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Tax Attractiveness And the Location of Patents

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Abstract: This paper analyzes the impact of taxation on the location of patents within multinational groups. Based on groups with parents from 36 countries globally and their patent holdings in 36 European countries, we provide insight into the determinants of three subsequent decisions: (1) the decision of whether to locate patents abroad; (2) in which countries to locate patents; and (3) how many patents to locate in each country. Our findings indicate that multinationals take the tax attractiveness of countries into account when making these decisions. Specifically, we show that the statutory tax rate, the taxation of royalties, R&D incentives, and transfer pricing rules help to explain the patent-location choices of multinationals.

Keywords: International taxation; Tax attractiveness; Intellectual property; Location decision; Multinational enterprise.

JEL classification: H25, H73, F23.

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1 Introduction

With the transition from agricultural economies to knowledge-based service and manufacturing economies, the importance of patents has increased considerably. As an illustration of this trend, the number of patent filings with the European Patent Office has doubled from 72,904 in 1997 to 148,494 in 2012 (European Patent Office (1997; 2012)). With more than 90% of German cross-border intellectual property (IP) licensing business, including patent licensing, being conducted between related companies (Deutsche Bundesbank (2011)), multinational groups are responsible for a huge part of IP-related trade. Anecdotal evidence from such multinationals as Google and Apple gives rise to the suspicion that these intra-group licenses are at least partially tax-motivated (Matlack (2013)). Two properties make patents particularly interesting for international tax-planning: immateriality and uniqueness. Immateriality allows for the legal location of patents being separated from the location of other corporate assets at close to zero direct cost. Furthermore, a patented object is unique by definition. Therefore, the determination of an appropriate transfer price charged to related entities for the use of a patent is subject to private information (Van Herksen (2009); Griffith, Miller and O'Connell (2014)). As a result, the owner can benefit from information asymmetries vis-à-vis tax authorities.

The aim of this paper is to empirically test the research question of whether patent-location decisions of multinationals are influenced by the tax attractiveness of countries. Based on the ideas of Devereux and Maffini (2006), who analyze sequential decisions on the location of new production facilities, we analyze the determinants of three specific, sequential patent-location decisions of multinational groups:

Abroad-Decision:	Shall patents be located abroad or in the parent's country of residence?
Country-Decision:	In which group-countries shall patents be located?
Quantity-Decision:	How many patents shall be allocated to each group-country?

Our results indicate that multinational companies take the statutory tax rate, the taxation of royalties, R&D incentives, and transfer pricing rules into account when making these decisions. Furthermore, the *Tax Attractiveness Index (TAX)*, a broad measure of a country's tax attractiveness taking into account 19 different tax aspects, explains these decisions. Our dataset contains information on groups with parents from 36 countries globally and their patent holdings in 36 European countries.

Prior literature finds a significant influence of taxation on the location of patents, intangible assets, and investment into R&D. The corporate statutory tax rate and controlled foreign corporation (CFC) rules are shown to play a role in patent-related location decisions (Griffith et al. (2014); Karkinsky and Riedel (2012); Dischinger and Riedel (2011); Ernst and Spengel (2011); Mutti and Grubert (2009)). Furthermore, some studies account for the preferential tax treatment of royalty income (e.g., patent boxes) and find a significant effect (Griffith et al. (2014); Ernst, Richter and Riedel (2014); Karkinsky and Riedel (2012)). Results with regard to the impact of incentives on R&D expenditures and withholding tax rates on royalties are, however, mixed (Ernst et al. (2014); Karkinsky and Riedel (2012); Ernst and Spengel (2011); Harris, Li and Trainor (2009); Bloom, Griffith and Van Reenen (2002); Hall and Van Reenen (2000)). Furthermore, companies in IP-intensive industries (e.g., manufacturing) are more likely to be involved in international tax-planning activities (Mutti and Grubert (2004); Gumpert, Hines and Schnitzer (2012)).

This paper makes two major contributions to the existing literature. First, it provides a more detailed understanding of the decision-making process of multinationals by decomposing the patent-location decision into three subsequent steps. This decomposition allows us to analyze the influence of tax attractiveness both from the perspective of the parent's and subsidiary's host country. Especially the result, that the tax attractiveness of the parent's country of residence matters, is novel. Besides Gumpert et al. (2012), prior literature mainly does not account for the ownership structure of the companies. Second, we analyze a broader set of tax variables than previous studies. We consider tax law aspects relevant for the development of patents (R&D incentives), for patent licensing (e.g., CFC rules, taxation of royalties received) and for their use as input factors in the production process (e.g., transfer pricing, statutory tax rate).

The next section discusses the institutional setting and develops the hypotheses. Section 3 presents the dataset and variables. Section 4 describes the econometric approach. Section 5 presents the results. Finally, section 6 concludes.

2 Institutional Setting And Hypotheses

2.1 Patent-related Definitions

In the following, we provide useful patent-related definitions for a better understanding of the data used in our analyses. The OECD (2009) defines a patent as a "[...] right to exclude others from making, using, selling, offering for sale or importing the patented invention for the term of the patent, which is usually 20 years from the filing date, and in the country or

countries concerned by the protection." Patents therefore create monopolies that can be exploited by licensing the right to use the invention to other parties or via their use in a production process. Patentable innovations include all kinds of novel technological products and processes that have industrial applications, whereas laws of nature and abstract ideas cannot be patented (OECD (2009)). According to Harhoff (2005), patents have four distinct functions: (1) minimization of conflicts; (2) allocation of disposition rights; (3) reward and incentive for innovators; and (4) diffusion and accessibility of information. In this paper, we focus on the second and third mentioned functions that allow for an interpretation of patents as government-certified assets for whose use their owner can charge a fee. Based on the anecdotal evidence mentioned in the introduction, it can be hypothesized that patents have a fifth, yet unintended, function, namely serving as a substantiation device for cross-border profit shifting activities as far as transactions between related parties are considered.

In order to obtain a patent, applicants can follow national, regional, and international processes. The OECD (2009) identifies three steps that form the basis of most patent authorities' procedures. In the first step, a patent application receives a priority date. According to the 'first-to-file' principle, no party applying for a patent for the same invention after this date can obtain a patent. In the second step, the patent office performs a novelty search and publishes the patent application. In the third step, a patent is granted if it is found to represent a non-obvious inventive step and to have an industrial applicability. Parts of the steps can be completed at international and regional patent offices (e.g., World Intellectual Property Organization and European Patent Office) in order to obtain patents in multiple countries at the same time. In our main regression, our dependent variable comprises both published patent applications and granted patents.

In our paper, we define the term 'patent location' as the country of residence of the corporation that is the legal owner of the patent. We do not refer to the country in which the protective rights of the patent are applicable. If, e.g., a subsidiary resident in the Netherlands is the owner of a patent that protects the use of a certain technology in Germany, the patent location in our definition is the Netherlands. Note that the legal location is not necessarily the location where the R&D activity took place. Cost-sharing agreements between the final legal owner and the R&D entity, that specify how the costs and risks associated with R&D are allocated among subsidiaries, are one way to achieve this separation without having to transfer the patent from one entity to the other (Griffith et al. (2014)).

2.2 The Taxation of Patents

There are three instances in the lifecycles of patents that have tax consequences in typical tax systems and that make them an interesting subject of tax research. We discuss them below and include them as independent variables in our analysis. First, the creation of a patent leads to tax deductible R&D expenditures. Some countries provide R&D incentives in the form of tax credits or deductions as a percentage of R&D expenditures. For example, in China, 150% of qualifying R&D expenditures can be deducted for tax purposes. The United States grants a tax credit equal to 20% of R&D expenditures in excess of a 'base amount' (Deloitte (2012)).

Second, the revenues associated with patents are taxed. There are two channels of value extraction from patents. On the one hand, patents can be licensed by their owner to other parties in return for a royalty. On the other hand, patents can be used by their owner in order to produce goods, whose sale results in business income. Licensing agreements transfer usage rights from the licensor to the licensee. According to most national tax codes, the licensee's country of residence reserves the right to withhold taxes on royalties. Unilaterally, the residence country of the licensor usually also reserves the right to charge taxes on the full amount of the royalty (mostly as part of ordinary business income) and then grants a tax credit in the amount of foreign withholding taxes paid. Double tax treaties, which generally have priority over unilateral national tax codes, try to resolve the problem of two states claiming taxing rights on the same royalty. The OECD Model Tax Convention, which serves as the basis for the majority of double tax agreements signed internationally, exclusively allocates the right to tax the royalty to the licensor's country of residence. In practice, however, many bilateral double tax treaties, including USA-Japan, Germany-China and UK-Canada, deviate from this suggestion and allow for a reduced withholding tax in the licensee's state of residence, which is then credited in the licensor's state of residence. Among European Union (EU) member states, the Interest and Royalties Directive applies since 2004. It abolishes the withholding taxes on royalties paid between related parties (minimum holding of 25%) (EU-Directive 2003/123/EG). Moreover, in a few countries (Belgium, China, Cyprus, France, Hungary, Ireland, Liechtenstein, Luxembourg, Malta, the Netherlands, and Spain) royalties received are not taxed at the regular statutory tax rate as part of ordinary business income, but effectively at reduced rates (‘patent box regimes’). Furthermore, certain countries have introduced CFC rules in recent years to prevent resident companies from setting up subsidiaries in low-tax foreign countries earning mainly passive income (e.g., royalties, interest) and shielding the profits from home country taxation by deferring distributions. If the conditions of these rules

are met, a country taxes the income of the foreign subsidiary as if it were a resident. However, a tax credit for foreign taxes paid is usually granted. If patents are used by their owner as an input factor in the production process of the patent-owning entity, value is extracted by the sale of final or intermediate goods. The resulting income is usually treated as ordinary business income. Unlike in the case of royalties, regular corporate tax rules apply to this type of income.

Third, the sale of a patent can induce taxable capital gains. These transactions are beneficial for patents on technologies in the early stages of their development when they cannot yet be foreseen to have much profit potential (Van Herksen (2009)). The acquired patent can usually be capitalized in the accounts of the buyer and subsequently amortized over the useful life for tax purposes (Kroppen, Roeder and Schmidke (2009)).

Besides patent-specific tax considerations, the patent-location decision is affected by related group-structure decisions (Oestreicher and Koch, 2012; Buettner, Overesch, Schreiber and Wamser (2012; 2011)). In order to be an attractive patent location, a country should be a tax attractive host to the subsidiary that owns the patents. Attractive properties include, e.g., attractive loss offset rules, low source taxation in the case of the repatriation of profits, or lax anti-avoidance rules.

2.3 Hypotheses

The aim of this study is to test whether multinationals' patent-location decisions are influenced by the tax attractiveness of countries. We base our hypotheses on the aptitude of patents as a tax-planning instrument. The location of patents can be determined largely independent of other considerations than tax-planning due to their immateriality. The uniqueness of each patent creates information asymmetries vis-à-vis tax authorities that can be exploited. Furthermore, the taxation of the income stream generated by patents is mainly based on the tax rules of the country where the patent is located.

In the *Abroad-Decision*, the parent decides whether or not to locate patents abroad. On the one hand, we analyze tax variables that describe the tax attractiveness of the parent-country as a patent location. The statutory tax rate and the taxation of royalties are the key determinants of the tax burden patent owners face when they sell products or licenses based on their patents. Therefore, we use these two tax characteristics to test our hypothesis H1a.

H1a: The more tax attractive the parent's country is for patent owners, the less likely patents are to be located abroad.

On the other hand, we consider tax aspects in the country of the parent that are relevant for parents that place patents in foreign subsidiaries. CFC rules, withholding tax rates on royalties, transfer pricing rules, and R&D incentives are the tax characteristics most relevant for owners of foreign patent-holding subsidiaries. As mentioned in the previous section, CFC rules limit the tax-planning opportunities of parents with regard to foreign subsidiaries generating passive income (e.g., royalties) due to the risk of parent-country taxation. Furthermore, if the parent company pays royalties to its patent-owning subsidiary, the country of the parent might charge a withholding tax. Thus, higher withholding tax rates on royalties reduce the attractiveness of a foreign patent-location. Additionally, if the country of the parent has strict transfer pricing rules in force, amounts (e.g., royalties) transferred from the parent to its patent-owning subsidiary are scrutinized and therefore are less suitable for profit-shifting purposes. Finally, if a parent is a productive inventor, e.g., due to attractive R&D incentives, the overall patent output is likely to be high and this increases the probability of holding patents, not only at home, but also in foreign subsidiaries. We use these tax characteristics to test our hypothesis H1b.

H1b: The more tax attractive the parent's country is for owners of foreign patent-holding subsidiaries, the more likely patents are to be located abroad.

Given that both hypothesis H1a and H1b take the perspective of the parent-country, we test them jointly. We include both variables relevant for patent owners and for owners of foreign patent-owning subsidiaries in our empirical analysis of the *Abroad-Decision*.

In the *Country-Decision*, multinationals select the group-countries to hold patents, given that the *Abroad-Decision* was in favor of a foreign location. We examine factors that describe the tax attractiveness of the subsidiary-country as a patent location. The statutory tax rate and the taxation of royalties determine the tax burden of patent-owning subsidiaries' income streams. Furthermore, attractive R&D incentives in the country of the subsidiary increase patent output and therefore the likelihood of patent ownership. We therefore use variables measuring the attractiveness of the statutory tax rate, the taxation of royalties, and R&D incentives to test hypothesis H2.

H2: The more tax attractive a group-country is for patent owners, the more likely patents are to be located in that group-country.

In the *Quantity-Decision*, a multinational group needs to decide how many patents to locate in a country, given that it has chosen that country as a patent location. Analogous to hypothesis H2, we use the statutory tax rate, the taxation of royalties, and R&D incentives as factors that describe the tax attractiveness of the subsidiary-country as a patent location to test hypothesis H3.

H3: The more tax attractive a group-country is for patent owners, the more patents are located in that group-country.

3 Data Description

3.1 The Company Sample

We tailor both the company sample and the variables used to the specific perspective of the three decisions and therefore end up with three datasets. In all three datasets, we cover the years 2005 to 2012.

The company-specific data is sourced from AMADEUS, a database that contains micro-level information on active companies located in Europe.[1] The available ownership information enables us to identify all direct and indirect subsidiaries of a parent.[2] Unfortunately, the ownership information is reported only for the point of time when the data is retrieved. In the case of M&A activity, this leads to the problem that we treat subsidiaries as part of a group already before they were acquired. We correct for this by using the ZEPHYR database, which contains information on M&A transactions, by eliminating all observations for acquired companies before the closing date of the transaction.

Table 1 summarizes the three datasets which constitute the basis of our analysis. We include all multinational groups, which operate a legal entity in at least two different countries and which own at least one patent, in the dataset for the *Abroad-Decision*. Each of the 3,414 observations is defined by the dimensions group and year. For the *Country-Decision*, we eliminate all observations with parents that do not hold patents via a foreign subsidiary since the *Country-Decision* is analyzed conditional on the *Abroad-Decision* being positive.[3] Moreover,

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1 AMADEUS contains companies that fulfill any of the following three criteria: turnover ≥ 1 million EUR, total assets ≥ 2 million EUR, or number of employees ≥ 15.

2 We define a parent as the ultimate owner in an ownership chain holding directly and indirectly at least a 50% stake in a subsidiary.

3 The number of groups shown in Table 1 still increases from the *Abroad-Decision* to the *Country-Decision* since we lose a lower number of observations due to missing values. While we might not observe all group-country data necessary to compute aggregate values for variables on a group level in the *Abroad-Decision*, we can often still use the available group-country data in the *Country-Decision* and the *Quantity-Decision*.

we add the host countries of the subsidiaries as another dimension besides group and year. The overall number of observations increases to 62,717. In the dataset for the *Quantity-Decision*, the number of observations decreases to 9,613 because only those group-country-year observations are retained, in which a group owns at least one patent. Appendix A.1 describes the steps taken to construct the three datasets in detail and Table A1 summarizes the datasets by country.

[Insert Table 1 about here]

3.2 Variables

3.2.1 Patents

Since we analyze patent-location decisions, our dependent variables are based on patent data. In our main analysis, we follow prior literature (Karkinsky and Riedel (2012)) by including both granted patents and published patent applications, which already enjoy a certain level of protection. Furthermore, we show that results do not change materially if only granted patents are included. The data used in our study are retrieved from AMADEUS, which in turn sources its information from the European Patent Office's PATSTAT database.[4] PATSTAT contains bibliographic patent data from more than 100 patent offices worldwide (de Rassenfosse, Dernis and Boedt (2014)). In our main analysis, we include patents issued by national, regional, and international patent offices worldwide. In one of our extensions, we also account for the number of forward citations as a proxy for the value of a patent and for the inventor location.

For the *Abroad-Decision*, we create a binary variable, *Patent Abroad*, which assumes a value of one if a group has at least one patent outside of the home country of the parent and a value of zero otherwise. In the *Country-Decision*, the binary variable, *Patent Country*, receives a value of one in any given year if a group has at least one patent in a given country and a value of zero otherwise. For the *Quantity-Decision*, we annually aggregate the number of patents owned by all entities of one group being located in the same country (*Patent Number*). Table 2 provides descriptive statistics summarizing the three patent variables in the sample.

[Insert Table 2 about here]

[4] The matching of the PATSTAT and AMADEUS databases is conducted jointly by the OECD and the Bureau van Dijk. It must be noted that this matching is not comprehensive, e.g., since not all applicants are reported by the PATSTAT database and because not all patents have companies as applicants.

3.2.2 Tax Variables

The main independent variables of interest in our study characterize the tax attractiveness of countries. First, we include *STR*, measuring the attractiveness of the statutory tax rate on business income. Using the observed statutory tax rate in country *c* and year *t* (*statutory tax rate*$_{ct}$) and the maximum observed statutory tax rate (*max. statutory tax rate*$_t$) among all countries in our sample in year *t*, *STR* is scaled between zero and one (see equation 1). Higher values indicate a lower tax rate and therefore a more attractive tax environment in year *t*.

$$STR_{ct} = \frac{max.statutory\ tax\ rate_t - statutory\ tax\ rate_{ct}}{max.statutory\ tax\ rate_t} \quad (1)$$

Next, we capture tax aspects relevant for value extraction through licensing *(ROY)*. *ROY* is defined as the scaled tax rate on royalties received. For most countries in our sample, royalties received are taxed at the statutory tax rate as part of ordinary business income. Eleven countries[5] in the sample, however, offered a favorable tax treatment of royalty income during the sample time horizon 2005-2012. The incentives come in various forms. Some countries offer special deductions from taxable income as a percentage of royalties received (e.g., Hungary). Others exempt a portion of royalty income (e.g., Luxembourg) or offer reduced tax rates (e.g., the Netherlands). We calculate the (unscaled) tax rate ($tax\ rate_{ct}^{Royalties}$) according to equation 2.

$$tax\ rate_{ct}^{Royalties} = (1 - deduction_{ct}) * statutory\ tax\ rate_{ct}^{Royalties} \quad (2)$$

deduction$_{ct}$ indicates the percentage deduction or exemption in country *c* and year *t*; and $statutory\ tax\ rate_{ct}^{Royalties}$ indicates the statutory tax rate on royalties in country *c* and year *t*. We scale *ROY* to range between zero and one, where a higher value indicates a more attractive tax rate, according to equation 3 and in analogy to *STR*. Table A2 in the appendix lists the 2005-2012 average values for *ROY* by country.

$$ROY_{ct} = \frac{max.\ tax\ rate_t^{Royalties} - tax\ rate_{ct}^{Royalties}}{max.\ tax\ rate_t^{Royalties}} \quad (3)$$

[5] Belgium, China, Cyprus, France, Hungary, Ireland, Liechtenstein, Luxembourg, Malta, the Netherlands, and Spain.

Furthermore, we include a patent-specific tax variable measuring the attractiveness of tax-related R&D incentives offered in a country *(RDI)*. Such incentives vary widely across countries. First, rules vary by incentive type. Some countries allow for a deduction of a certain percentage of R&D expenditures[6] from taxable income (deduction method) and some from the tax liability (credit method). Furthermore, countries vary by the scope of expenses recognized. Some countries generously recognize all expenditures related to R&D, while others limit recognition to certain expenditure types (e.g., personnel cost, buildings, etc.). Other countries limit R&D incentives to specific industries or to small enterprises. Moreover, countries differ in their treatment of unused deductions or credits. Some allow for a carryback or carryforward, while others do not. In addition, carryback/-forward periods vary across countries. The most often used measure of R&D incentives is the B-Index developed by Warda (2001). The B-Index is based on a hypothetical R&D investment project and captures some of the aspects mentioned above. However, it is based on several assumptions, e.g., that earnings are sufficiently high to allow for a full offset against any deductions/credits in the year that they occur. Therefore, not all aspects (e.g., carryforward/-back periods), which are relevant in practice, are captured. Furthermore, data on the B-Index are not available for our full sample of countries and time period covered. Therefore, we construct our own measure that also abstracts from many details, but for which we have data for our full sample. *RDI* assumes a value of zero if no R&D incentives are offered. If a country offers an incentive, expressed as a percentage of R&D cost,[7] which is among the 25% highest in a sample of 100 countries globally and in its respective category (deduction/credit), *RDI* assumes a value of one. If an incentive scheme is offered which is not among the 25% most attractive globally, *RDI* assumes a value of 0.5. Table A2 in the appendix lists the 2005-2012 average values for *RDI* by country.

As mentioned in the institutional analysis, transfer pricing is another tax aspect of special importance in the context of our research question. For this reason, we include the year-specific variable *TP* in our dataset for the *Abroad-Decision*. It assumes a value of one if there are no specific rules concerning transfer pricing codified in law beyond the anti-avoidance rules and a value of zero otherwise. Using this scale, we abstract from a number of details in transfer pricing rules. Lohse, Riedel and Spengel (2012) list the definition of related parties, transfer pricing methods, documentation requirements, submission deadlines, penalties, the time period during which tax authorities can adjust transfer prices (statute of limitations), and the existence of advance pricing agreements as dimensions along which transfer pricing re-

6 Some countries grant incentives on the basis of R&D expenditures in a year, or on the incremental expenditures above past years, or a combination of both.

7 We take into account only volume incentives and abstract from incremental incentives.

gimes in different countries can be differentiated. However, when they translate qualitative information on those dimensions into a quantitative measure, they use a scale that is mainly based on documentation requirements. Unfortunately, this measure is available only for a limited set of countries. We therefore measure *TP* as outlined above. Table A2 in the appendix lists the 2005-2012 average values for *TP* by country.

Moreover, we include a dummy variable, *CFC*, in the *Abroad-Decision* which indicates whether CFC rules exist in a country (zero) or not (one). As mentioned in the institutional analysis, the existence of such rules might deter parents from placing patents abroad.

As an additional tax variable specific to the *Abroad-Decision,* we include *WHT-ROY*, indicating the attractiveness of withholding tax rates on royalties in the country of the parent. Using the highest withholding tax rate observed among all countries in a year (max. withholding tax rate$_t$), we scale *WHT-ROY* to range between zero and one, where a higher value indicates a higher attractiveness.

$$WHT\text{-}ROY_{ct} = \frac{max.\ withholding\ tax\ rate_t - withholding\ tax\ rate_{ct}}{max.\ withholding\ tax\ rate_t} \quad (4)$$

Finally, we include an aggregate measure of tax attractiveness, the *Tax Attractiveness Index* (*TAX*) (Keller and Schanz (2013)), consisting of 19 tax variables,[8] in an alternative specification of our analysis. Patent-location decisions always have to be made in conjunction with other location decisions. In order to own patents in a certain country, multinationals need to own subsidiaries there, employ staff, and repatriate profits to their home country. The *Tax Attractiveness Index* (*TAX*) captures a broad set of tax aspects relevant for both patent-location decisions and related location decisions,[9] including the taxation of dividends received and capital gains, withholding taxes on dividends, interest and royalties, a dummy for EU membership, loss carryback, loss carryforward and group relief provisions, the number of double tax treaties signed, thin capitalization rules, anti-avoidance legislation, the personal income tax rate, favorable holding provisions, and the above mentioned 'patent-specific' tax variables. The index ranges between zero and one, where higher values indicate higher tax attractiveness from a corporate perspective.

We adjust the country perspective of all tax variables to fit each of the three decisions. In the dataset for the *Abroad-Decision,* we use the parents' countries' values since this deci-

[8] The *Tax Attractiveness Index* created by Keller and Schanz (2013) consists of 16 components. We add *ETR Royalties*, *RDI*, and *TP* to reflect the specifics of our research question.

[9] Dinkel et al. (2014) use the *Tax Attractiveness Index* (*TAX)* to show that the subsidiary location decisions of German multinationals are influenced by tax attractiveness.

sion takes an outbound view. We want to find out whether the tax environment at home drives the parent to locate patents elsewhere. According to hypothesis H1a, we expect the (scaled) statutory tax rate *(STR)*, the taxation of royalties *(ROY)*, and the *Tax Attractiveness Index (TAX)* of the parent-country to be negatively associated with the likelihood of holding a patent abroad, while we expect a positive association for R&D incentives *(RDI)*, transfer pricing rules *(TP)*, CFC rules *(CFC)*, and (scaled) withholding tax rates on royalties *(WHT-ROY)* based on hypothesis H1b.

In the *Country-Decision*, management decides among several group-countries where to locate patents by comparing the tax attractiveness of these countries. A natural reference point for such a comparison is the most attractive group-country. We therefore define the tax variables in the *Country-Decision* as the value of the respective country under consideration minus the maximum value observed among all group-countries. Specifically, we measure for each group-country the attractiveness gap to the most attractive group-country and then invert the scales. This ensures that the most attractive group-country receives the maximum value of zero and all other countries receive negative values. A lower value indicates a comparatively less attractive tax environment. Therefore, we expect all tax variables in this definition to be positively associated with the likelihood to locate a patent within the respective country (hypothesis H2).

In the *Quantity-Decision*, we examine whether the tax environment in a group-country determines how many patents are located there, given that the country has already been chosen as a patent location in the *Country-Decision*. Therefore, we define the tax variables from the perspective of the group-countries. Here, we expect a positive relationship between *Patent Number* and our tax variables (hypothesis H3). The more attractive the tax environment is in a country, the more patents are expected to be located in this country. Summary statistics for the tax variables in all three decisions can be found in Table 2.

3.2.3 Control Variables

Besides the tax variables, we use additional variables in order to control for non-tax effects that might influence the three decisions. First, we include a company-level size variable, *REV*, which is defined as the natural logarithm of revenues in thousand EUR. In the dataset for the *Abroad-Decision*, we aggregate company revenues by group for each year. For the *Country-Decision* and the *Quantity-Decision*, we aggregate revenues by group-country. For the *Abroad-Decision*, we hypothesize that groups are more likely to locate patents abroad the larger they are. For the *Country-Decision*, we expect them to locate patents in countries

where they have a larger presence, and for the *Quantity-Decision*, we also expect them to locate a greater number of patents in those countries. Therefore, we expect a positive association between our group size measure *(REV)* and the dependent variables in all three decisions. Since patents are associated with royalties or sales of goods and services and both types of income are part of revenues, we potentially have a problem of endogeneity. We therefore replace revenues *(REV)* by the number of employees *(EMP)* as a size variable in one of our robustness tests and show that our main results hold. There should be only a weak, if any, causality running from the number of legally owned patents in a subsidiary to the number of employees located there because there exist economies of scale in the administrative duties connected to legal ownership, that need to be performed locally.

Second, we include various country-level control variables in the datasets. In the case of the *Abroad-Decision*, these variables assume the perspective of the host country of the parent. In the case of the *Country-Decision* and *Quantity-Decision*, the perspective of the respective group-country under consideration is used. As a measure of economic size, we use *GDP*, again in natural logarithmic scale. Larger countries often have a better availability of export and foreign investment facilitators, such as trade chambers, which suggests a positive relationship between *GDP* and the likelihood of placing patents abroad *(Abroad-Decision)*. Furthermore, we expect that both the likelihood and the quantity of patents located in a certain country increases in *GDP*. As another country-level indicator, we use *RES*, calculated as the natural logarithm of the number of researchers in a country per million inhabitants, as published by the World Bank. As a measure of the innovative potential in a country, we expect a positive impact on the *Abroad-Decision*. The more innovative the home country of the parent is, the more likely patents are to be developed there, some of which then can be located abroad. We also expect *RES* to be positively correlated with the dependent variables of the *Country-Decision* and the *Quantity-Decision*. Next, we control for the legislative environment concerning patents by including the variables *APP-RES* and *EMP-INV*. *APP-RES* is a dummy assuming a value of one if there exist regulations requiring a resident company to file the primary patent application at home (e.g., United States, Russia). If such restrictions do not exist or if these restrictions only apply to inventions relevant for national security and defense, *APP-RES* assumes a value of zero.[10] *EMP-INV* assumes a value of one if employee inventors have an explicit and indispensable right to receive remuneration from their employer by the

[10] The data are sourced from the 'Information on Contracting States (Annex B)' as published on the website of the World Intellectual Property Organization.

laws of their employer's country of residence.[11] If no such legislation exists, *EMP-INV* assumes a value of zero. As both variables turn out to be time-invariant, we include them only in the analysis of the *Abroad-Decision* and the *Country-Decision*. In the *Quantity-Decision*, their effect is accounted for in the estimates for unobserved fixed effects. Legal provisions regulating the compensation for employee inventions *(EMP-INV)* are expected to increase legal certainty for employee inventors, as compared to a situation in which remuneration is solely subject to privately negotiated contracts. Harhoff and Hoisl (2007) find that 60% of employee inventors surveyed in Germany, a country with employee-inventor remuneration rules, self-report a positive impact of these rules on their motivation. Given the positive motivational impact of such rules, we expect patent output and ownership to be higher in countries that have such rules in place than in those that do not. *APP-RES*, on the one hand, potentially reduce the options for the tax-efficient value extraction from inventions made in a country and therefore deter inventive activities. On the other hand, such restrictions increase the likelihood of inventive activity resulting in patent ownership of the inventing subsidiary and not of a foreign-related entity. Depending on which effect prevails, we expect a positive or negative impact of such rules on the patent-location decisions.

Furthermore, we include *DIST*, defined as the natural logarithm of the population-weighted distance between main agglomerations of the parent's country and the given group-country in the datasets for the *Country-Decision* and the *Quantity-Decision*. We hypothesize that it is negatively associated with the dependent variables in both decisions. Even if there is no proportional direct cost related to the distance in the case of intangibles, we still assume that parents want to have their IP close by, e.g., due to cultural and psychological reasons.

Finally, in order to be able to control for patterns across industries, each group is classified according to its industry based on the two-digit NAICS code (Markle and Shackelford (2012)).[12]

Table 2 lists the control variables, including their descriptive statistics, for each of the three datasets. Table A4 in the appendix shows the correlation coefficients among the independent variables included in the analysis of the *Country-Decision*. Correlations are similar for the variables analyzed in the other two decisions (not reported). The variables for applica-

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11 The data are sourced from Trimborn and Fabry (2009) and national intellectual property law as published on the website of the World Intellectual Property Organization.

12 Since not all of the parents in our study are companies and the NAICS code of a parent company can be a poor representative of the whole group, we combine all group members' NAICS codes to derive the groups' industry classification based on revenues, number of employees, fixed assets, number of subsidiaries, and the parent's industry classification. We control for industry effects in the datasets for the *Abroad-Decision* and the *Country-Decision* only. In the *Quantity-Decision*, such effects are captured by the fixed effects estimators.

tion restrictions and the number of researchers in a country *(APP-RES* and *RES)* exhibit the highest correlation (0.42) among the variables included in the regressions. All other correlation coefficients are in the range of +/-0.40. A check of the variance inflation factors (not reported), which are far below the commonly applied threshold of 10 for all variables in all three datasets, indicates that multicollinearity seems not to be an issue.

4 Econometric Approach

We tailor the econometric framework to the specifics of the three decisions and the properties of their datasets. While we use binary dependent variables for the *Abroad-Decision* and the *Country-Decision*, *Patent Number* in the dataset for the *Quantity-Decision* contains overdispersed[13] count data. For this reason, we use probit models[14] to analyze the *Abroad-Decision* and the *Country-Decision*, and negative binomial models for the *Quantity-Decision*. Furthermore, the binary variables, *Patent Abroad* and *Patent Country*, exhibit low within subject variance over time,[15] i.e., the decision of groups of whether to locate patents abroad and in which country to locate them is relatively stable over time. We therefore refrain from using a panel framework for the *Abroad-Decision* and the *Country-Decision*, and pool the data over time. Nevertheless, we estimate year and industry fixed effects in order to control for unobserved constant effects on an industry level. For the *Quantity-Decision*, we apply a panel framework and estimate fixed effects. Furthermore, we estimate heteroscedasticity robust standard errors and cluster them by group *(Abroad-Decision)* or group-country *(Country-Decision* and *Quantity-Decision)*.

Equation (5) shows the regression equation for modeling the *Abroad-Decision* for group g and year t.

$$Patent\ Abroad_{gt} = \alpha_0 + \beta_{TAX-VAR} TAX\text{-}VAR_{gt} + \beta_{REV} REV_{gt} + \beta_{GDP} GDP_{gt} + \beta_{RES} RES_{gt} + \beta_{APP-RES} APP\text{-}RES_{gt} + \beta_{EMP-INV} EMP\text{-}INV_{gt} + \beta_i Industry_{igt} + \alpha_t + \varepsilon_{gt} \quad (5)$$

TAX-VAR is a vector of the six tax variables, *STR*, *ROY*, *RDI*, *TP*, *CFC*, and *WHT-ROY* in our main model specification and represents the *TAX* in an alternative specification.

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13 As Table 2 shows, the variance of *Patent Number* exceeds its mean.

14 Note that there is no incidental parameters problem here. Since the number of industries and number of years is fixed, the number of fixed effects 'nuisance parameters' has a natural limit. Therefore, the use of a probit model is appropriate.

15 The within-subject standard deviations (0.063 and 0.073) are considerably lower than the between-subject standard deviations (0.494 and 0.431) for *Patent Abroad* and *Patent Country*, respectively.

Industry indicates dummy variables for each of the two-digit NAICS classifications in order to estimate industry fixed effects, α_t denotes the year fixed effects, and ε_{gt} is the error term.

Equation (6) specifies the regression equation for analyzing the *Country-Decision* for group *g*, country *c*, and year *t*.

$$Patent\ Country_{gct} = \alpha_0 + \beta_{TAX\text{-}VAR} TAX\text{-}VAR_{gct} + \beta_{REV} REV_{gct} + \beta_{GDP} GDP_{ct} + \beta_{RES} RES_{ct} + \beta_{APP-RES} APP\text{-}RES_{ct} + \beta_{EMP\text{-}INV} EMP\text{-}INV_{ct} + \beta_{DIST} DIST_{gct} + \beta_i Industry_{igt} + \alpha_t + \varepsilon_{gct} \quad (6)$$

Here, *TAX-VAR* is a vector of the three tax variables *STR*, *ROY*, and *RDI* in our main specification. In our alternative specification, it represents the *TAX*. Equation (7) shows the regression equation for the *Quantity-Decision*.

$$Patent\ Number_{gct} = \alpha_0 + \beta_{TAX\text{-}VAR} TAX\text{-}VAR_{ct} + \beta_{REV} REV_{gct} + \beta_{GDP} GDP_{ct} + \beta_{RES} RES_{ct} + \beta_{DIST} DIST_{gct} + \alpha_{gc} + \varepsilon_{gct} \quad (7)$$

TAX-VAR is defined as in equation 6. α_{gc} denotes the fixed effects estimators.

5 Results

5.1 Main Results

Table 3 presents the results from the regressions analyzing the *Abroad-Decision*, the *Country-Decision*, and the *Quantity-Decision*. While specification A includes individual tax variables, specification B uses the *Tax Attractiveness Index (TAX)* as the measure of tax attractiveness.

[Insert Table 3 about here]

Specification A for the *Abroad-Decision* reveals that the taxation of royalties *(ROY)*, R&D incentives *(RDI)*, and transfer pricing rules *(TP)* drive the decision of the parent of whether to locate patents abroad. However, we do not find a significant effect of the statutory tax rate *(STR)*, CFC rules *(CFC)*, and the withholding tax rate on royalties *(WHT-ROY)*. *ROY* negatively impacts the *Abroad-Decision*, indicating that parents in countries where they can receive royalties at low tax rates rather keep their patents at home. A parent located in a coun-

try with average tax rates on royalties has a 41% higher marginal probability[16] (20.93%) of locating patents abroad than parents in countries with the lowest tax rates in our sample (14.88%). This result supports hypothesis H1a. Multinationals with parents in countries that offer attractive R&D incentives have a higher likelihood of foreign patent ownership. As hypothesized, an attractive R&D environment in the parent's home country leads to a greater output of patents, some of which can be located abroad. This result is supported by the significantly positive coefficient of *RES*, indicating that a greater innovative potential in the parent's home country increases the likelihood of foreign patent ownership. A parent located in a country that offers R&D incentives which belong to the 25% most attractive schemes globally has a marginal probability (31.61%) to own a foreign subsidiary with patents that is three times higher compared to a country that does not offer such incentives (9.60%). This result supports hypothesis H1b. Furthermore, strict transfer pricing rules in the parent's country decrease the likelihood of owning patents abroad. Parents from countries that do not have specific transfer pricing rules in place, have a threefold marginal probability (44.90%) of placing patents abroad compared to those located in countries that have enacted such rules (14.46%). This result also supports hypothesis H1b. Our aggregate tax measure, the *Tax Attractiveness Index (TAX)*, has explanatory power in the *Abroad-Decision*. A higher tax attractiveness of the parent-country, as indicated by a higher index value, decreases the likelihood of foreign patent ownership.

These results are novel. They show that the tax attractiveness of the parent's home country plays a role in outbound patent-location decisions. In contrast, other studies of the field focus on quantity decisions, i.e., how many patents to locate in each of the countries.

Besides the tax variables, the group size, as measured by *REV*, plays a significantly positive role in the decision of whether to locate patents abroad. As expected, a larger group is more likely to own patents via at least one of its foreign subsidiaries. Similarly, multinationals from larger countries, as measured by *GDP*, are more likely to own patents via foreign subsidiaries. As mentioned, the coefficients for the number of researchers *(RES)* are significant in both specifications. Application restrictions *(APP-RES)* tend to decrease the likelihood of owning patents abroad. This finding supports the theory that these restrictions increase the likelihood of a patent application being filed at home rather than deterring R&D activity in the country of the parent. Similarly, codified obligations to remunerate employee-inventors

[16] The marginal probability is the predicted probability of locating a patent abroad given the specified value of the tax variable and given that all other variables in the regression assume their mean value.

(EMP-INV) also decrease the likelihood of foreign patent ownership. Such rules seem to increase the legal certainty in countries and motivate employees in their innovative activity.[17]

Regarding the *Country-Decision,* results in specification A indicate that the closer a country's tax attractiveness, as measured by the statutory tax rate *(STR),* the taxation of royalties *(ROY),* and R&D incentives *(RDI),* is to the most attractive group-country, the more likely the group locates patents in this country. Group-countries with the lowest statutory tax rates compared to their peers have a 36% higher marginal probability (13.79% vs. 10.17%) of being chosen as a patent location than group-countries with an average attractiveness. Similarly, group-countries with the relatively lowest taxation of royalties have a 23% higher marginal probability (12.47% vs. 10.17%) of being chosen as a patent location than group-countries with an average tax burden. For *RDI,* results show a 12% higher marginal probability (11.41% vs. 10.17%). We can, therefore, conclude that the relative tax attractiveness of a country matters for a multinational group's choice of patent locations and that our results support hypothesis H2. Moreover, specification B reveals that the *Tax Attractiveness Index (TAX*) is a useful indicator for explaining the *Country-Decision* of multinationals. A higher tax attractiveness of a group-country, as indicated by the index, is positively associated with the likelihood of patent ownership in that country.

Furthermore, a larger group size *(REV*), a larger economy (*GDP*), and a favorable innovative environment *(RES*) in a group-country increase the likelihood of patent ownership in that country. The existence of application restrictions (*APP-RES)* decreases the likelihood of a country being chosen as a patent location. By contrast, the existence of employee invention rules *(EMP-INV)* increases this likelihood. While the argument that employee invention rules increase legal certainty, and therefore patent output, is valid in both the *Country-Decision* and the *Abroad-Decision*, the existence of application restrictions seems to have a deterring effect only, when choosing countries as patent locations outside of the home country. Multinational groups seem to be willing to cope with such rules in their home country, but are unwilling to invest in IP in foreign countries with such restrictions. Finally, a long distance to the home country *(DIST*) of the parent decreases the odds of being chosen as a patent location. Even if the immateriality property allows for a separation of patents from other steps in the value creation process without a direct cost, parents seem to want their patent rights to be located close to their home country. All coefficients of our control variables exhibit the expected sign.

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[17] Note that employee-inventor laws specify that rights (e.g., patents) pertaining to an invention are transferred to the employer. Therefore, a higher inventive output due to these rules does not necessarily increase the likelihood of foreign patent ownership (unlike in the case of *RDI* or *RES*).

The *Quantity-Decision* is also positively related to tax attractiveness as measured by all three tax variables, statutory tax rate *(STR)*, the taxation of royalties *(ROY)*, and R&D incentives *(RDI)*. With 4.41 patents, a group-country that has the lowest statutory tax rate observed in our sample (Cyprus in 2011), receives an 11% higher marginal number of patents[18] than a country (e.g., Germany in 2011) with an average statutory tax rate (3.96 patents). Regarding the taxation of royalties, the marginal patent gap between the most attractive and an average country is 3% (4.07 vs. 3.96 patents) and for R&D incentives the gap is 1% (3.99 vs. 3.95). These results support hypothesis H3. The *Tax Attractiveness Index (TAX)* also proves to play a significant role in the *Quantity-Decision*. We find that a higher tax attractiveness in a group-country increases the number of patents allocated to that country.

Moreover, results indicate that both the country size *(GDP)* and the size of the group *(REV)* in a country are important for the scaling decision. As expected, the distance *(DIST)* to the parent-country negatively influences the number of patents located in a group-country. The number of researchers *(RES)* in a group-country is significantly positively related to the number of patents hosted in that country. As expected, a greater innovative strength of a country implies a higher patent output and a higher number of patents owned by subsidiaries in that country.

With regard to the effect of the corporate statutory tax rate and the taxation of royalties, our results for the *Country-Decision* and the *Quantity-Decision* confirm findings in prior literature. The result that a higher taxation of royalty income is negatively associated with the number of patents that a subsidiary owns, confirms the results obtained by Karkinsky and Riedel (2012). Several other results are new. Contrary to their expectations, Ernst and Spengel (2011) are not able to find a significant impact of R&D incentives on the scaling decision. Applying our novel measure across a broader sample of countries, we do find a significant effect. Furthermore, most prior studies exclusively use a measure based on the tax rates on patent income (Karkinsky and Riedel (2012); Ernst et al. (2014)), while other studies only use measures based on the statutory tax rate on business income (Ernst and Spengel (2011)). Based on the two different ways of value extraction from patents (licensing or production), we show that both the taxation of business income and the taxation of royalty income matter for the scaling decisions.

In summary, we show that the tax environment with regard to the extraction of patent value via business profits, as measured by the statutory tax rate *(STR)*, is relevant in the *Coun-*

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[18] The marginal number of patents is the predicted number of patents given the specified value of the tax variable and given that all other variables in the regression assume their mean value.

try-Decision and the *Quantity-Decision*. Tax rules relevant for patent value extraction through licensing, as measured by the taxation of royalties *(ROY)*, are relevant in all three decisions. We also find strong supportive evidence for the impact of R&D incentives *(RDI)* in the three patent-location decisions. Transfer pricing rules *(TP)* are found to matter in the *Abroad-Decision*. However, we do not find a significant effect for CFC rules *(CFC)* and withholding taxes on royalties *(WHT-ROY).*

5.2 Robustness Tests And Extensions

5.2.1 Replacing Revenues by Number of Employees as Group-Level Size Measure

In our main analysis, we use *REV* as a group-level size measure. We discussed the endogeneity problem that potentially exists with this measure due to the fact that royalties on patents form part of corporate revenues. We therefore use the number of employees *(EMP)* reported in AMADEUS to derive an alternative size measure and find that our main results are robust (not reported). Our finding, that the tax attractiveness, as measured by the taxation of royalties *(ROY)*, plays an important role in all three patent-location decisions, holds. In accordance with our main results, the statutory tax rate *(STR)* is still found to play a significant role in the *Country-Decision* and *Quantity-Decision*. R&D incentives *(RDI)* still exhibits significant positive coefficients in the *Abroad-Decision* and the *Country-Decision* but loses its significance in the *Quantity-Decision*. In the *Abroad-Decision*, we find a significant coefficient for CFC rules *(CFC)* instead of transfer pricing rules *(TP)*.

5.2.2 Exclusion of Outliers

In the analysis of the *Quantity-Decision*, outliers in the dependent variable, *Patent Number*, are not eliminated. As Table 2 shows, the maximum number of patents owned by a group in a particular country is 12,764. This number is considerably higher than the median of six. In order to avoid that our results are skewed by outliers, we winsorize the upper percentile of *Patent Number* capping the maximum value of *Patent Number* at 204, the maximum number of patents among the lower 99% of observations.

The results of the regression analysis are presented in Table A5. When comparing these results with our main results presented in Table 3, we can conclude that our findings are robust both against the inclusion and exclusion of outliers. With the exception of the statutory tax rate *(STR)*, whose coefficient is not significant, all variables keep their sign and statistical significance.

5.2.3 Inclusion of Granted Patents Only

The definition of the dependent variables in all three decisions includes both published patent applications and granted patents. As another check for robustness, we exclude published patent applications. Consequently, the alternative dependent variables, *Granted Patents Abroad* in the *Abroad-Decision*, *Granted Patents Country* in the *Country-Decision*, and *Granted Patent Number* in the *Quantity-Decision* are based on granted patents only. Besides the change in scope, the definition of the variables remains unchanged.

We rerun the regressions with the altered dependent variables. Next to the taxation of royalties *(ROY)* and the *Tax Attractiveness Index (TAX)* in the *Quantity-Decision*, for which we do not find significant coefficients in this robustness test, results (see Table A6) show that the main findings remain valid in this setting.

5.2.4 Inclusion of National Patent Office Patents Only

In the description of the patenting process, we show that there is an international and regional route to obtain patents besides national patent office procedures. In our analyses presented so far, we include granted patents and patent applications from all three routes in our analysis. However, this potentially introduces a bias in our analysis of the *Quantity-Decision* since the choice of routes influences the number of patent (application) documents that are issued and counted. If the international or regional route is chosen by companies that seek patent protection in more than one country, we record a lower number of patent (application) documents than if the national route is chosen. This is due to the fact that only one patent document is issued by international or regional organizations during the international stage rather than one per country. In the case of the European Patent Office, even granted patents that have passed the national stage are recorded in one document.

Therefore, we exclude all patent documents issued by international or regional patent offices[19] from our dependent count variable in the *Quantity-Decision* and rerun our analysis with the new variable, *Patent Number National*, as a robustness check. Results are summarized in Table A7. We find that these results are largely unchanged compared to our main regression results.

[19] Documents excluded stem from the African Intellectual Property Organization, African Regional Industrial Property Organization, Eurasian Patent Organization, European Patent Office, Gulf Cooperation Council, and those issued under the Patent Cooperation Treaty (PCT) system.

5.2.5 Applying Forward Citations as Measure of Patent Value

In the analysis presented so far, we treat all patents equally regardless of their value. However, this dimension could matter for location decisions. The more valuable a patent is, the higher is the royalty that can be justified in internal transactions. Therefore, patents with higher values are expected to be more valuable for profit-shifting purposes. However, assessing the value of a patent is difficult, especially since the value distribution of patents is highly skewed (Griliches (1990)). Harhoff, Narin, Scherer and Vopel (1999) and Harhoff, Scherer and Vopel (2003) find that the number of forward citations, among other measures, best approximates a sample of patent values as estimated by the patent owners. Thus, we aggregate the number of citations that patents in our sample receive from other patents, by group, country, and year (*Patent Citations*). We then use this measure as an alternative dependent variable in the analysis of the *Quantity-Decision*.

Table A8 shows that the statutory tax rate *(STR)* is a significant determinant of the value of patents that groups locate in a country. We do not find a significant effect for the taxation of royalties *(ROY)*, R&D incentives *(RDI)*, and the *Tax Attractiveness Index (TAX)*.

5.2.6 Location of Patents Outside the Inventor's Country

Finally, we account for the location of the inventor given in the patent document and focus on patents that are owned by a subsidiary located in a country different from the countries of any of the inventors.[20] This provides us with the opportunity to separate the decision of where to locate a patent from the decision of where the inventive activity takes place. However, this focus also significantly reduces our sample size for all three decisions. Based on this group of patents, we redefine our three dependent variables. *Patent Abroad ex-Inventor* assumes a value of one if a multinational group holds at least one patent outside of the country of the parent and outside the country of the inventor. *Patent Country ex-Inventor* assumes a value of one if a group-country hosts a subsidiary owning at least one patent with inventors outside of this group-country. *Patent Number ex-Inventor* is the number of patents held within a group-country, that were invented in another country.

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[20] There have been discussions on the reliability of the inventor information stated on patent documents in the literature. Some authors suspect that some of the inventors named in patent documents need not necessarily have contributed to the invention, but are listed due to other reasons, e.g., hierarchy (Brockhoff (1997)), while the results from the survey by Harhoff and Hoisl (2007) suggest, that this is only a minor issue. Furthermore, our measure of the number of patents owned by a subsidiary outside of the country where the inventive activity took place is conservative. We eliminate patents if only one of several inventors is located in the country of the subsidiary. There are numerous other patents for which parts of the inventive process took place elsewhere, which we do not capture in our measure.

The results for the regressions are summarized in Table A9. For the *Abroad-Decision*, we find a significant effect for the statutory tax rate *(STR)*, R&D incentives *(RDI)*, and transfer pricing *(TP)*. In the *Country-Decision*, both the statutory tax rate *(STR)* and the taxation of royalties *(ROY)* play a role. This also applies to the *Tax Attractiveness Index (TAX)* in specification B. In the *Quantity-Decision*, we do not find a significant coefficient for any tax variable.

6 Conclusion

A majority of German cross-border licensing business is conducted between related parties. Recent reports on multinationals, such as Apple and Google, give rise to the suspicion that the location of intellectual property, and, thus, related cross-border trade, is partially chosen based on tax considerations.

This paper goes beyond this anecdotal evidence in showing that the location of patents within multinationals is indeed influenced by the tax attractiveness of those countries. Our sample contains groups with parents from 36 countries globally and their patent holdings in 36 European countries. It is the first paper to decompose the location decision regarding patents into three decisions, the decision of whether to locate patents abroad *(Abroad-Decision)*, in which countries to locate patents *(Country-Decision)*, and how many patents to locate in each country *(Quantity-Decision)*. The analysis of these three decisions contributes a more detailed understanding of the corporate tax-planning process to the current discussion in the field and identifies the relevant tax characteristics.

We show that the tax attractiveness of both parent and subsidiary countries matter in all three decisions. Taxation of royalties, as the key determinant of the tax burden faced by patent owners selling licenses, matters in all three decisions. The statutory tax rate, which determines the tax burden on regular business income, e.g., the sale of final or intermediate goods based on patents, plays a role in the *Country-Decision* and *Quantity-Decision* only. In contrast, the statutory tax rate does not influence the probability that a multinational decides to locate patents abroad rather than in the home country. These findings are of relevance, e.g., in the current European Union debate on new patent boxes (Council of the European Union (2014); KPMG (2014)). R&D incentives also play a role in the three decisions. R&D incentives in the parent-country seem to increase overall output of patents, some of which are then located in foreign subsidiaries. Similarly, attractive R&D incentives in the subsidiary's country increase the likelihood and quantity of patent ownership in that country. Transfer pricing rules in the country of the parent seem to make it more difficult to shift profits to foreign pa-

tent-owning subsidiaries and therefore decrease the likelihood of owning patents abroad. This result is important for policy makers, as it indicates the effectiveness of strict transfer pricing rules. In addition, we show that a broad set of tax aspects, as summarized by the *Tax Attractiveness Index (TAX),* helps to explain all three decisions. These general tax aspects matter because patent-location decisions have to be made in conjunction with other location decisions (e.g., subsidiary location decisions) which are influenced by a bundle of tax characteristics.

This study suffers from certain limitations. Even if we capture a broad set of tax aspects, we are not able to capture all aspects of national and international taxation. Moreover, the quantification of the variables necessarily abstracts from many details in tax codes. Furthermore, due to the properties of the dataset, we cannot control for unobserved fixed effects on a group-country level in the *Abroad-Decision* and the *Country-Decision*.

Nevertheless, this study is interesting for researchers and policy makers. It contributes to current literature, as the study analyzes the largest number of influencing tax factors on patent-location decisions. Furthermore, it encourages researchers to consider the multiple perspectives of multinationals, including the parent-country's point of view, instead of focusing on the tax attractiveness of the subsidiary's country only. Following Devereux and Maffini (2006) and our analysis, researchers might separate other tax questions in three different stages *(Abroad-Decision, Country-Decision, Quantity Decision).* Policy makers on a country level can use the results to compare their country's position to that of other jurisdictions in the international competition for intellectual property. It may provide them with guidance on whether and where to make policy adjustments. The finding that the tax attractiveness of the parents' home country matters for outbound patent-location decisions is relevant for governments trying to attract intellectual property. Our results show that they should not only try to attract patents from groups with foreign parents, but they should also try to convince parents in their own country to keep patents at home.

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Table 1 - Company Sample

This table describes the company samples from 2005 to 2012 used for the main analysis of the three location decisions. *Abroad-Decision* is the decision of whether to locate patents abroad. *Country-Decision* is the decision of in which countries to locate patents. *Quantity-Decision* is the decision of how many patents to locate in each country. *No. of observations* and *No. of groups* indicate totals, while *No. of years / group* and *No. of countries / group* indicate mean values. The dimensions G/C/Y stand for group/country/year.

	Abroad-Decision	**Country-Decision**	**Quantity-Decision**
No. of observations	3,414	62,717	9,613
No. of groups	1,054	2,647	1,451
No. of years / groups	3.24	5.89	5.75
No. of countries / groups	NA	4.03	1.15
Dimensions	G, Y	G, C, Y	G, C, Y

…

Table 2 - Descriptive Statistics

This table reports descriptive statistics for the variables used in the three datasets for the *Abroad-Decision*, *Country-Decision*, and *Quantity-Decision*. *Patent Abroad* is a binary variable assuming a value of one if a group holds at least one patent via a subsidiary located outside of the parent's country in a given year and zero otherwise. The binary variable *Patent Country* assumes a value of one if a group holds at least one patent via a subsidiary in a given country in a given year and zero otherwise. *Patent Number* counts the patents that a group holds in a given year in a given country. *TAX* is the *Tax Attractiveness Index*, *STR* is the scaled statutory tax rate applying to ordinary business income, *ROY* is the scaled tax rate on royalties received, and *WHT-ROY* is the scaled withholding tax rate on royalties. These four tax variables range between zero and one, where a higher value indicates a higher attractiveness. *RDI* assumes a value of one if R&D incentives offered in a country are among the 25% most attractive schemes offered globally, a value of 0.5 if they are not among the most attractive, and a value of zero if no incentives are offered. The tax variable *TP* is a dummy indicating whether there exist special transfer pricing laws beyond a general anti-avoidance rule (zero) or not (one). *CFC* is a dummy variable indicating whether there exist CFC rules in a country (zero) or not (one). In the dataset for the *Abroad-Decision*, the tax variables assume the value of the parent's home country, in the *Quantity-Decision* they take the perspective of a given group-country, and in the *Country-Decision* they are defined as the value of the parent's country less the value of the most attractive country in which the group is active. *REV* is the natural logarithm of the aggregate of the revenues of individual group members in the given observation. *GDP* denotes the natural logarithm of the GDP in EUR. For the *Abroad-Decision*, we use the *GDP* of the parent's home country. For the *Country-Decision* and *Quantity-Decision*, we use the *GDP* of the country given. *RES* indicates the natural logarithm of the number of researchers per million inhabitants of a country and assumes the same perspectives as *GDP* in the three datasets. *DIST* is defined as the natural logarithm of the population-weighted distance between main agglomerations of the parent's country and the given group-country. *APP-RES* assumes a value of zero if no or only very narrow regulations exist that require a company to file its primary application for an invention in its country of residence and one otherwise. *EMP-INV* assumes a value of one if employee-inventors have an explicit and indispensable right to remuneration by law and zero otherwise. Both patent law variables assume the same perspectives as *GDP*.

Decision	Variable	Unit	N	Mean	Std. Dev.	Min.	Median	Max.
Abroad	Patent Abroad	Binary	3,414	0.17	0.38	0.00	0.00	1.00
Country	Patent Country	Binary	62,717	0.16	0.37	0.00	0.00	1.00
Quantity	Patent Number	Count	9,613	29.00	335.06	1.00	6.00	12,764.00
Abroad	TAX	Index	3,414	0.42	0.09	0.15	0.43	0.71
Country	TAX	Index	62,717	-0.11	0.10	-0.46	-0.10	0.00
Quantity	TAX	Index	9,613	0.48	0.08	0.25	0.48	0.71
Abroad	STR	Index	3,414	0.24	0.12	0.00	0.23	0.76
Country	STR	Index	62,717	-0.24	0.17	-0.70	-0.24	0.00
Quantity	STR	Index	9,613	0.27	0.12	0.05	0.27	0.76
Abroad	ROY	Index	3,414	0.32	0.20	0.00	0.26	1.00
Country	ROY	Index	62,717	-0.34	0.21	-0.95	-0.34	0.00
Quantity	ROY	Index	9,613	0.39	0.20	0.05	0.34	1.00
Abroad	RDI	Index	3,414	0.32	0.28	0.00	0.50	1.00
Country	RDI	Index	62,717	-0.57	0.35	-1.00	-0.50	0.00
Quantity	RDI	Index	9,613	0.34	0.31	0.00	0.50	1.00
Abroad	TP	Index	3,414	0.02	0.14	0.00	0.00	1.00
Abroad	CFC	Index	3,414	0.10	0.30	0.00	0.00	1.00
Abroad	WHT-ROY	Index	3,414	0.46	0.21	0.00	0.43	1.00
Abroad	REV	Ln(th. EUR)	3,414	10.14	1.56	-1.39	10.23	16.55
Country	REV	Ln(th. EUR)	62,717	9.57	2.14	-8.35	9.64	18.23
Quantity	REV	Ln(th. EUR)	9,613	10.46	2.10	-6.91	10.61	17.11
Abroad	GDP	Ln(EUR)	3,414	27.61	1.08	22.89	28.07	30.03
Country	GDP	Ln(EUR)	62,717	26.57	1.34	22.29	26.53	28.60
Quantity	GDP	Ln(EUR)	9,613	27.41	1.08	23.14	28.05	28.60
Abroad	RES	Ln(#/pop.)	3,414	7.91	0.49	5.07	7.94	8.99
Country	RES	Ln(#/pop.)	62,717	7.96	0.52	6.05	7.98	8.99
Quantity	RES	Ln(#/pop.)	9,613	8.11	0.43	6.60	8.20	8.95
Abroad	APP-RES	Binary	3,414	0.21	0.41	0.00	0.00	1.00
Country	APP-RES	Binary	62,717	0.26	0.44	0.00	0.00	1.00
Abroad	EMP-INV	Binary	3,414	0.95	0.22	0.00	1.00	1.00
Country	EMP-INV	Binary	62,717	0.86	0.35	0.00	1.00	1.00
Country	DIST	Ln(km)	62,717	7.51	1.17	2.95	7.30	9.88
Quantity	DIST	Ln(km)	9,613	7.19	1.26	2.95	7.04	9.84

Table 3 - Tax Attractiveness And the Location of Patents

This table describes the regression results for the three patent-location decisions, i.e., whether to locate patents abroad (*Abroad-Decision*), in which countries to locate patents (*Country-Decision*), and how many patents to locate in each country (*Quantity-Decision*). In the case of the *Abroad-Decision*, the dependent variable, *Patent Abroad*, assumes the value one if a group owns at least one patent via a foreign subsidiary and zero otherwise. In the case of the *Country-Decision*, *Patent Country* receives a value of one if a group has at least one patent in one of its subsidiaries in a particular country and zero otherwise. For the *Quantity-Decision*, *Patent Number* is a count of the number of patents. *TAX* is the *Tax Attractiveness Index*, *STR* is the scaled statutory tax rate applying to ordinary business income, *ROY* is the scaled tax rate on royalties received, and *WHT-ROY* is the scaled withholding tax rate on royalties. These four tax variables range between zero and one, where a higher value indicates a higher attractiveness. *RDI* assumes a value of one if R&D incentives offered in a country are among the 25% most attractive schemes offered globally, a value of 0.5 if R&D incentives are not among the most attractive, and a value of zero if no such incentives are offered. The tax variable TP is a dummy indicating whether there exist special transfer pricing laws beyond a general anti-avoidance rule (zero) or not (one). *CFC* is a dummy variable indicating whether there exist CFC rules in a country (zero) or not (one). For the *Abroad-Decision* the tax variables are defined by the parent's host country (G), for the *Quantity-Decision* by each of the group's entities' host countries (S), and for the *Country-Decision* by the value of the parent's host country less the maximum value observed among all countries in which the group has an entity (S - Max(S)). REV is the natural logarithm of each group's total revenues for the *Abroad-Decision* and the natural logarithm of revenues by country for the *Country-Decision* and the *Quantity-Decision*. The *GDP* is the natural logarithm of the Gross Domestic Product. *RES* indicates the natural logarithm of the number of researchers per million inhabitants of a country. *APP-RES* assumes a value of zero if no or only very narrow regulations exist that require a company to file its primary application for an invention in its country of residence and one otherwise. *EMP-INV* assumes a value of one if employee inventors have an explicit and indispensable right to remuneration by law and zero otherwise. Both patent law variables assume the same perspectives as *GDP*. *GDP*, *RES*, *APP-RES*, and *EMP-INV* are defined from the perspective of the parent's host country for the *Abroad-Decision* and from the perspective of the respective entities' host countries in the *Country-Decision* and the *Quantity-Decision*. *DIST* is the natural logarithm of the distance between the parent's host country and the subsidiaries. For the *Abroad-Decision* and the *Country-Decision*, results are derived from a pooled probit model estimating year and industry fixed effects. Standard errors are clustered by country. For the *Quantity-Decision*, a negative binomial panel model is used estimating fixed effects. The 1%, 5%, and 10% significance level is indicated by ***, **, and *, respectively.

	Abroad Decision					Country Decision					Quantity Decision				
Variables	Exp. Sign	A		B		Exp. Sign	A		B		Exp. Sign	A		B	
TAX	-			-2.03	***	+			2.42	***	+			0.58	***
STR	-	-1.09				+	0.75	***			+	0.92	***		
ROY	-	-0.74	**			+	0.36	***			+	0.17	***		
RDI	+	0.83	***			+	0.12	***			+	0.05	**		
TP	+	0.93	***			NA					NA				
CFC	+	0.40				NA					NA				
WHT-ROY	+	-0.13				NA					NA				
REV	+	0.11	***	0.12	***	+	0.17	***	0.16	***	+	0.02	***	0.02	***
GDP	+	0.15	*	0.12	*	+	0.40	***	0.35	***	+	0.64	***	0.71	***
RES	+	0.71	***	0.94	***	+	0.57	***	0.27	***	+	1.08	***	1.28	***
APP-RES	+/-	-0.09		-0.28	*	+/-	-0.27	***	-0.17	***	NA				
EMP-INV	+/-	-0.75	***	-1.09	***	+/-	0.29	***	0.48	***	NA				
DIST	NA					-	-0.16	***	-0.14	***	-	-0.10	***	-0.11	***
Const.	+/-	-11.69	***	-11.38	***	+/-	-15.63	***	-11.80	***	+/-	-22.16	***	-25.51	***
Observations		3,414		3,414			62,717		62,717			9,613		9,613	
Groups		1,054		1,054			2,647		2,647			1,451		1,451	
Log likelihood		-1,326		-1,355			-22,270		-22,173			-17,100		-17,202	
Estimation		Pooled		Pooled			Pooled		Pooled			Panel		Panel	
Tax Var. Def.		G		G			G - Max(S)		G - Max(S)			S		S	

A Appendix

A.1 Construction of Datasets

(i) Our base dataset contains corporate parents and all their subsidiaries of which they own directly and/or indirectly more than 50%. Furthermore, we require these groups to be multinationals (i.e., to be present in at least two different countries), to own at least one patent, and to have unconsolidated accounts published in AMADEUS. The base dataset contains 184,118 companies that are part of 7,053 groups, which are active in 4.68 countries on average and which we observe for 7.73 years on average. In a group-country-year format, this results in 254,855 observations.

(ii) For the *Abroad-Decision*, we eliminate the country dimension since we are purely interested in the decision of whether or not to locate patents abroad. After we eliminate all observations with missing observations in variables included in the main analysis, the number of observations in the dataset for the *Abroad-Decision* is 3,414.

(iii) For the dataset of the *Country-Decision*, we add back the country dimension, but eliminate all observations that involve groups which do not have patents abroad. After the elimination of observations with missing values, the number of observations in the dataset for the *Country-Decision* is 62,717.

(iv) The structure of the dataset of the *Quantity-Decision* is identical to that of *Country-Decision*. We eliminate cases in which a group does not have a patent in a particular country and observations with missing values. This results in 9,613 observations in the dataset for the *Quantity Decision*.

Table 1 summarizes the three final datasets. The number of observations shown in the tables for extensions and robustness tests can deviate due to missing observations in independent variables.

A.2 Sample by Country

Table A1 – Sample by Country

This table reports for the three datasets by country the number of parents (column 2) and the number of groups that have a presence in the respective country (columns 3 and 4) in any of the years 2005-2012. The *Abroad-Decision* is the decision of whether to locate patents abroad. The *Country-Decision* is the decision of in which countries to locate patents. The *Quantity-Decision* is the decision of how many patents to locate in each country chosen.

	Abroad-Decision	Country-Decision	Quantity-Decision
Country	# of parents	# of groups present	# of groups present
Italy	400	1,132	298
Germany	120	780	321
Spain	117	1,066	161
Norway	70	548	71
Austria	51	602	83
France	51	652	227
Japan	31	-	-
Finland	30	460	79
United States	23	-	-
Belgium	19	680	93
Czech Republic	19	804	74
Sweden	18	702	147
Great Britain	13	576	174
Portugal	12	334	17
Slovenia	12	177	14
Denmark	10	215	22
Poland	10	792	49
Luxembourg	8	206	18
Switzerland	7	116	-
Croatia	5	216	1
Ireland	4	97	8
Korea	3	-	-
Netherlands	3	228	28
Slovakia	3	267	13
Hungary	2	59	12
Latvia	2	153	2
Serbia	2	179	1
Brazil	1	-	-
Canada	1	-	-
Cyprus	1	5	-
Estonia	1	152	2
Greece	1	249	2
Israel	1	-	-
India	1	-	-
Iceland	1	13	-
Romania	1	538	4
Bulgaria	-	141	2
Lithuania	-	153	1
Macedonia	-	7	-
Malta	-	53	-
Russia	-	388	1
Turkey	-	59	1
Ukraine	-	146	-
Total	1,054	12,945	1,921

A.3 Patent-Specific Tax Variables

Table A2 – Patent-Specific Tax Variables

This table summarizes novel patent-specific tax variables. All values stated are averages across all country-years (2005-12) observed in the dataset for the *Abroad-Decision*. *ROY* is the scaled tax rate on royalties received. It ranges between zero and one. Higher values indicate a more attractive tax treatment of royalties. *RDI* assumes a value of one if R&D incentives offered in a country are among the 25% most attractive schemes offered globally, a value of 0.5 if R&D incentives are not among the most attractive, and a value of zero if no such incentives are offered. *TP* is the 2005-2012 average of a dummy variable assuming a value of one if a country does not have transfer pricing rules implemented in tax law and zero otherwise.

Country	ROY	RDI	TP
Austria	0.39	0.50	0.00
Belgium	0.79	0.47	0.00
Brazil	0.15	0.50	0.00
Canada	0.17	1.00	0.00
Croatia	0.51	0.68	0.00
Cyprus	0.75	0.00	1.00
Czech Republic	0.48	0.57	0.00
Denmark	0.39	0.02	0.00
Estonia	0.48	0.00	0.00
Finland	0.36	0.00	0.13
France	0.62	0.77	0.00
Germany	0.22	0.00	0.00
Great Britain	0.30	0.50	0.00
Greece	0.51	0.00	0.00
Hungary	0.75	0.64	0.00
Iceland	0.59	0.25	1.00
India	0.16	0.50	0.00
Ireland	0.92	0.50	0.75
Israel	0.41	0.00	0.00
Italy	0.20	0.22	0.00
Japan	0.00	0.42	0.00
Korea	0.38	0.50	0.00
Latvia	0.63	0.00	0.00
Luxembourg	0.73	0.00	1.00
Netherlands	0.75	1.00	0.00
Norway	0.31	0.50	0.00
Poland	0.53	0.50	0.00
Portugal	0.38	0.50	0.00
Romania	0.61	0.50	0.00
Serbia	0.76	0.00	0.00
Slovakia	0.53	0.00	0.00
Slovenia	0.47	0.43	0.15
Spain	0.50	0.50	0.00
Sweden	0.34	0.00	0.06
Switzerland	0.50	0.00	1.00
United States	0.03	0.50	0.00

A.4 Industry Structure of Dataset

Table A3 – Industry Structure

This table summarizes the three datasets by industry. It reports the number of groups in the dataset constructed for each of the three patent-location decisions by industry as defined by two-digit NAICS codes. *Abroad-Decision* is the decision of whether to locate patents abroad. *Country-Decision* is the decision of in which countries to locate patents. *Quantity-Decision* is the decision of how many patents to locate in each country.

	Decisions		
	Abroad	**Country**	**Quantity**
Industry	# of groups	# of groups	# of groups
Accommodation and Food Services	3	12	7
Admin., Support , Waste Mgmt.	11	52	19
Agricult., Forestry, Fish. and Hunt.	-	4	3
Arts, Entertain., and Recreation	-	2	1
Construction	41	75	36
Educational Services	-	-	-
Finance and Insurance	5	54	30
Health Care and Social Assist.	-	8	4
Information	11	46	20
Mgmt. of Comp. and Enterpr.	13	184	101
Manufacturing	690	1,438	871
Mining, Quarrying, and Oil and Gas	-	23	13
Other Services	5	15	6
Professional, Scientific, and Techn. Serv.	86	217	92
Public Administration	-	2	2
Real Estate and Rental and Leasing	12	15	9
Retail Trade	15	34	14
Transportation and Warehousing	7	38	19
Utilities	-	14	5
Wholesale Trade	155	414	199
Not Available	-	-	-
Total	**1,054**	**2,647**	**1,451**

A.5 Correlation Matrix

Table A4 – Correlation Matrix – Country-Decision

This table reports the Pearson correlation coefficients of the variables used in the *Country-Decision*, i.e., the decision of how many patents to locate in each country. The *Tax Attractiveness Index* (*TAX)* is a composite index of 19 tax factors that describe relevant aspects of the corporate tax environment in countries. *STR* is the scaled statutory tax rate in a country. *ROY* is the scaled tax rate on royalties received. *RDI* assumes a value of one if R&D incentives offered in a country are among the 25% most attractive schemes offered globally, a value of 0.5 if R&D incentives are not among the most attractive, and a value of zero if no such incentives are offered. The tax variables range between zero and one, where a higher value indicates a higher attractiveness. All tax variables are defined as the value of the group-country minus the highest value observed among all countries. *REV* is the natural logarithm of the aggregate of the revenues of individual group members in the given observation. *GDP* denotes the natural logarithm of the GDP. *RES* indicates the natural logarithm of the number of researchers per million inhabitants of a country. *APP-RES* assumes a value of zero if no or only very narrow regulations exist that require a company to file its primary application for an invention in its country of residence and one otherwise. *EMP-INV* assumes a value of one if employee inventors have an explicit and indispensable right to remuneration by law and zero otherwise. *GDP*, *RES*, *APP-RES*, and *EMP-INV* are defined from the perspective of the respective entities' host countries. *DIST* is defined as the natural logarithm of the population-weighted distance between main agglomerations of the parent's country and the given group-country.

	TAX	STR	ROY	RDI	REV	GDP	RES	APP-RES	EMP-INV	DIST
TAX	1.00									
STR	0.03	1.00								
ROY	0.36	0.40	1.00							
RDI	0.28	0.09	0.35	1.00						
REV	-0.09	-0.26	-0.18	-0.06	1.00					
GDP	0.10	-0.36	-0.16	0.26	0.15	1.00				
RES	0.37	-0.20	-0.09	0.01	0.06	0.16	1.00			
APP-RES	-0.04	-0.10	-0.13	-0.15	0.03	0.12	0.42	1.00		
EMP-INV	-0.08	-0.02	-0.28	0.03	0.04	0.29	0.29	0.24	1.00	
DIST	-0.14	0.02	-0.14	-0.13	0.02	0.05	-0.04	0.14	0.05	1.00

A.6 Exclusion of Outliers

Table A5 – Tax Attractiveness And the Location of Patents – Exclusion of Outliers

This table describes the regression results for the *Quantity-Decision*, i.e., the decision of how many patents to locate in each country. The dependent variable, *Patent Number*, is a count of the number of granted patents and published patent applications. The upper percentile of the data is winsorized. *TAX* is the *Tax Attractiveness Index*, *STR* is the scaled statutory tax rate on ordinary business income. *ROY* is the scaled tax rate on royalties received. The three tax variables range between zero and one, where a higher value indicates a higher attractiveness. *RDI* assumes a value of one if R&D incentives offered in a country are among the 25% most attractive schemes offered globally, a value of 0.5 if R&D incentives are not among the most attractive, and a value of zero if no such incentives are offered. All three tax variables are defined from the perspective of the group's entities' host countries (S). REV is the natural logarithm of revenues by group and country. *GDP* is the natural logarithm of the Gross Domestic Product. *RES* indicates the natural logarithm of the number of researchers per million inhabitants of a country. *GDP* and *RES* are defined from the perspective of the respective entities' host countries. *DIST* is the natural logarithm of the distance between the parent's host country and the respective entity's host country. Results are derived from a fixed effects negative binomial panel model. The 1%, 5%, and 10% significance level is indicated by ***, **, and *, respectively.

		Quantity-Decision			
Variables	Exp. Sign	A		B	
TAX	+			0.56	***
STR	+	0.88	***		
ROY	+	0.20			
RDI	+	0.03	***		
REV	+	0.02	***	0.02	***
GDP	+	0.68	***	0.74	***
RES	+	1.04	***	1.23	***
DIST	-	-0.15	***	-0.16	***
Const.	+/-	-22.36	***	-25.48	***
Observations		9,613		9,613	
Groups		1,451		1,451	
Log likelihood		-17,003		-17,107	
Estimation		Panel		Panel	
Tax Var. Def.		S		S	

A.7 Inclusion of Granted Patents Only

Table A6 - Tax Attractiveness And the Location of Granted Patents

This table describes the regression results for patent-location decisions, i.e., the *Abroad-Decision*, the *Country-Decision*, and the *Quantity-Decision*. In the case of the *Abroad-Decision*, the dependent variable, *Granted Patent Abroad*, assumes the value one if a group owns at least one granted patent via a foreign subsidiary and zero otherwise. In the case of the *Country-Decision*, *Granted Patent Country* receives a value of one if a group has at least one granted patent in one of its subsidiaries in a particular country and zero otherwise. For the *Quantity-Decision*, the dependent variable, *Granted Patent Number*, is a count of the number of granted patents. *TAX* is the *Tax Attractiveness Index*, *STR* is the scaled statutory tax rate applying to ordinary business income, *ROY* is the scaled tax rate on royalties received, and *WHT-ROY* is the scaled withholding tax rate on royalties. These four tax variables range between zero and one, where a higher value indicates a higher attractiveness. *RDI* assumes a value of one if R&D incentives offered in a country are among the 25% most attractive schemes offered globally, a value of 0.5 if R&D incentives are not among the most attractive, and a value of zero if no such incentives are offered. The tax variable *TP* is a dummy indicating whether there exist special transfer pricing laws beyond a general anti-avoidance rule (zero) or not (one). *CFC* is a dummy variable indicating whether there exist CFC rules in a country (zero) or not (one). For the *Abroad-Decision* the tax variables are defined by the parent's host country (G), for the *Quantity-Decision* they are defined from the perspective each of the group's entities' host countries (S), and for the *Country-Decision* they are defined as the value of the parent's host country less the maximum value observed among all countries in which the group has an entity (S - Max(S)). Here, a higher value indicates a country being closer to the most attractive country. REV is the natural logarithm of each group's total revenues for the *Abroad-Decision* and the natural logarithm of revenues by country for the *Country-Decision* and the *Quantity-Decision*. The GDP is the natural logarithm of the Gross Domestic Product. *RES* indicates the natural logarithm of the number of researchers per million inhabitants of a country. *APP-RES* assumes a value of zero if no or only very narrow regulations exist that require a company to file its primary application for an invention in its country of residence and one otherwise. *EMP-INV* assumes a value of one if employee-inventors have an explicit and indispensable right to remuneration by law and zero otherwise. *GDP*, *RES*, *APP-RES*, and *EMP-INV* are defined from the perspective of the parent's host country for the *Abroad-Decision* and from the perspective of the respective entities' host countries in the *Country-Decision* and the *Quantity-Decision*. *DIST* is the natural logarithm of the distance between the parent's host country and the respective entity's host country. For the *Abroad-Decision* and the *Country-Decision*, results are derived from a pooled probit model estimating year and industry fixed effects. Standard errors are clustered by country. For the *Quantity-Decision*, a negative binomial panel model is used estimating fixed effects. The 1%, 5%, and 10% significance level is indicated by ***, **, and *, respectively.

	Abroad-Decision				Country-Decision				Quantity-Decision			
Variables	Exp. Sign	A		B	Exp. Sign	A		B	Exp. Sign	A		B
TAX	-		-1.68 **		+		2.49 ***		+		0.35	
STR	-	-0.31			+	0.68 ***			+	0.61 ***		
ROY	-	-0.64 *			+	0.37 ***			+	-0.04		
RDI	+	0.83 ***			+	0.12 **			+	0.05 **		
TP	+	0.99 ***			NA				NA			
CFC	+	0.27			NA				NA			
WHT-ROY	+	-0.51			NA				NA			
REV	+	0.14 ***	0.13 ***		+	0.17 ***	0.16 ***		+	0.12	0.00	
GDP	+	0.13	0.08		+	0.42 ***	0.37 ***		+	12.74 ***	1.06 ***	
RES	+	0.53 ***	0.69 ***		+	0.57 ***	0.26 ***		+	17.91 ***	1.41 ***	
APP-RES	+/-	-0.22	-0.29 *		+/-	-0.24 ***	-0.14 ***		NA			
EMP-INV	+/-	-0.75 ***	-1.01 ***		+/-	0.29 ***	0.47 ***		NA			
DIST	NA				-	-0.15 ***	-0.13 ***		-	0.28 ***	0.29 ***	
Const.	+/-	-9.87 ***	-8.89 ***		+/-	-16.17 ***	-12.35 ***		+/-	-34.58 ***	-36.62 ***	
Observations		3,414	3,414			54,920	54,920			5,190	5,190	
Groups		1,054	1,054			2,258	2,258			718	718	
Log likelihood		-1,155	-1,185			-18,123	-18,009			-7,906	-7,918	
Estimation		Pooled	Pooled			Pooled	Pooled			Panel	Panel	
Tax Var. Def.		G	G			G - Max(S)	G - Max(S)			S	S	

A.8 Inclusion of National Patents Only

Table A7 - Tax Attractiveness And the Location of National Patents

This table describes the regression results for the *Quantity-Decision*, i.e., the decision of how many patents to locate in each country. The dependent variable, *Patent Number National*, is a count of the number of patents and published patent applications issued by national patent offices. *TAX* is the *Tax Attractiveness Index*, and *STR* is the scaled statutory tax rate. The tax variable *ROY* is the scaled tax rate on royalties received. The tax variables range between zero and one, where a higher value indicates a higher attractiveness. Both tax variables range between zero and one, where a higher value indicates a higher attractiveness. *RDI* assumes a value of one if R&D incentives offered in a country are among the 25% most attractive schemes offered globally, a value of 0.5 if R&D incentives are not among the most attractive, and a value of zero if no such incentives are offered. The tax variables are defined from the perspective of the group's entities' host countries (S). REV is the natural logarithm of revenues by group and country. *RES* indicates the natural logarithm of the number of researchers per million inhabitants of a country. *GDP* and *RES* are defined from the perspective of the respective entities' host countries. *DIST* is the natural logarithm of the distance between the parent's host country and the respective entity's host country. Results are derived from a fixed effects negative binomial panel model. The 1%, 5%, and 10% significance level is indicated by ***, **, and *, respectively.

		Quantity-Decision			
Variables	Exp. Sign	A		B	
TAX	+			0.61	***
STR	+	0.91	***		
ROY	+	0.14	**		
RDI	+	0.04	**		
REV	+	0.03	***	0.02	***
GDP	+	0.63	***	0.72	***
RES	+	1.19	***	1.37	***
DIST	-	-0.06		-0.06	
Const.	+/-	-22.88	***	-26.43	***
Observations		9,330		9,330	
Groups		1,451		1,451	
Log likelihood		-15,427		-15,504	
Estimation		Panel		Panel	
Tax Var. Def.		S		S	

A.9 Tax Attractiveness And the Location of Patent Value

Table A8 - Tax Attractiveness And the Location of Patent Value

This table describes the regression results for the *Quantity-Decision*, i.e., the decision of how many patents to locate in each country. The dependent variable, *Patent Citations*, is a count of the number of citations of granted patents and published patent applications received. *TAX* is the *Tax Attractiveness Index*, and *STR* is the scaled statutory tax rate. The tax variable *ROY* is the scaled tax rate on royalties received. The tax variables range between zero and one, where a higher value indicates a higher attractiveness. Both tax variables range between zero and one, where a higher value indicates a higher attractiveness. *RDI* assumes a value of one if R&D incentives offered in a country are among the 25% most attractive schemes offered globally, a value of 0.5 if R&D incentives are not among the most attractive, and a value of zero if no such incentives are offered. The tax variables are defined from the perspective of the group's entities' host countries (S). *REV* is the natural logarithm of revenues by group and country. *RES* indicates the natural logarithm of the number of researchers per million inhabitants of a country. *GDP* and *RES* are defined from the perspective of the respective entities' host countries. *DIST* is the natural logarithm of the distance between the parent's host country and the respective entity's host country. Results are derived from a fixed effects negative binomial panel model. The 1%, 5%, and 10% significance level is indicated by ***, **, and *, respectively.

		Quantity-Decision			
Variables	Exp. Sign	A		B	
TAX	+			0.18	
STR	+	0.30	***		
ROY	+	0.00			
RDI	+	0.02			
REV	+	0.01	*	0.01	*
GDP	+	0.24	***	0.28	***
RES	+	0.32	***	0.34	***
DIST	-	-0.02		-0.01	
Const.	+/-	-0.86		-2.00	
Observations		6,476		6,476	
Groups		1,032		1,032	
Log likelihood		-10,533		-10,543	
Estimation		Panel		Panel	
Tax Var. Def.		S		S	

A.10 Tax Attractiveness And the Location of Patents Outside the Inventor's Country

Table A9 - Tax Attractiveness And the Location of Patents Outside the Inventor's Country

This table describes the regression results for the *Abroad-Decision*, the *Country-Decision*, and the *Quantity-Decision*. In the *Abroad-Decision*, the dependent variable, *Patent Abroad ex-Inventor*, assumes the value one if a group owns at least one patent via a foreign subsidiary outside the country of the inventor and zero otherwise. In the *Country-Decision*, *Patent Country ex-Inventor* receives a value of one if a group has at least one such patent in a particular country and zero otherwise. In the *Quantity-Decision*, *Patent Number ex-Inventor* is a count of the number of patents in a country that are located outside of the country of the inventor. *TAX* is the *Tax Attractiveness Index*, *STR* is the scaled statutory corporate tax rate, *ROY* is the scaled tax rate on royalties received, and *WHT-ROY* is the scaled withholding tax rate on royalties. These four tax variables range between zero and one, where a higher value indicates a higher attractiveness. *RDI* assumes a value of one if R&D incentives offered in a country are among the 25% most attractive schemes offered globally, a value of 0.5 if they are not among the most attractive, and a value of zero if no such incentives are offered. *TP* is a dummy indicating whether there exist special transfer pricing laws (zero) or not (one). *CFC* is a dummy variable indicating whether there exist CFC rules in a country (zero) or not (one). For the *Abroad-Decision* the tax variables are defined by the parent's host country (G), for the *Quantity-Decision* by the group's entities' host countries (S), and for the *Country-Decision* by the value of the parent's host country less the maximum value observed among all countries in which the group has an entity (S - Max(S)). *REV* is the natural logarithm of each group's total revenues for the *Abroad-Decision* and the natural logarithm of revenues by country for the *Country-Decision* and the *Quantity-Decision*. The GDP is the natural logarithm of the Gross Domestic Product. *RES* indicates the natural logarithm of the number of researchers per million inhabitants of a country. *APP-RES* assumes a value of zero if no regulations exist that require the primary patent application to be filed in its country of residence and one otherwise. *EMP-INV* assumes a value of one if employee-inventors have an explicit and indispensable right to remuneration by law and zero otherwise. *GDP*, *RES*, *APP-RES*, and *EMP-INV* are defined from the perspective of the parent's host country for the *Abroad-Decision* and the respective host countries in the *Country-Decision* and the *Quantity-Decision*. *DIST* is the natural logarithm of the distance between the parent's host country and the respective entity's host country. For the *Abroad-Decision* and the *Country-Decision*, results are derived from a pooled probit model estimating year and industry fixed effects. Standard errors are clustered by country. For the *Quantity-Decision*, a negative binomial panel model is used estimating fixed effects. The 1%, 5%, and 10% significance level is indicated by ***, **, and *, respectively.

	Abroad-Decision					Country-Decision					Quantity-Decision				
Variables	Exp. Sign	A		B		Exp. Sign	A		B		Exp. Sign	A		B	
TAX	-			-0.95		+			3.93	***	+			-0.04	
STR	-	-4.44	***			+	1.12	***			+	0.41			
ROY	-	0.45				+	0.81	***			+	0.03			
RDI	+	1.07	*			+	0.01				+	-0.03			
TP	+	2.55	***			NA					NA				
CFC	+	-0.66				NA					NA				
WHT-ROY	+	-0.15				NA					NA				
REV	+	0.03		0.04		+	0.15	***	0.14	***	+	0.09	***	0.09	***
GDP	+	0.40	*	0.48	***	+	0.36	***	0.28	***	+	0.93	***	0.94	***
RES	+	-0.09		0.17		+	0.74	***	0.23	***	+	0.97	***	0.97	***
APP-RES	+/-	-0.20		-0.08		+/-	-0.42	***	-0.20	***	NA				
EMP-INV	+/-	-0.14		-0.57		+/-	-0.08		0.13		NA				
DIST	NA					-	-0.08	***	-0.05	**	-	-0.67	***	-0.68	***
Const.	+/-	-12.62	*	-14.15	**	+/-	-16.33	***	-10.06	***	+/-	-23.87	***	-23.89	***
Observations		354		354			28,277		28,277			2,259		2,259	
Groups		134		134			973		973			432		432	
Log likelihood		-197		-197			-6,465		-6,403			-2,816		-2,818	
Estimation		Pooled		Pooled			Pooled		Pooled			Panel		Panel	
Tax Var. Def.		G		G			G - Max(S)		G - Max(S)			S		S	

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