analyze how the strengthening of patent rights affects the size of foreign affiliates and the ownership share held in these affiliates.

For the analysis, we use rich firm-level panel data of German multinationals and their foreign affiliates from the Microdatabase Direct Investment (MiDi) conducted by the Deutsche Bundesbank. MiDi is a comprehensive yearly database that gathers location and balance sheet information on German foreign affiliates and on affiliates of foreign investors in Germany. By law, German firms are required to report yearly on their foreign direct investments when particular thresholds regarding ownership participation and balance sheet totals of foreign affiliates are exceeded. To measure the local strength of patent protection, we use the Ginarte-Park index (Ginarte and Park, 1997; Park, 2008). This index approximates the strength of patent protection across 110 countries between 1960 and 2005. It considers the categories coverage, membership in international treaties, duration of protection, enforcement

mechanisms and provisions for loss of patent protection.

To isolate the effect of patent protection, we exploit variation of patent protection across countries and time, as well as variation of the dependence on patent protection across sectors and time. Conditioning on an extensive set of fixed effects, we account for unobserved firm- and country-specific heterogeneity and capture potential omitted variable bias. The key explanatory variable is the interaction term between host countries' patent protection and the sectoral patent dependence of the parent, which allows for nonlinear effects of patent reforms.

Patent reforms in countries with high initial levels of protection are expected to impose different effects than patent reforms in countries with weak or no protection. Similarly, depending on a country's previous level of economic development, changes in patent law could exert different effects. Therefore, we additionally add triple interaction terms that allow the effect of patent protection to further vary with a country's pre-reform patent protection and level of economic development.

Our empirical analysis shows that patent protection affects the foreign investment decisions of German multinationals in different ways. First, reforms of the patent system positively affect the location decision of German multinationals. This effect is strongest for firms in sectors that highly depend on patent protection. Moreover, significant nonlinear effects in a host country's initial patent protection and economic development are found. After strengthening patent protection, countries with an already sufficient patent protection experience the highest increase in their location advantage. Further, the results show that countries starting from a low level of economic development also disproportionately attract FDI by reforming their patent system. Second, regarding the intensive margin, we find some evidence for a positive effect of patent protection. However, the effect is much weaker than for the location decision. Given that a foreign affiliate is established, changes in patent reforms play a minor role on the size of the affiliate. Third, we find that firms take into account a higher risk of patent infringement by adapting the capital structure of the foreign affiliate: average ownership shares increase significantly after strengthening patent protection.

The paper complements the literature on the relation between IPR and FDI. A rich theoretical literature has investigated the global effect of IPR protection.[1] In a seminal work, Helpman (1993) shows in a dynamic general equilibrium model of two regions, the innovative

[1] Branstetter et al. (2011) provide a detailed discussion of the theoretical literature.

North and the imitative South, that the latter never benefits from stronger IPR protection. Extensions by Lai (1998) and Branstetter et al. (2006), which allow for endogenous responses in FDI, innovation or imitation activities, provide conditions under which a strengthening of IPR protection increases the industrial development of the South. In their models, the total effect depends on whether an increase in northern FDI compensates for the decrease in southern imitation activities.[2]

Previous empirical studies on international trade and FDI mainly relied on aggregated country- or industry-level data and have led to mixed conclusions.[3] However, high correlations between IPR protection and other omitted host country characteristics as well as no time variation constitute common problems of cross-country studies and provide explanations for the ambiguous results.

A recently growing empirical literature uses firm-level data to examine how IPR protection affects the global investment decisions of individual multinationals. The following recent studies are particularly relevant to this work. Branstetter et al. (2011) investigate the impact of patent reforms in 16 countries on the investment behavior of U.S. multinationals and show a positive effect on the intensive margin of FDI, i.e., the size of foreign affiliates. They find that parents that intensively license technologies increase their foreign investments disproportionately. Furthermore, using the same sample, Branstetter et al. (2006) show that patent reforms stimulate the transfer of technology to reforming countries. Using time- and country-specific variations in the Ginarte-Park patent index, Bilir (2011) confirms a positive effect of patent protection on the FDI of U.S. multinationals. She shows that the effect is strongest for firms that are active in sectors with long product lifecycle lengths and therefore rely more on patent protection. Javorcik (2004) finds a positive effect of patent protection on FDI in technologically intensive sectors for transition countries. Moreover, she demonstrates that strong IPR protection encourages multinational enterprises to invest in local manufacture rather than in the distribution of goods.

This paper is also related to the literature that examines how political risk in general influences the capital structure decisions of multinationals. Kesternich and Schnitzer (2010)

[2]In this literature, the South can gain access to new technology through FDI or imitation. Yang and Maskus (2001a) additionally allow for licensing as a third channel for technology transfer and show theoretically that stronger IPR can raise technology transfer to the South. Yang and Maskus (2001b) provide empirical evidence that licensing activities are more likely to take place in countries with strong IPR protection.

[3]Maskus (2000) provides a detailed discussion of previous empirical analysis based on aggregated data. See, e.g., Ferrantino (1993), Lee and Mansfield (1996), Maskus and Penubarti (1995), and Smith (1999).

provide theoretical and empirical evidence that local political risk adversely affects the capital structure of foreign affiliates in terms of ownership. The optimal ownership share decreases with higher political risk, since expected returns are reduced, while the managerial costs of running the affiliate are unaffected.

This paper contributes to the literature in three ways. First, we provide a strong identification strategy that allows for nonlinear effects of patent protection and considers various sources of omitted variable bias. The identification is based on variation in patent protection across countries and time as well as on variation in patent sensitivities across sectors and time. Additionally, we also take into account variation on host countries' previous levels of legal and economic development, which enables us to draw more precise policy recommendations for reforming countries. We show that the identified effects of patent protection are robust to the inclusion of country-time fixed effects, which absorb all observed and unobserved time-varying country characteristics. Second, the paper provides a comprehensive analysis of FDI decisions. It decomposes the various levels of FDI decisions of multinationals, namely decisions on location, size and ownership structure, something which has been missing in the previous analysis.[4] Third, this paper provides the first firm-level evidence on German multinationals. Insights into how German multinationals are affected by international patent protection are particularly interesting because German firms play an important role in international FDI outflows. With a total FDI outflow of 105 billion USD in 2010, Germany is second largest in the ranking of FDI outward countries (UNCTAD, 2011). A systematic analysis of German multinationals has not yet existed.

The rest of the paper is organized as follows. Section 2 discusses the empirical strategy and presents the empirical model. Section 3 provides a detailed description of the data sources used in the analysis and presents the descriptive statistics. The results are discussed in Section 4. Section 5 reports various robustness checks and Section 6 concludes.

2. Empirical Specification

2.1. Identification

The impact of patent protection on foreign direct investment decisions is investigated along three dimensions: the location decisions of German multinationals, the size of the investment

[4]The analysis by Bilir (2011) provides for the first time a joint analysis on the extensive margin (industry-level) and intensive margin (firm-level) of FDI.

and the ownership structure. Varieties of the following baseline specification will be estimated for the different levels of the investment decision.

$$FDI_{ict} = \beta_1 PAT_{c,t-1} + \beta_2 PAT_{c,t-1} * PATDEP_{it} + \gamma X_{c,t-1} + \delta Y_{i,t} + \eta_i + \eta_c + \eta_t + \lambda_{ict} \quad (1)$$

where FDI_{ict} is a measure of the global investment activity of firm i in country c during year t, $PAT_{c,t-1}$ captures the patent protection in country c at year $t-1$, and $PATDEP_{it}$ represents different sectoral measures of firms' sensitivity to patent protection.

To establish a causal effect, different potential issues need to be addressed. Most importantly, one might be concerned that the level of patent protection could be correlated with unobserved host country characteristics that influence FDI decisions, which could lead to omitted variable bias. To guard against omitted variable bias, we condition on an extensive set of fixed effects. Country fixed effects η_c capture time-invariant country characteristics such as legal origin, language and geography (including distance and natural resources). These time-constant heterogeneities are expected to influence foreign direct investment decisions and can simultaneously be correlated with the level of patent protection. Further, time dummies η_t are included to absorb the impact of common shocks that affect host countries in a similar manner over time.

To additionally take into account country-specific dynamics of potential FDI determinants, various time-varying host country covariates $X_{c,t-1}$ are included. We control for changes in the statutory corporate tax rates, changes in the school system (approximating human capital; measured by the share of pupils that progress to secondary school), changes in the GDP per capita (approximating trends in market attractiveness), and changes in the host country's exports (capturing strategic platform motives). Furthermore, indexes for general rule of law and the overall openness to trade are included to capture general reforms of the legal system and altering trade barriers.[5] All country-specific variables are lagged once.

Moreover, parent fixed effects η_i are included to capture firm-specific heterogeneities, and

[5]The corporate tax rate data is taken from various issues of the corporate tax guides of PriceWaterhouseCoopers, KPMG, Coopers&Lybrand, Ernst&Young, and information from the International Bureau of Fiscal Documentation (IBFD). Country data on GDP per capita, the school system and exports (exports of goods and services as a share of of GDP) are taken from the World Bank Development Indicator. The indexes on the rule of lae and trade freedom are obtained from the Heritage Foundation. The definitions of the variables are summarized in Table A.1 in Appendix 6.

in particular unobserved firm-specific differences, such as risk aversion or business practices, that are expected to strongly correlate with a firm's investment decisions. Note that parent fixed effects capture fixed industry-specific differences as well as time constant ownership links to holding firms. To capture differences in parent-specific time-varying effects such as different growth rates, we in addition include a parent's productivity measured by the logarithm of the ratio of sales over employees.

A further factor that could interfere with identification is the possibility that patent reforms can be accompanied by simultaneous institutional reforms. Consequently, changes in FDI behavior following patent reforms would then not be fully attributable to a better legal protection of patents. Exploiting variation across reforming countries as well as variation across sectors with varying levels of sensitivity to patent protection allows to isolate the effect of patent reforms from that of other potentially confounding factors.[6] The index of patent protection is therefore interacted with measures of the industry-specific dependence on patent protection. Since not all companies rely equally intensely on patent protection, the influence of patent reforms on a firm's investment decision is expected to be heterogeneous.

We explore two different measures that reflect the sensitivity to patent protection: R&D intensity (R&D) and the perceived effectiveness of patents for protecting inventions (PATEFF). The industry-specific R&D intensity provides continuous time-varying approximations for the sensitivity to patent protection at the parent sector-level. A higher intensity in R&D accompanies a higher rate of innovations, resulting in a greater need to protect inventions against imitations. To directly measure the dependence on the patent system, the industry-specific perception of the effectiveness of patent protection is taken from Cohen et al. (2000). This measure takes into account the relative importance of patents for protecting inventions compared to other protection strategies, such as secrecy.[7] In the related literature, e.g., measures of industry-specific product cycle lengths (Bilir, 2011), technology licensing (Branstetter et al., 2011) and patent usage (Branstetter et al., 2006) have been used to allow

[6]This difference-in-difference type approach can be found, e.g., in Rajan and Zingales (1998), Chor and Manova (2012) and Manova (2013), where interactions between sector-specific measures of financial vulnerability are used to isolate the effect of country-specific financial development. Bilir (2011) uses sector-specific variations in product cycle lengths to strengthen the identification of the effect of patent protection.

[7]The perception-based measure PATEFF is taken from a survey of U.S. manufacturing firms. This time constant information refers to the year 1994, so before the changes in patent law that we investigate in this analysis. PATEFF should therefore be clearly exogenous to patent reforms in particular host countries. The measure of R&D intensity refers to German industries. Thereby, national and international German firms are considered. The aggregated information on German firms should be not systematically related to changes in patent protection of particular foreign countries.

for nonlinear effects of patent protection. A detailed description of the measures can be found in Section 3.2.

Furthermore, one would expect the effect of strengthening patent protection to depend on the initial level of protection. It could make a difference whether a reform takes place in a country with an already high initial level of patent protection or whether it takes place in a country with a minimal or no protection. The same applies to different levels of economic development. An patent reforming country with a very low level of economic development might not attract FDI in the same manner as a highly developed reforming country. Triple interaction terms ($PAT_{c,t-1} * PATDEP_{it} * Low/High\ Level_c$) allow the effect to further differ according to whether the country falls in the lowest (highest) 25th percentile of patent protection within all included countries (analogue for GDP per capita).[8]

Finally, the main variables of interest are the double and triple interaction terms. The coefficient of $PAT_{c,t-1} * PATDEP_{it}$, β_2 estimates the effect of changes in host countries' strength of patent protection over time on the investment behavior of German multinationals. β_2 is identified from the variation in patent protection across countries, the variation in patent protection over time within a country, and the variation in patent sensitivity across and within sectors. The coefficients of the triple interaction terms are additionally identified from variation in the initial levels of patent protection and economic development across countries.

2.2. Estimating Equations

Location Decision. To investigate the location decision of German multinationals, we follow Javorcik (2004) and inflate the dataset by all observable host countries, such that each parent firm could have invested in each host country within each time period. The number of observations equals the number of parents times the number of host countries in each year. The binary variable y_{ict} equals 1 if parent i holds an affiliate in host country c in year t. We specify the following linear probability model

$$\begin{aligned} Pr(y_{ict} = 1) = \beta_1 PAT_{c,t-1} + \beta_2 PAT_{c,t-1} * PATDEP_{it} + \gamma X_{c,t-1} + \delta Y_{i,t} \\ + \eta_i + \eta_c + \eta_t + \lambda_{ict} \end{aligned} \tag{2}$$

[8]The relative position of a country is determined at the first year of the sample. This avoids that a country changes its relative position over time due to other countries' patent reforms or increases in GDP per capita, without implementing own improvements.

where η_i captures parent fixed effects that account for time-invariant firm-specific characteristics, η_c time-constant host country fixed effects and η_t year fixed effects. The vector $X_{c,t-1}$ summarizes time-varying host country covariates (lagged once), $Y_{i,t}$ the time-varying parent-level controls.

A linear probability model has the advantage of not requiring a distributional assumption regarding the firm-specific unobserved effects η_i. An independence assumption on the responses (y_{ic1},...,y_{icT}) conditional on the explanatory variables and the unobserved effect is further not necessary (Wooldridge, 2010). Since the identification is based on an extensive set of fixed effects, many dummies have to be included in the regression. In maximum likelihood estimations of nonlinear models this could introduce an incidental parameters problem, which can result in inconsistent estimations of all coefficients, while in linear regression models the slope estimator is unbiased and consistent (Greene, 2008, p.587). Therefore, a linear probability model is preferable in this setting. Furthermore, linear probability models allow to directly interpret the marginal effects of the interaction terms, which are of main interest in this study.[9] In a robustness check, the location decision is re-estimated with nonlinear fixed effects models. Standard errors are clustered on the parent-level to account for heteroskedasticity and serial dependence in the firm-level panel data.[10]

Size of Investment. For the intensive margin of FDI, we investigate how patent protection influences the size of foreign affiliates, given that a multinational has invested in a specific country. The basic specification takes the form

$$\begin{aligned} Size_{ijt} = {} & \beta_1 PAT_{c,t-1} + \beta_2 PAT_{c,t-1} * PATDEP_{it} + \gamma X_{c,t-1} + \delta Y_{i,t} \\ & + \eta_i + \eta_c + \eta_t + \lambda_{ict}, \end{aligned} \tag{3}$$

where i indexes the parent, j the foreign affiliate, c the country and t the year. The variable $Size_{ijt}$ contains the alternative size measures *Log(FDI)*, *Log(Sales)* and *Log(Employees)*. In all specifications, we include dummies for the affiliate age and sector.[11]

[9] This is not straightforward in nonlinear models, see Ai and Norton (2003) for a detailed discussion.

[10] Clustering on country-level does not affect the results of the key variables concerning patent protection and leads to the same conclusions.

[11] Unfortunately, direct information on the year of foundation is not available. Instead, we approximate an affiliate's age with the number of years since the affiliate has entered the dataset.

Ownership Structure. In the global investment decision of multinationals, the influence of patent protection on the composition of the FDI is of particular interest. Multinational firms can adapt the ownership structure of their foreign affiliates to respond to country specific risks that affect the expected profitability of their investments. We estimate

$$Ownership_{ijt} = \beta_1 PAT_{c,t-1} + \beta_2 PAT_{c,t-1} * PATDEP_{it} + \gamma X_{c,t-1} + \delta Y_{i,t} + \epsilon Z_{ijct} + \eta_i + \eta_c + \eta_t + \lambda_{ict} \quad (4)$$

where $Ownership_{ijt}$ is the share of the affiliate's equity held by the German parent. The vector Z_{ijct} captures time-varying affiliate characteristics that are expected to influence the ownership structure. Following Kesternich and Schnitzer (2010), we include an affiliate's fixed over total assets, log(sales), and profits over total assets as additional control variables. Further, dummies for an affiliate's sector and age are included.

3. Data

The empirical analysis requires a time-varying measure of patent protection that ideally covers all potential host countries, proxies for the sectors' sensitivity to patent protection, and detailed firm-level data on multinational activities across countries and time. In the following, the data sources used are described in detail and the descriptive statistics are presented.

3.1. Patent Protection Across Countries

Ginarte and Park (1997) provide an index of patent protection, which has been widely used in the literature.[12] That index has been updated by Park (2008) and covers 110 countries for 1960-2005, surveyed every five years. It documents the strength of patent rights in five categories: extent of coverage, membership in international patent agreements, duration of protection, enforcement mechanisms, and provisions for loss of patent protection. The categories are scored with values ranging from 0 to 1 and an unweighted sum is constructed, so that the index varies between 0 and 5 (for details, see Park, 2008; Ginarte and Park, 1997).

Table A.2 in Appendix 6 summarizes the patent protection across the host countries in the sample for 1996-2006. Across countries, the average patent protection varies between 1.41 (Guyana) and 4.88 (USA). Between the years 1996 and 2006, many countries introduced

[12] See, e.g., Kumar (2001), Javorcik (2004), Branstetter et al. (2006), Falvey et al. (2006), Qian (2007) and Bilir (2011).

a minimum protection level or strengthened their existing patent laws, such that the global average protection level increased over time from 2.78 to 3.57. In the entire panel the index has a mean of 3.24 and a standard deviation of 1.03.

For robustness, we also use a perception-based measure of IPR protection provided by the World Economic Forum. This measure is available for 98 countries with yearly values for 2005-2009. A potential disadvantage of this measure is that it covers a relative short time period and does not include observations from the 90s, when major reforms took place.

3.2. Sensitivity to Patent Protection Across Sectors

Two different measures for a firm's sensitivity to patent protection are explored. First, information on the R&D intensity is taken from the Centre for European Economic Research (ZEW). The measure is based on the proportion of expenditures for innovation over total sales and provides a continuous time-varying measure of the R&D intensities of German industries. Firms in industries with high R&D intensities exhibit, on average, a higher rate of innovation, which goes along with a greater need to protect inventions against imitations.

Second, a perception-based measure of the dependence on patent protection is taken from the survey of Cohen et al. (2000). This survey is based on a sample of U.S. manufacturing firms for the year 1994, in which firms were asked how effective they perceived patents to be at protecting their innovation. The important difference with regard to R&D intensity is that some industries, depending on the type of invention, more often prefer not to file a patent application and thereby disclose sensitive information, but to strategically keep inventions secret. However, it has to be assumed that the perceptions of firms from the respective German sector are sufficiently correlated and that the ranking across sectors is relatively stable over time. Otherwise the measure would contain a lot of noise or even no information and the estimated coefficient would be biased towards zero. The measures for the sensitivity to patent protection for the 29 included industries (mainly matched at the 2-digit level of the NACE 1 industry code) are listed in Table A.3 in Appendix 6.

3.3. German Outward FDI

The analysis is based on the Microdatabase Direct Investment (MiDi) provided by the Deutsche Bundesbank (German Central Bank). It constitutes a comprehensive dataset, since German parents are required by law to report on their foreign investments if certain thresholds on balance-sheet totals and ownership shares are exceeded (Lipponer, 2006). For this research

yearly firm-level panel data on German multinationals and their foreign affiliates for the years 1996-2010 were used.

The research interest lies in direct outward FDI, such that observations on outward FDI that constitute ownership chains of dependent affiliates are excluded. Reporting thresholds have been changed several times during the covered time period, influencing the composition of the sampled firms. To harmonize the sample between years, the strictest reporting threshold is considered, such that only parents with a participation share of at least 50 percent and a balance sheet total of 3 million EUR are included.[13] Furthermore, the analysis concentrates on parents from manufacturing sectors, since information on patent sensitivity is mainly available for these sectors. Since the patent protection index is available in five-year intervals, data can be matched for the years 1996, 2001 and 2006. Thereby, 84 of 138 destination countries for German multinational can be matched, covering 89 percent of total outward FDI of the considered multinationals in the sampled years. The final sample comprises 2,726 individual German parents which hold in total 12,152 foreign affiliates in 84 different destination countries (see Table 1). Table 2 summarizes the descriptive statistics for all variables.

Table 1: Sample characteristics

Year	# Parents	# Affiliates	# Destinations
1996	1,342	2,954	39
2001	1,781	4,689	67
2006	1,509	4,509	74
Total	2,726	12,152	84

Figure 1 presents scatter plots for the dependent variables.[14] The first graph illustrates the relation between patent protection and the logarithm of the number of German affiliates in a host country. There is a positive and convex relation. The better the patent protection, the more German affiliates are localized in a host country. The next three graphs present how the mean of the size measures *Log(Sales)*, *Log(FDI)* and *Log(Employees)* varies with patent protection. Countries with a better patent protection host on average larger affiliates with higher sales amounts. With regard to the number of employees, no clear relation appears. The

[13] Before 1999, the reporting threshold was an ownership share of more than 20 percent and a balance sheet total of more than 1 million DM, for 1999-2002 an ownership share of 50 percent or more and a balance sheet total of more than 1 million DM (10-50 percent for more than 10 million DM) and since 2002 an ownership share of 10 percent or more and a balance sheet total of more than 3 million EUR. See Lipponer (2006) for more details.

[14] Due to the confidentiality of the data, only information on host countries with affiliates from at least three different parent firms are used for the graphs.

Table 2: Descriptive statistics

Variable	Mean	St Dev	Min	Max
Parent-level				
Productivity	5.78	1.34	0.79	12.71
R&D	3.52	2.41	0.35	8.96
PATEFF	34.96	9.03	12.08	50.20
Affiliate-level				
Ownership	0.93	0.15	0.50	1.00
Log(Sales)	7.99	4.78	-4.60	16.33
Log(FDI)	8.69	1.46	0.15	17.08
Log(Employees)	3.21	3.04	-4.60	11.22
Fixed/Total Assets	0.24	0.25	0.00	1.00
Profitability	0.04	0.14	-1.42	1.18
Country-level				
PAT	3.27	0.99	0.00	4.88
Log(GDPpc)	8.14	1.60	4.16	11.30
Corporate Tax	29.92	8.75	0	60
Schooling	33.81	23.02	0.46	93.49
Exports	43.64	29.69	7.26	229.68
Rule of Law	55.22	22.63	10	90
Trade Openness	66.20	14.68	0	90

Notes: All min (max) values refer to averages of the three smallest (largest) firms. The number of firms for the smallest (largest) category is increased, if the standard devition is equal to zero for the three firms. The definitions of the variables are summarized in Table A.1.

last graph presents the relation between average ownership shares of foreign affiliates and patent protection. Although high ownership shares can be found in countries at all levels of patent protection, the highest values are concentrated in countries with strong protection. To study the above observed patterns more precisely, multivariate regressions are presented in the following.

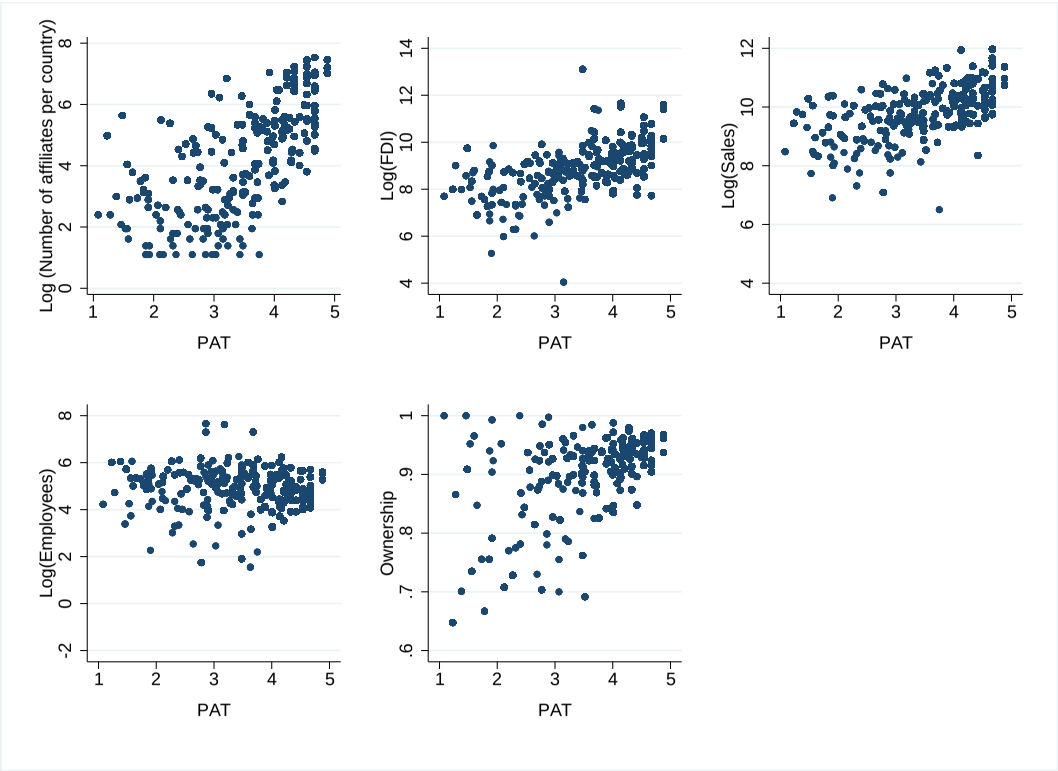

Figure 1: Scatter plots of the dependent variables

4. Results

The aim of the analysis is to investigate the effect of patent protection on various dimensions of FDI. This section presents the multivariate regressions on the decision where to locate a foreign affiliate and, given that an affiliate has been established, the decisions how much to invest, and how to set the ownership share of the affiliate.

4.1. Location Decision

Table 3 presents the results for the location decision. The coefficient of PAT in the specification without interactions (Column 1) is positive and significant. A strengthening of patent protection by one standard deviation (1.03) is associated with an on average 1.25 percentage points higher probability of locating a foreign affiliate. Furthermore, GDP per capita, the quality of the schooling system, the connectedness to the world (in terms of exports) and higher trade freedom are also found to significantly attract German FDI, while a higher tax rate reduces the probability of affiliate location.

Since identification is stronger when allowing for nonlinear effects of patent protection, Columns 2 and 3 present interactions between PAT and the measures of patent sensitivity. Both coefficients of the interaction terms are significantly positive and indicate a strong nonlinear relation that increases with the industry-specific sensitivity for patent protection. An increase in patent protection by one standard deviation increases the probability of having located a foreign affiliate by 1.80 percentage points (with PATEFF) and 0.73 percentage points (with R&D) for an average firm. The direct measure of patent sensitivity quantifies a stronger effect of patent protections.

With regard to the parent explanatory variables, we find that a higher productivity of the parent increases the general probability of FDI. This is in line with theoretical predictions that a productivity cut off exists.[15] Further, firms active in industries with high R&D intensities generally less often invest abroad.[16]

Table 4 summarizes the results for the triple interactions that allow the effect of patent reforms to further vary with a country's initial level of patent protection or economic development. The elasticity to patent reforms significantly differs with the initial level of

[15] See, e.g., Melitz (2003) for the role of firm productivity in international trade and Helpman et al. (2004) for FDI and exports.

[16] Note, that the measure PATEFF is time invariant and is therefore captured in the parent FE effect.

Table 3: Location decision

Dependent variable: Location			
	(1)	(2)	(3)
Productivity	0.0102***	0.0110***	0.0105***
	(0.0012)	(0.0014)	(0.0013)
Log(GDPpc)	0.0237***	0.0233***	0.0234***
	(0.0023)	(0.0024)	(0.0023)
Corporate Tax	-0.0003***	-0.0003**	-0.0003***
	(0.0001)	(0.0001)	(0.0001)
Schooling	0.0004***	0.0004***	0.0003***
	(0.0001)	(0.0001)	(0.0001)
Exports	0.0005***	0.0005***	0.0005***
	(0.0001)	(0.0001)	(0.0001)
Rule of Law	-0.0001	-0.0001	-0.0001
	(0.0000)	(0.0000)	(0.0000)
Trade Openness	0.0003***	0.0003***	0.0003***
	(0.0001)	(0.0001)	(0.0001)
PAT	0.0121***	-0.0039	0.0036
	(0.0015)	(0.0030)	(0.0025)
PAT*PATEFF		0.0005***	
		(0.0001)	
PAT*R&D			0.0020***
			(0.0004)
R&D			-0.0078***
			(0.0018)
Observations	284523	261434	275373
Indiv. Parents	2726	2490	2630
Destinations	84	84	84
Adjusted R^2	0.1897	0.1944	0.1929

Notes: Standard errors are clustered by parent firm, with ***, **, * denoting significance at 1%, 5% and 10% levels respectively. The dependent variable is the binary location variable y_{ict} that equals 1 if parent i holds an affiliate in host country c in year t. All specifications include country, year and parent fixed effects.

patent protection. Reforming countries with an already high patent protection level (upper 25 percentile) are able to attract more FDI than countries with a low or middle level of protection. With regard to the initial level of economic development, we observe a U-shaped relation. The previously observed pattern that more patent sensitive firms have a higher elasticity to patent reforms remains robust in all specifications. In comparison to countries with an average initial development level (25 to 75 percentile), we find additional positive effects of strengthening patent protection for low developed countries (lowest 25 percentile) as well as for high developed countries.

Table 4: Location decision with heterogeneity in initial host country characteristics

Dependent variable: Location Triple interaction with:	Initial PAT		Initial GDPpc	
	(1)	(2)	(3)	(4)
Productivity	0.0110***	0.0105***	0.0110***	0.0105***
	(0.0014)	(0.0013)	(0.0014)	(0.0013)
Log(GDPpc)	0.0223***	0.0242***	0.0223***	0.0226***
	(0.0023)	(0.0023)	(0.0024)	(0.0023)
Corporate Tax	-0.0003***	-0.0003***	-0.0004***	-0.0004***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Schooling	0.0003***	0.0003***	0.0004***	0.0004***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Exports	0.0005***	0.0005***	0.0004***	0.0004***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Property Rights	-0.0001	-0.0001**	-0.0001**	-0.0001**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Trade Openness	0.0003***	0.0003***	0.0003***	0.0003***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
PAT	0.0120***	0.0079***	0.0063**	0.0040*
	(0.0028)	(0.0023)	(0.0027)	(0.0023)
PAT*PATEFF	0.0001		0.0001*	
	(0.0001)		(0.0001)	
PAT*PATEFF*Low Level	0.0000		0.0002***	
	(0.0000)		(0.0000)	
PAT*PATEFF*High Level	0.0003***		0.0004***	
	(0.0000)		(0.0000)	
PAT*R&D		0.0009**		0.0015***
		(0.0004)		(0.0004)
PAT*R&D*Low Level		0.0003**		0.0014***
		(0.0001)		(0.0002)
PAT*R&D*High Level		0.0008***		0.0008***
		(0.0002)		(0.0002)
R&D		-0.0049***		-0.0075***
		(0.0016)		(0.0017)
Observations	261434	275373	261434	275373
Indiv. Parents	2490	2630	2490	2630
Destinations	84	84	84	84
Adjusted R^2	0.1949	0.1931	0.1951	0.1933

Notes: Standard errors are clustered by parent firm, with ***, **, * denoting significance at 1%, 5% and 10% levels respectively. The dependent variable is the binary location variable y_{ict} that equals 1 if parent i holds an affiliate in host country c in year t. All specifications include country, year and parent fixed effects.

4.2. Size of Investment

The estimations for the size measures *Log(FDI)*, *Log(Sales)* and *Log(Employees)* are summarized in Table 5. Regarding patent protection, the results for the intensive margins

of FDI are much weaker than for the extensive margin. In the baseline regressions without interaction terms (Columns 1, 4 and 7) a significant positive effect of patent protection is found for affiliate's sales and employees. When including interaction terms between PAT and patent sensitivity, a significant effect is found with PATEFF for *Log(FDI)*, while the coefficients in the other specifications are not significant. Taken together with the previous results, this suggests that patent protection plays a major role for the location decision, while, given that a multinational has established a foreign affiliate, it seems to play a minor role for the scope of the investment.

Instead, the most important determinant for the intensive margin of FDI is GDP per capita. Given that a firm is located in a specific host country, raises in the GDP per capita significantly increase affiliate size. A host country's tax rates and schooling system are not found to influence an affiliate's size. Similar to PAT, these determinants are found to have major importance for the location decision, but given location, they seem not to influence the decision on the size of the investment. Interestingly, exports are found to have a significant and positive effect on the number of employees, such that platform motives are found to influence the extensive and intensive margins of FDI. However, with regard to *Log(Sales)* or *Log(FDI)*, no such relation is found. Better terms of trade freedom are associated with higher FDI and more employees in foreign affiliates. Rule of law has a significant negative, but small effect. However, identification in the fixed effect model is based on time variation and since rule of law does not change much over time, this could explain the contradictory results.

4.3. Ownership Structure

The analysis on how the capital structure in terms of ownership share reacts to changes in patent protection is presented in Table 6. A lack of patent protection goes along with a higher risk of patent infringements and can be seen as a form of political risk. An increase in patent protection, which is associated with a reduction in political risk, leads to an overall increase in the ownership shares of foreign affiliates held by German parents. This confirms the results of Kesternich and Schnitzer (2010) that provide evidence that multinationals adapt the capital structure of their foreign affiliates with respect to local political risk and reduce their ownership shares in high-risk host countries. The results extend the literature by providing first empirical evidence for political risk in terms of patent infringement.

However, the nonlinear effects of patent sensitivity, which would provide a more reliable

identification, are not significantly different from zero. One limitation of the analysis that might affect the results is that much variation of the ownership structure is not captured, since only firms with participation shares above the required threshold are required to report on their FDI.[17]

[17]In an alternative estimation, we ignored the harmonization problem of our sample and estimated the determinants of the ownership share with all available observations of foreign affiliates. However, the results did not change.

Table 5: Size of foreign affiliates

Dependent variable:	Log(FDI)			Log(Sales)			Log(Employees)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Productivity	0.1045***	0.1127***	0.1125***	-0.4474***	-0.4199***	-0.4367***	-0.5834***	-0.5645***	-0.5751***
	(0.0262)	(0.0274)	(0.0266)	(0.0556)	(0.0575)	(0.0559)	(0.0292)	(0.0307)	(0.0297)
Log(GDPpc)	0.5262***	0.5354***	0.5295***	0.9645***	1.0461***	0.9784***	0.5368***	0.5399***	0.5222***
	(0.1161)	(0.1232)	(0.1160)	(0.1962)	(0.1926)	(0.1982)	(0.0981)	(0.1015)	(0.0986)
Corporate Tax	-0.0040	-0.0058	-0.0050	-0.0090	-0.0066	-0.0073	-0.0029	-0.0046	-0.0034
	(0.0048)	(0.0050)	(0.0048)	(0.0071)	(0.0070)	(0.0070)	(0.0037)	(0.0038)	(0.0037)
Schooling	0.0014	0.0019	0.0022	0.0017	0.0034	0.0029	-0.0006	-0.0004	-0.0001
	(0.0026)	(0.0027)	(0.0026)	(0.0034)	(0.0036)	(0.0035)	(0.0020)	(0.0020)	(0.0020)
Exports	0.0027	0.0038	0.0034	-0.0054	0.0003	-0.0037	0.0059*	0.0074**	0.0061*
	(0.0038)	(0.0041)	(0.0039)	(0.0069)	(0.0064)	(0.0070)	(0.0033)	(0.0033)	(0.0033)
Rule of Law	-0.0070**	-0.0063**	-0.0073**	-0.0136***	-0.0134***	-0.0140***	-0.0076***	-0.0068***	-0.0076***
	(0.0029)	(0.0030)	(0.0029)	(0.0035)	(0.0036)	(0.0035)	(0.0021)	(0.0022)	(0.0022)
Trade Openness	0.0077**	0.0075*	0.0082**	0.0006	0.0024	0.0035	0.0093**	0.0089**	0.0094**
	(0.0037)	(0.0038)	(0.0037)	(0.0052)	(0.0051)	(0.0050)	(0.0037)	(0.0038)	(0.0037)
PAT	0.0364	-0.1092	0.0033	0.1851*	0.0492	0.0475	0.1292**	0.0873	0.0923
	(0.0707)	(0.0925)	(0.1071)	(0.1087)	(0.1449)	(0.1558)	(0.0610)	(0.0839)	(0.1046)
PAT*PATEFF		0.0033**			0.0023			0.0012	
		(0.0015)			(0.0025)			(0.0016)	
PAT*R&D			0.0032			0.0256			0.0102
			(0.0200)			(0.0256)			(0.0195)
R&D			-0.0345			-0.1586			-0.0543
			(0.0884)			(0.1148)			(0.0858)
Observations	10801	10002	10544	11189	10332	10906	11189	10332	10906
Indiv. Parents	2556	2344	2472	2616	2394	2526	2616	2394	2526
Destinations	73	72	73	73	72	73	73	72	73
Adjusted R^2	0.4205	0.4248	0.4215	0.489	0.5045	0.4976	0.6599	0.6632	0.6635

Notes: Standard errors are clustered by parent firm, with ***, **, * denoting significance at 1%, 5% and 10% levels respectively. All specifications include country, year and parent fixed effects. Additionally, dummies for an affiliate's age and sector are included.

Table 6: Ownership share of foreign affiliates

Dependent variable: Ownership Share			
	(1)	(2)	(3)
Productivity	-0.0008	-0.0024	-0.0013
	(0.0030)	(0.0032)	(0.0031)
Log(Sales)	0.0032	0.0038	0.0032
	(0.0027)	(0.0030)	(0.0028)
Profitability	-0.0286*	-0.0241	-0.0298*
	(0.0160)	(0.0178)	(0.0163)
Fix/Total Assets	-0.0149	-0.0148	-0.0140
	(0.0155)	(0.0163)	(0.0156)
Log(GDPpc)	-0.0168	-0.0173	-0.0191
	(0.0146)	(0.0153)	(0.0146)
Corporate Tax	-0.0012*	-0.0012	-0.0012*
	(0.0007)	(0.0007)	(0.0007)
Schooling	-0.0004	-0.0004	-0.0003
	(0.0003)	(0.0003)	(0.0003)
Exports	-0.0003	-0.0004	-0.0004
	(0.0005)	(0.0005)	(0.0005)
Rule of Law	-0.0003	-0.0002	-0.0004
	(0.0004)	(0.0004)	(0.0004)
Trade Openness	0.0018***	0.0019***	0.0019***
	(0.0005)	(0.0005)	(0.0005)
PAT	0.0275***	0.0325***	0.0293**
	(0.0083)	(0.0107)	(0.0128)
PAT*PATEFF		-0.0001	
		(0.0002)	
PAT*R&D			-0.0007
			(0.0024)
R&D			0.0069
			(0.0112)
Observations	11187	10330	10904
Indiv. Parents	2615	2393	2525
Destinations	73	72	73
Adjusted R^2	0.3148	0.3137	0.3164

Notes: Standard errors are clustered by parent firm, with ***, **, * denoting significance at 1%, 5% and 10% levels respectively. All specifications include country, year and parent fixed effects. Additionally, dummies for an affiliate's age and sector are included.

5. Sensitivity Analysis

5.1. Estimation with Country-Year Fixed Effects

To rule out that other changes in a country beyond patent protection are influencing the results, we include time-varying country-year fixed effects. These fixed effects capture all observable and unobservable time-varying components and control for potential omitted time-varying factors at the country level. All changes in the country-specific explanatory variables are adsorbed, including changes in patent protection, such that only the coefficient on the interaction between patent protection and patent sensitivity can be identified in these specifications. Table A.4 to A.6 present the results for location, size and ownership. The results for the interaction terms remain very robust and strengthen our previous findings in the basis estimations. These findings indicate, that no omitted time-varying factors interfere with the estimated effect of patent protection.

5.2. Identification of Patent Reforms

To strengthen the identification, different measures of the sensitivity to patent protection have been interacted with PAT, which allows for nonlinear effects of patent protection and provides additional industry-level variation. A concern might still be that the estimated effects could capture reforms of general legal institutions. To verify whether the methodology identifies the effects of changes in patent law alone, we carry out a falsification test and interact PAT with a measure of the industry-specific importance of secrecy for protecting inventions.

Similarly to patent sensitivity, a measure of the effectiveness of secrecy is expected to be positively correlated with industry-specific technological complexity. Yet, additional variation occurs due to industry-specific differences in the patentability of inventions and business practices in protecting innovations. Depending on the type of invention, keeping an invention secret could be preferable to filing a patent and thereby disclosing sensitive information. Most importantly, the degree of reliance on secrecy should not directly depend on formal patent law, which provides no protection for secrecy. If the effect of PAT is correctly identified from changes in patent law alone, the coefficient of an interaction term between secrecy and PAT should be insignificant. By contrast, a significant coefficient would indicate that changes in general legal institutions are not disentangled and could influence the results.[18]

[18] An alternative explanation for a significant effect could also be that secrecy is, due to the expected correlation with technological complexity, highly correlated with patent sensitivity. However, this would work against the

Table A.7 in Appendix 6 summarizes the estimations for all FDI dimensions with an interaction term between PAT and a measure of secrecy, which is also taken from the survey of Cohen et al. (2000). Firms that greatly rely on secrecy as a protection strategy do not change their investment behavior due to changes in patent law. For the location decision, where patent protection was found to play the most important role, the interaction term is not significant. Similarly, for all size specifications, no significant effect is found. Only in the ownership regression a weakly significant (at the ten percent level) coefficient is found for the interaction term, indicating that after a reduction of political risk in the form of PAT infringement, parents with a high sensitivity for secrecy increase their ownership share in their affiliates.

6. Conclusions

The present paper analyzes how national patent protection influences various levels in the global investment decisions of German multinationals. In particular, we show that patent protection is a significant factor in attracting technologically sophisticated FDI, since strengthening patent protection increases the probability of locating a foreign affiliate in a reforming country, especially so for R&D intensive and firms that are sensitive to patent protection. This has important policy implications for host countries, as the attraction of FDI can contribute to technology spillovers and foster domestic growth.

Moreover, we show that the effect of patent reforms differs with a host country's pre-reform characteristics. With regard to the initial level of patent protection, we find the strongest effects for countries with an already sufficient pre-reform patent protection. Evidence that a too high patent protection could distort FDI has not been found. With regard to the initial level of economic development, we find the effect of patent reforms is significantly positive at all stages of economic development. However, reforming countries with a relatively high level of economic development exhibit stronger effects of legal reforms and are hence able to attract FDI more successfully than countries with an average economic development. For less developed countries, also disproportional positive effects of patent protection are found. How the effect of patent reforms interacts with pre-reform country characteristics should be of interest for policy makers that need to forecast future FDI inflows to be able to assess the benefits of patent reforms.

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falsification test.

Regarding the size of a foreign affiliate, we identify circumstances under which patent reforms significantly increase the size of affiliates. However, the results are much weaker than for the location decision. Given that an affiliate is established in a country, the effect of patent protection is found to play a minor role for the size of an investment. For the capital structure of multinational firms, we find that a stronger patent protection results in higher ownership shares held by the German parent. This is an important finding, since a higher share of ownership is associated with lower agency costs and higher incentives to transfer technology.

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Appendix

Table A.1: Definition of variables

Variable	Definition and Source
Parent-level	
y_{ict}	Binary location variable that equals 1 if parent i holds an affiliate in host country c in year t and zero else. Source: MiDi
Productivity	Logarithm of the ratio of sales over employees. Source: MiDi
Parent-sector-level	
R&D	Expenditures for innovation over total sales among German industries. Source: Centre for European Economic Research (ZEW)
PATEFF	Perception-based measure of the effectiveness of patents for protecting product innovation. Source: Cohen et al. (2000)
Affiliate-level	
Log(Sales)	Logarithm of affiliate sales. Source: MiDi
Log(FDI)	Stock of direct investment (IMF/OECD method, see Lipponer (2006) for details). Source: MiDi
Log(Employees)	Logarithm of total number of an affiliate's employees. Source: MiDi
Ownership share	Share of affiliate's equity held by German parent. Source: MiDi
Fixed/Total Assets	Fixed over total assets. Source: MiDi
Profitability	Profit over total assets. Source: MiDi
Country-level	
PAT	Index of patent protection that covers the five categories extent of coverage, membership in international patent agreements, duration of protection, enforcement mechanisms and provisions for loss of patent protection. The categories are scored with values ranging from 0-1 and an unweighted sum (0-5) is constructed. Source: Park (2008); Ginarte and Park (1997)
PERC-IPR	Perception-based index of intellectual property right protection, 1-7 (best). Source: World Economic Forum
Corporate Tax	Statutory corporate tax rate. Sources: Various issues of corporate tax guides of PriceWaterhouseCoopers, KPMG, Coopers&Lybrand, Ernst&Young and information from the International Bureau of Fiscal Documentation (IBFD)
Schooling	Share of pupils that progress to secondary school. Source: World Bank Development Indicator
Log(GDPpc)	Logarithm of GDP per capita. Source: World Bank Development Indicator
Exports	Exports of goods and services as a share of GDP. Source: World Bank Development Indicator
Rule of Law	Rule of Law (property rights, freedom from corruption). Source: Heritage Foundation
Trade Openness	Open Markets (trade freedom, investment freedom, financial freedom). Source: Heritage Foundation

Table A.2: Patent protection across countries

Country	Mean	SD	Country	Mean	SD	Country	Mean	SD
Algeria	2.96	0.19	Guyana	1.41	0.33	Pakistan	1.99	0.54
Argentina	3.56	0.72	Honduras	2.58	0.59	Panama	2.91	1.26
Australia	4.17	0.00	Hong Kong	3.51	0.53	Paraguay	2.27	0.69
Austria	4.29	0.07	Hungary	4.19	0.27	Peru	3.12	0.34
Bangladesh	1.87	0.00	India	2.42	1.27	Philippines	3.57	0.88
Belgium	4.63	0.08	Indonesia	2.27	0.63	Poland	3.86	0.38
Bolivia	3.08	0.61	Iran	1.91	0.00	Portugal	4.03	0.52
Brazil	2.89	1.22	Ireland	4.49	0.31	Romania	3.80	0.33
Bulgaria	4.06	0.72	Israel	3.80	0.57	Russian Federation	3.61	0.12
Cameroon	2.46	0.52	Italy	4.56	0.20	Saudi Arabia	2.21	0.66
Canada	4.56	0.19	Jamaica	3.09	0.25	Senegal	2.34	0.52
Chile	4.16	0.21	Japan	4.59	0.14	Slovak Republic	3.38	0.72
China	3.10	0.98	Jordan	2.51	1.26	Spain	4.29	0.07
Columbia	3.35	0.53	Kenya	2.84	0.40	Sweden	4.50	0.07
Congo	2.40	0.60	South Korea	4.12	0.22	Switzerland	4.29	0.07
Costa	2.45	0.77	Lithuania	3.39	0.66	Tanzania	2.53	0.18
Cyprus	3.25	0.40	Luxembourg	4.06	0.14	Thailand	2.53	0.13
Czech Republic	3.50	0.73	Malaysia	3.07	0.39	Trinidad and Tobago	3.24	0.79
Democratic Congo	1.86	0.33	Malta	2.75	1.01	Tunisia	2.41	0.80
Denmark	4.63	0.08	Marocco	2.79	0.90	Turkey	3.56	0.79
Egypt	2.12	0.57	Mauritius	2.14	0.37	USA	4.88	0.00
El Salvator	3.36	0.13	Mexico	3.57	0.38	Uganda	2.94	0.08
Ethiopia	1.38	1.19	Mozambique	1.26	1.17	Ukraine	3.68	0.00
Finland	4.54	0.13	Nepal	1.92	0.23	United Kingdom	4.54	0.00
France	4.63	0.08	Netherlands	4.63	0.08	Uruguay	2.91	0.73
Ghana	3.11	0.26	New Zealand	4.01	0.00	Venezuela	3.15	0.29
Greece	3.91	0.42	Nigeria	2.97	0.18	Vietnam	2.94	0.08
Guatemala	1.84	1.14	Norway	4.14	0.15	Zambia	1.77	0.16
Overall mean			3.24					
Overall standard deviation			1.03					
Between standard deviation			0.93					
Within standard deviation			0.46					

Notes: The Table presents the country means for the time-varying Ginarte-Park index of patent protection.

Table A.3: Industry characteristics

NACE 1 Code	Industry	R&D	PATEFF
1500	Manufacture of food products, beverages	1.40	18.26
1600	Manufacture of tobacco products	1.37	-
1700	Manufacture of textiles	1.94	20.00
1800	Manufacture of textile products	1.95	-
1900	Manufacture of leather, leather products	1.92	-
2000	Manufacture of wood, wood products	3.16	-
2100	Manufacture of pulp, paper, paper products	3.13	36.94
2200	Publishing, printing, reproduction of recorded media	3.16	12.08
2300	Manufacture of coke, refined petroleum products and nuclear fuel	4.64	33.33
2400	Manufacture of chemicals, chemical products	4.44	37.46
2440	Manufacture of pharmaceutical products	4.20	50.20
2500	Manufacture of rubber, plastic products	3.65	32.71
2600	Manufacture of other non-metallic mineral products	2.92	21.11
2700	Manufacture of basic metals	2.74	20.00
2800	Manufacture of metal products	2.74	39.43
2900	Manufacture of machinery, equipment n.e.c.	4.80	42.94
3000	Manufacture of office machinery, computers	6.90	41.00
3100	Manufacture of electrical machinery, apparatus	6.85	34.55
3200	Manufacture of radio, television, communication equipment and apparatus	7.21	25.82
3300	Manufacture of medical, precision, optical instruments, watches and clocks	8.23	40.43
3400	Manufacture of motor vehicles, trailers, semi-trailers	6.84	43.09
3500	Manufacture of other transport equipment	6.07	-
3510	Building, repairing of ships, boats	7.94	-
3520	Manufacture of railed vehicles	7.94	-
3530	Manufacture of aircraft, spacecraft	7.94	32.92
3540	Manufacture of motorcycles, bicycles, invalid	7.94	-
3550	Manufacture of other transport equipment	7.94	-
3600	Manufacture of furniture, Manufactureacturing	2.60	33.81
3700	Recycling	2.62	-
4000	Electricity, gas, steam, hot water supply	0.60	-
Industry average		4.41	32.43
Industry standard deviation		2.40	9.93

Notes: The Table presents the values for the time-constant measure of patent effectiveness (PATEFF) and the mean values for the time-varying measures of R&D intensity (R&D). All definitions of the variable are summarized in Table A.1.

Table A.4: Entry decision (with country-year FE)

Dependent variable: Location		
	(1)	(2)
Productivity	0.0109***	0.0105***
	(0.0014)	(0.0013)
PAT*PATEFF	0.0005***	
	(0.0001)	
PAT*R&D		0.0020***
		(0.0004)
R&D		-0.0078***
		(0.0018)
Observations	261434	275373
Indiv. Parents	2490	2630
Destinations	84	84
Adjusted R^2	0.1958	0.1943

Notes: Standard errors are clustered by parent firm, with ***, **, * denoting significance at 1%, 5% and 10% levels respectively. The dependent variable is the binary location variable y_{ict} that equals 1 if parent i holds an affiliate in host country c in year t. All specifications include country-year, year and parent fixed effects.

Table A.5: Size (with country-year FE)

Dependent variable:	Log(FDI)		Log(Sales)		Log(Employees)	
	(1)	(2)	(3)	(4)	(5)	(6)
Productivity	0.1114***	0.1128***	-0.4260***	-0.4408***	-0.5684***	-0.5768***
	(0.0263)	(0.0256)	(0.0579)	(0.0563)	(0.0309)	(0.0297)
PAT*PATEFF	0.0032**		0.0022		0.0013	
	(0.0015)		(0.0026)		(0.0016)	
R&D		-0.0508		-0.1724		-0.0493
		(0.0920)		(0.1163)		(0.0857)
PAT*R&D		0.0075		0.0282		0.0085
		(0.0207)		(0.0261)		(0.0195)
Observations	10002	10544	10332	10906	10332	10906
Indiv. Parents	2344	2472	2394	2526	2394	2526
Destinations	72	73	72	73	72	73
Adjusted R^2	0.4243	0.4208	0.5040	0.4970	0.6646	0.6650

Notes: Standard errors are clustered by parent firm, with ***, **, * denoting significance at 1%, 5% and 10% levels respectively. All specifications include country-year, year and parent fixed effects. Additionally, dummies for an affiliate's age and sector are included.

Table A.6: Ownership (with country-year FE)

Dependent variable: Ownership Share		
	(1)	(2)
Productivity	-0.0027	-0.0018
	(0.0033)	(0.0031)
Log(Sales)	0.0030	0.0024
	(0.0030)	(0.0029)
Profitability	-0.0253	-0.0313*
	(0.0180)	(0.0166)
Fix/Total Assets	-0.0157	-0.0153
	(0.0161)	(0.0155)
PAT*PATEFF	-0.0002	
	(0.0002)	
R&D		0.0112
		(0.0110)
PAT*R&D		-0.0018
		(0.0024)
Observations	10330	10904
Indiv. Parents	2393	2525
Destinations	72	73
Adjusted R^2	0.3178	0.3207

Notes: Standard errors are clustered by parent firm, with ***, **, * denoting significance at 1%, 5% and 10% levels respectively. All specifications include country-year, year and parent fixed effects. Additionally, dummies for an affiliate's age and sector are included.

Table A.7: Sensitivity check with dependency on secrecy

Dependent variable:	Location	Log(Sales)	Log(Employees)	Log(FDI)	Ownership
	(1)	(2)	(3)	(4)	(5)
Productivity	0.0110***	0.1856**	-0.1446***	0.0031	0.0052*
	(0.0014)	(0.0803)	(0.0437)	(0.0332)	(0.0031)
Log(GDPpc)	0.0234***	0.9708***	0.5286***	0.6568***	-0.0153
	(0.0024)	(0.3002)	(0.1966)	(0.1158)	(0.0134)
Corporate Tax	-0.0003**	0.0035	0.0052	-0.0066	-0.0013*
	(0.0001)	(0.0121)	(0.0078)	(0.0049)	(0.0007)
Schooling	0.0004***	-0.0001	-0.0010	0.0003	-0.0004*
	(0.0001)	(0.0054)	(0.0030)	(0.0027)	(0.0002)
Exports	0.0005***	0.0232**	0.0171**	0.0054	-0.0003
	(0.0001)	(0.0104)	(0.0071)	(0.0040)	(0.0005)
Rule of Law	-0.0001	-0.0131	-0.0061	-0.0066**	-0.0003
	(0.0000)	(0.0080)	(0.0042)	(0.0031)	(0.0004)
Trade Openess	0.0003***	0.0330***	0.0169**	0.0082**	0.0017***
	(0.0001)	(0.0111)	(0.0068)	(0.0037)	(0.0005)
PAT	0.0171***	-0.0879	-0.3374	-0.0186	-0.0031
	(0.0048)	(0.3232)	(0.2389)	(0.1467)	(0.0208)
PAT*Secrecy	-0.0001	0.0072	0.0054	0.0003	0.0006*
	(0.0001)	(0.0068)	(0.0049)	(0.0028)	(0.0004)
Affiliate Age	no	yes	yes	yes	yes
Affiliate Controls	no	no	no	no	yes
Observations	261434	11208	11208	10818	11208
Indiv. Parents	2490	2399	2399	2351	2399
Destinations	84	73	73	73	73
Adjusted R^2	0.1939	0.6105	0.6211	0.4236	0.3092

Notes: Standard errors are clustered by parent firm, with ***, **, * denoting significance at 1%, 5% and 10% levels respectively. All specifications include country, year and parent fixed effects. The specifications in Columns 2-5 additionally include dummies for an affiliate sector.