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Olena Dudar and Johannes Voget

ZEW
Zentrum für Europäische Wirtschaftsforschung GmbH
Centre for European Economic Research

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Olena Dudar[1]

(ZEW Mannheim)

Johannes Voget

(University of Mannheim)

Abstract

Numerous empirical studies have analysed the influence of corporate taxation on the location of intangible assets within a company group. However, the previous literature has rather focused on studying the impact of taxation on patent location choices assuming that these assets represent the rest of intangibles as well. This paper complements previous studies by estimating and comparing the tax elasticities of two different types of intangibles – patents and trademarks. We employ data on European and US patent and trademark applications in the period of 1996-2012 and estimate a multinomial logit model that incorporates various observed and unobserved factors of the intangible's location choice. According to our main findings, trademarks are more sensitive to changes in taxation as compared to patents. This implies that firms use trademarks more eagerly for tax planning purposes than patents.

Keywords: intangible assets; patent; trademark; tax planning; corporate taxation

JEL-Classification: H25, F23, H26, H3

[1] Corresponding Author: Centre for European Economic Research (ZEW Mannheim), e-mail: dudar@zew.de, phone: +49 (0) 621-1235-141. P.O. Box: ZEW Mannheim, L7,1, 68161 Mannheim, Germany.

1. Introduction

Nowadays the ownership of an intangible asset[2] is mobile within a company group. Even though one affiliate develops an intangible asset, another one could become its official owner because of such instruments as a cost-sharing agreement, a contract research, or a sale of an intangible. Moreover, a company group might strategically re/locate its research and development facilities to a certain affiliate. Then an intangible asset would be not only registered, but also developed by a new company within a group.

There are several reasons why a company group might be willing to choose strategically the location where its intangibles are developed and owned. Beside various operational and financial motives, taxation could serve as an explanation for a strategic re/location of intangible assets. For instance, if an affiliate in a low-tax jurisdiction owns an intangible, then other group members that use this asset have to pay royalty fees to the intangible's owner. Consequently, the royalties are taxed on a low rate and the tax base of firms in other countries decreases. This leads to a shifting of profits from one group member to another and eventually reduces the overall tax burden of a group.

Indeed, there is plenty of anecdotal evidence on large multinational companies such as *Starbucks Corporation*[3], *Apple Inc.*[4] or *Microsoft Corporation*[5] using intangible assets to minimize their consolidated tax burdens. For example, the world's largest spirits producer *Diageo plc* has been accused of relocating its famous trademarks, including *Johnnie Walker Scotch*, *J&B Rare,* and *Gilbey's Gin* for the purposes of profit shifting[6]. Numerous academic studies have provided empirical evidence on this issue as well (see, for example, Ernst and Spengel (2011), Karkinsky and Riedel (2012), Ernst et al. (2014), Griffith et al. (2014), Alstadsæter et al. (2015), Böhm et al. (2015), Dinkel and Schanz (2015)). The findings of these authors support the argument that firms use intangible assets with the aim of tax planning.

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[2] According to the OECD (2013) an intangible is "something which is not a physical asset or a financial asset, which is capable of being owned or controlled for use in commercial activities, and whose use or transfer would be compensated had it occurred in a transaction between independent parties in comparable circumstances." The examples include patents, trademarks, copyrights, goodwill, know-how, franchises, and others. Source: < http://www.oecd.org/ctp/transfer-pricing/revised-discussion-draft-intangibles.pdf>

[3] See *The Economist* (2012), available at <http://www.economist.com/news/business/21568432-starbuckss-tax-troubles-are-sign-things-come-multinationals-wake-up-and-smell>

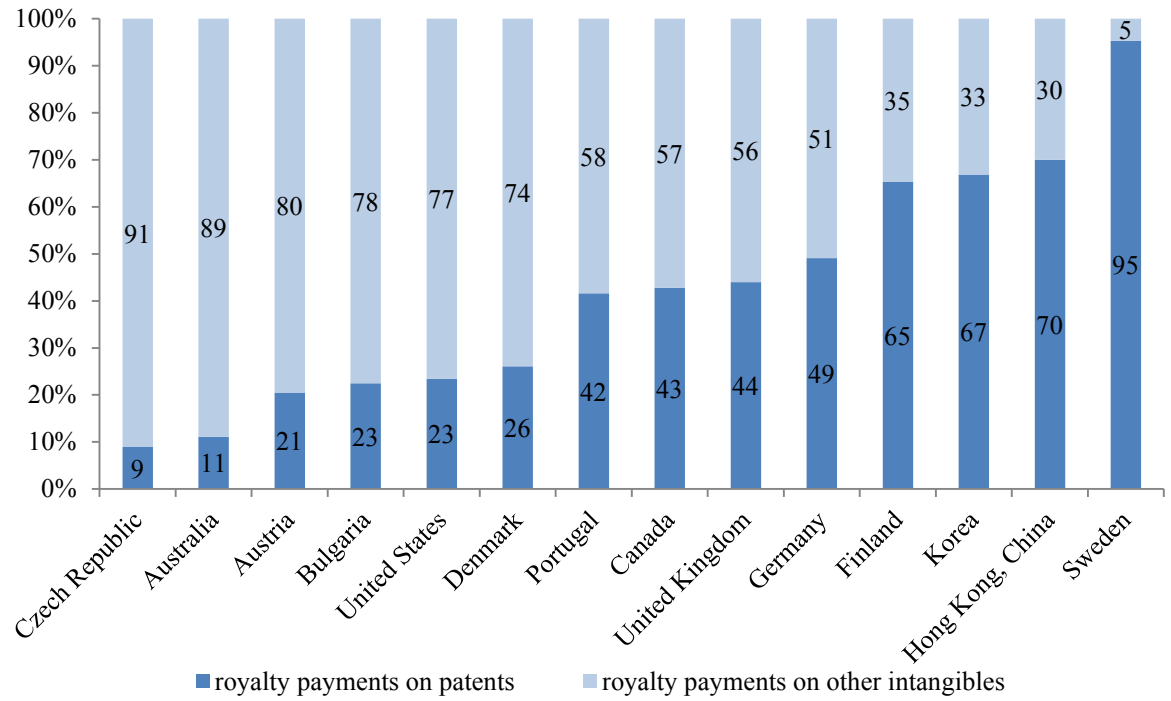
[4] See *Forbes* (2013), available at <http://www.forbes.com/sites/beltway/2013/05/21/the-real-story-about-apples-tax-avoidance-how-ordinary-it-is/>

[5] See *Business Insider* (2013), available at <http://www.businessinsider.com/apple-microsoft-avoids-taxes-loopholes-irs-2013-1?IR=T>

[6] See *The Guardian* (2009), available at < http://www.theguardian.com/business/2009/feb/02/tax-gap-diageo-johnnie-walker>

The previous empirical literature on the strategic use of intangible assets is rather concentrated on patents. Researchers usually assume that data on patents represents all other intangibles including trademarks, copyrights, goodwill, know-how, franchises, and others. This might just constitute a research gap because of the two following reasons. First, there are many kinds of intangibles and firms might use them along or instead of patents for profit shifting, as the *Diageo plc* example shows. Second, in most countries patents represent only a fraction of total intangible assets meaning that the possibility to shift profits through other types of intangibles is high. For instance, Figure 1 demonstrates that in 2013 only 49% of royalty outflows from Germany consisted of royalty payments for the use of patents. The rest included royalties for the use of trademarks, copyrights, goodwill, know-how, franchises, and other intangible assets.

Figure 1. Patent Royalties as a Share of Total Royalty Payments, Outflows, 2013, in %



Note: This figure is based on the data on royalty exchange with respect to the rest of the world. In case of the UK and the US only the royalty exchange with respect to the EU28 are taken into consideration because of the data availability issue. Data Sources: the OECD.Stat and Eurostat.

The main goal of this paper is to analyse whether and (if yes) to which extent corporate taxation influences the location of different types of intangible assets within company groups. Answering this research question could shed some light on the true magnitude of profit shifting through the channel of intangible assets. The focus of this study lies on an empirical comparison of the strategic use of two kinds of intangibles – patents and trademarks.

We would ideally approach this research question using information on the patent and trademark ownership within company groups. Since most companies do not publicly report such data, we follow previous studies in this field employing the data on patent and trademark applications. As Ernst and Spengel (2011) note, the intangible applicant is its legal owner because only the asset's legal owner is entitled to apply for its registration at an international office[7]. Therefore, we use the Orbis database provided by Bureau van Dijk to gather the data on all trademark and patent applications filled out at the European Patent Office (EPO), the Office for Harmonization in the Internal Market (OHIM), and the United States Patent and Trademark Office (USPTO) over the period of 1996-2012.

The analysis includes companies located in seventeen countries, namely Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Spain, Sweden, Switzerland, the United Kingdom, and the US[8]. The final dataset includes 396,447 trademark and 518,475 patent applications filled out by 31,682 firms. Following Griffith et al. (2014), the empirical estimation is implemented by applying a mixed logit model in a panel-data framework, which allows to control for various observed and unobserved heterogeneity in the intangibles' location[9] choices. This identification strategy also permits to calculate own and cross-country tax elasticities of patents' and trademarks' locations.

Our main finding is that the tax elasticity[10] of a patent location choice varies between -0.05% and -0.85%, while the one of a trademark lies between -0.77% and -3.14%. This implies that increasing a country's tax rate on royalty income by one percent will on average result into a -0.05% to -0.85% decrease in the number of patents and a -0.77% to -3.14% drop in the number of trademarks in a given country.

The contribution of this paper to the previous literature is twofold. First, we extend the analysis on a strategic use of intangible assets to trademarks. The earlier studies either focus exclusively on patents (Ernst and Spengel (2011), Karkinsky and Riedel (2012), Ernst et al. (2014), Griffith et al. (2014), Alstadsæter et al. (2015), Böhm et al. (2015), Dinkel and Schanz (2015)) or do not distinguish between different types of intangibles treating them as one

[7] Ernst and Spengel (2011) refer to the EPO data. Therefore, in case of the European patents and trademarks, we consider the applicant to be the legal owner of an intangible. As for the USPTO database, both the owner and the inventor of an intangible can be clearly observed in the dataset.

[8] According to our datasets, these states are the top seventeen locations in which companies apply for patent and trademark registration.

[9] In this study, the location of an intangible equals the country of its ownership (the terms location, country, jurisdiction, state are thus used as synonyms).

[10] Elasticity is defined as a percentage change in the dependent variable in response to a percentage change in the independent variable.

(Huizinga et al. (2008) and Dischinger and Riedel (2011)). In the first part of the analysis, this study confirms the results of previous literature by finding a negative association between taxation and the patent location choices. Then we go a step further by comparing the tax elasticity of trademark location choices with the tax elasticity of patent location choices. This allows us to draw some conclusions about the relative importance of these two types of intangibles for the tax-planning strategies of company groups.

Second, by laying a special focus on trademarks, this study also contributes to Graham and Somaya (2006), von Graevenitz (2007), Greenhalgh and Rogers (2012), Crass (2014) and Crass and Peters (2014), who empirically analyse different aspects of trademark ownership. These authors express concerns about a relative neglect of the non-patent intellectual property (IP) research. While they focus on the empirical association between trademarks and firm value, profitability or its level of innovation, we analyse the impact of corporate taxation on the location choices of trademarks.

Our study relates most to Griffith et al. (2014), since we apply a comparable identification strategy and use similar data. For example, in line with these authors, we also apply a multinomial logit model. An important difference to Griffith et al. (2014) lies in estimating not only data on patent applications filled out at the EPO, but also the ones at the USPTO. In addition, we analyse a slightly different spectrum of countries and years. Nevertheless, the main results of our study are very similar to Griffith et al. (2014), namely they argue that the tax semi-elasticity[11] of patent location choice varies between -0.5% and -3.9%. The main results of our estimation point to an average tax semi-elasticity of patent location choice that equals -1.9%. This implies that increasing the tax rate on royalty income by one percentage point leads to a decrease in the country's number of patents by on average -1.9%. Contributing to Griffith et al. (2014), we perform a similar kind of investigation for trademarks and consequently compare the obtained tax elasticity of trademark and patent location choices. We find that the average tax semi-elasticity of trademarks' location equals -6.2%, which means that a one percentage point increase in a statutory tax rate on royalty income leads to a decrease in the country's number of trademarks by on average -6.2%.

Our study also contributes to the literature on the impact of taxation on the quantity or quality of patents, such as Ernst and Spengel (2011), Karkinsky and Riedel (2012), as well as Ernst et al. (2014). These authors perform an empirical analysis on the firm level usually taking the

[11] Semi-elasticity is defined as a percentage change in the dependent variable in response to a unit change in the independent variable.

number of company's patents as the dependent variable and a country's statutory corporate tax rate as the main independent variable of interest. Even though our methodology differs, the results are still comparable to this flow of literature. For example, Karkinsky and Riedel (2012), argue that the tax semi-elasticity of patents lies between -3.5% and -3.8%. The average tax semi-elasticity of patent location choice in our study is -1.9% (we observe the lowest tax semi-elasticity of -0.3% in Ireland and the highest one of -2.5% in Austria and Denmark). Thus, the tax semi-elasticities found in our study are slightly lower than the ones of Karkinsky and Riedel (2012). This could be explained by the differences in the samples and identification strategies that we apply. The main contribution of our study to this flow of literature lies in comparing the tax semi-elasticity of patents with the one of trademark location choices. Hence, we find the lowest value of tax semi-elasticity of trademark location choice to equal -2.9% in the US and the highest value to be -8.7% in Belgium.

Furthermore, our results contribute to the literature on the impact of taxation on a share of the intangible assets held by an affiliate. Huizinga et al. (2008) and Dischinger and Riedel (2011), for instance, do not distinguish between different types of intangible assets, such as patents, trademarks, copy-right, know-how, but rather treat them all as one. Their findings are in line with the literature on patent location choices. Huizinga et al. (2008) and Dischinger and Riedel (2011) argue that the group affiliates that are located in low-tax jurisdictions have a higher intangibles-to-total-assets ratio as compared to their counterparts in high-tax countries. Our results support this argumentation. We find that an increase in the tax rate on royalty income negatively influences the patent and trademark ownership of group affiliates located in this country. Moreover, our findings suggest that if the tax rate difference between a country of an affiliate and a country of its parent company increases, the given group member is likewise to own less patents and trademarks.

The paper is organized as follows. Section 2 presents the hypotheses development. Section 3 describes our baseline model and the identification strategy. In the next part, the data sources and the construction of key variables are discussed. Some descriptive statistics are also shown here. Section 5 gives a summary of the main findings and is followed by conclusions.

2. Hypothesis Development

Intangible assets are more mobile compared to other kinds of physical or human capital. They can be transferred relatively easily from one affiliate to another within a company group. In addition, intangibles often have a unique nature, which hinders the determination of their true

prices in case of selling or licencing. This makes such assets as patents and trademarks rather suitable instruments for tax planning strategies. Thus, companies that operate in numerous countries do not only get an incentive to re/locate their real research and development (R&D) to low-tax jurisdictions, but also to carry out cost-sharing agreements, contract R&D, or to sale the existing IP from one affiliate to another in order to minimize the eventual taxation of royalty income. Indeed, Hines (1995), Collins and Shackelford (1998), and Dudar et al. (2015) find some evidence for a negative impact of taxation on the direction and amount of bilateral royalty flows. These authors argue that more payments for the use of intangible assets are flowing into low-tax jurisdictions than into high-tax countries and explain this development at least to some extent through the tax planning strategies of company groups. Therefore, Hypothesis 1 of this study states:

> *The location choices of patents and trademarks are sensitive to the tax rates that apply to the income generated by these intangibles.*

However, there are a few important differences between patents and trademarks, which might influence the magnitude of their tax elasticities. According to the Organization for Economic Cooperation and Development (OECD), a patent is the right granted by a government to an inventor for an exclusive usage of a certain invention during an agreed period. In contrast, a trademark usually refers to the right to use exclusively a word, symbol or other mark, which distinguishes firm's products or services from those offered by others[12]. Following the definitions, one might conclude that the main goal of a patent is to protect company's technological investments, while a trademark aims at protecting firm's marketing assets.

The development of patents typically involves greater physical and human capital compared to trademarks. For example, Greenhalgh and Rogers (2012) argue that gaining a patent requires an item to be novel, non-obvious, as well as to embody a sufficiently large inventive step. The development of such an invention often causes substantial R&D expenditures. Besides, in certain industries the R&D facilities and human capital required for the patent development are country-specific. For example, Germany has a long history and a large stock of research personnel and tangible assets needed for the innovative activity in the automotive industry. By contrast, developing a trademark involves merely selecting a word or designing a symbol that has a non-generic nature and is not identical or similar to the existing marks. Marketing expenses related to this procedure are usually of a smaller scale and are not

[12] Source: Glossary of Industrial Organization Economics and Competition Law, compiled by R. S. Khemani and D. M. Shapiro, commissioned by the Directorate for Financial, Fiscal and Enterprise Affairs, OECD, 1993

country-specific. Since developing a trademark involves fewer expenses and relies less on the availability of particular R&D resources in a country, the choice of its location might be less elastic to country's natural endowments and thus more elastic to country's tax rate than the choice of a patent location.

Furthermore, obtaining a patent is usually more costly in terms of expenses and time than registering a trademark. Applying for European protection of a trademark at the Office for Harmonization in the Internal Market costs 900 euros, whereas filing out a patent application at the European Patent Office amounts to a fee of 1405 euros. It does not only cost more, but usually also takes longer to grant a patent. While the granting process for a trademark takes on average two to three years at the OHIM, an equivalent procedure for a patent at the EPO requires on average four to five years. Therefore, trademarks appear to be easier to develop and register than patents. This implies that if a company group decides to strategically re/locate its royalty payments, trademarks provide a faster solution. This once again predicts a higher tax elasticity of trademarks compared to the tax elasticity of patents.

From a tax point of view, there is another important difference between patents and trademarks. The majority of expenditures connected with the patent development are undertaken *before* the patent is actually registered. According to Sandner and Block (2011), it is different in the case of trademarks, where a large share of marketing expenses occurs only *after* the trademark is granted. Therefore, during a patent development a firm faces R&D expenditures in the first period, but receives an income from a resulting patent only in the second period. As a result, the company has an incentive to develop a patent in a high-tax country in order to deduct the relating R&D expenses from the tax base diminishing its overall tax liability in a given state. In the case of a trademark, a firm faces the marketing costs and the income from a trademark in the same period. From the beginning on, a company is at least as concerned about the taxation of the profits generated by a given trademark as it is concerned about the deductibility of its marketing expenditures. That is why firms have a greater incentive to register a trademark in a low-tax country right from the start. This again would lead to greater tax sensitivity of trademarks compared to patents. Based on the above argumentation, Hypothesis 2 of this study states:

> *The location choice of a trademark ownership is more elastic to tax than the location choice of a patent ownership.*

3. Conceptual Framework

Following Griffith et al. (2014), let us assume that the latent variable payoff, which firm *k* obtains from choosing the location *j* to place the ownership of its intangible *i,* is modelled as follows:

$$\pi_{ikj} = \alpha_i Tax_{ij} + \beta \boldsymbol{X}_j + \vartheta_{rj} + \varepsilon_{ikj} \quad (1)$$

In equation 1, π_{ikj} represents the payoff generated by firm *k* from the intangible *i* in country *j*. The term Tax_{ij} denotes the statutory corporate income tax (CIT) rate that applies to the payoff generated by the intangible *i* in country *j*. This variable is equal to the IP-Box tax rate, if such a regime exists in country *j*[13]. Tax_{ij} is substituted by the corporate income tax rate of the parent company if the Controlled Foreign Company rules apply. The variable vector $\boldsymbol{X}_j$ and the error term ε_{ij} represent all other observable and unobservable factors that might have an impact on the payoff π_{ikj}. For instance, $\boldsymbol{X}_j$ includes the quality of country *j*'s institutions, its market size, wealth, and endowment in needed resources. The baseline estimation also contains ϑ_{rj}, which captures country fixed effects as well as the fixed effects of an industry-firm-size category *r*. Firm *k* will choose the location *j* for the ownership of its intangible assets if,

$$\pi_{ikj} > \pi_{ikh}, \quad \forall\ h \in (1, \ldots, H), h \neq j \quad (2)$$

the probability of which is given by

$$P(\pi_{ikj} > \pi_{ikh} \mid Tax_{i1}, \boldsymbol{X}_{i1}, \ldots, Tax_{iH}, \boldsymbol{X}_{iH}) = \frac{\exp(\alpha_i Tax_{ij} + \beta \boldsymbol{X}_j + \vartheta_{rj})}{\sum_{h=1}^{H} \exp(\alpha_i Tax_{ih} + \beta \boldsymbol{X}_h + \vartheta_{rh})} \quad (3)$$

In equation 3, the subscript *H* indicates the number of potential location choices. The parameters α_i and β can be estimated with the means of a mixed logit model. Furthermore, in the baseline specification we follow Griffith et al. (2014) and randomize the coefficient on Tax_{ij}. As a result, α_i is defined as follows:

$$\alpha_i = \alpha_i' + \varphi_r \mu_i, \quad (4)$$

where the parameter α_i' captures the mean marginal effect of tax on the payoff, while φ_r shows the standard deviation in the effect of tax on the payoff. μ_i is a random term in the tax parameter α_i. This implies relaxing the independence of irrelevant alternatives (IIA) assumption. In other words, by randomizing the coefficient on the tax rate we allow the

[13] Tax_{ij} is intangible-specific (as denoted by the subscript *i*) because some IP Boxes apply only to patents, whereas others include trademarks as well.

payoffs of different location choices to be correlated. According to Nevo (2001) and Train (2009), this step results into a more realistic model design that captures greater flexibility of the substitution patterns between different locations.

In line with Hypothesis 1 of this study, we expect a negative value of α_i. It would imply that affiliates of a company group that are located in countries with higher tax rates are likely own less intangible assets than the affiliates in states with comparatively lower tax rates. According to Hypothesis 2, the coefficient α_i should be larger in the case of trademarks than in the case of patents.

4. Data

4.1. Data on Patents and Trademarks

In order to test the hypotheses described in Section 2, we perform an empirical analysis in which patent and trademark ownership choices constitute a dependent variable. However, most companies do not disclose information on the intangible ownership of their group members. Therefore, we follow previous literature and use data on patent and trademark applications as a proxy for patent and trademark ownerships. As Ernst and Spengel (2011) note, the intangible applicant is its legal owner because only the asset's legal owner is entitled to apply for its registration at an international office.

The data on patent and trademark applications were obtained from the Bureau van Dijk and include all patent and trademark applications to the European Patent Office, the Office for Harmonization in the Internal Market, and the United States Patent and Trademark Office. In comparison, most previous studies on patent applications use only the EPO statistics. In total, the final sample includes patent and trademark applications made by 31,682 subsidiaries of 23,782 parent firms that are located in one of the following seventeen countries: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Spain, Sweden, Switzerland, the United Kingdom, and the US[14]. These enterprises in total applied for 518,475 patents and 396,447 trademarks in the period of 1996-2012. Only subsidiaries with at least one patent and one trademark application during this time are included in the estimation.

[14] Both a subsidiary and a parent firm have to be located in one of these countries.

In order to control for industry heterogeneity among firms, we divide all patents and trademarks of the final sample into three industry classes[15]. Following Griffith et al. (2014), three industry sectors used in the baseline estimations are chemical, engineering, and electrical. The chemical industry includes patents and trademarks connected to agriculture, an extraction and processing of raw materials, chemicals, metals, and natural resources. The engineering category includes primarily intangibles related to engineering and manufacturing. Finally, the electrical sector includes patents and trademarks, which arise in the area of technology and telecommunications, electronics, research, and other similar fields. Table 1 shows the exact number of patents and trademarks in each industry class.

Table 1. Summary Statistics on the Number of Patents and Trademarks by Country

	No. of applications	% of total, by industry:			% of total, by size:	
		chemical	engineering	electrical	large	non-large
Austria	12816	26.9	34.7	38.4	22.2	77.8
Belgium	6176	35.0	36.2	28.8	17.3	82.7
Denmark	8109	25.9	38.2	35.9	26.3	73.7
Finland	20666	25.6	61.4	13.0	68.3	31.7
France	73074	30.5	27.7	41.8	67.8	32.2
Germany	201788	24.2	50.0	25.8	47.0	53.0
Ireland	5186	13.1	34.8	52.1	53.6	46.4
Italy	49083	31.2	54.7	14.1	20.1	79.9
Luxembourg	2079	10.5	30.8	58.7	36.7	63.3
Netherlands	17297	19.4	22.6	58.0	20.7	79.3
Norway	5299	48.9	21.3	29.8	42.5	57.5
Poland	4579	32.8	46.4	20.8	26.1	73.9
Spain	23994	32.5	35.6	31.9	17.7	82.3
Sweden	15216	23.1	34.2	42.7	19.3	80.7
Switzerland	22501	16.0	34.0	50.0	28.7	71.3
United Kingdom	58350	23.6	30.0	46.4	37.5	62.5
USA	388709	22.6	59.0	18.4	69.1	30.9
Total	914922	24.5	48.9	26.6	53.1	46.9

Note: Large firms stand for companies with the total number of intangible applications above the 80th percentile in each industry. Non-large firms represent enterprises of all other sizes.

Moreover, in order to account for the firm-size differences between companies, we split each industry into two size groups. Large companies are the ones, which apply in total for a number of intangibles (including patents and trademarks) that lies above the 80th percentile of a given industrial sector. The rest of firms are classified as medium and small and are

[15] For the industry identification, we employ the information on intangibles. In case these data are missing, the industry classification of a firm is used.

assigned to the Non-large category. Table 1 presents some country-specific statistics on the patents and trademarks within each firm-size group.

According to Table 1, the greatest number of both patents and trademarks are owned by the companies located in the US and Germany. As for the industry classification, almost a half of all intangible assets in our sample arise in the engineering sector. Interestingly, the large firms, which represent only 20% of the total sample, own around 53% of all patents and trademarks.

Sometimes intangible assets generated by the same company in the same industrial sector closely relate to each other in terms of their idea and innovation process. We follow Griffith et al. (2014) allowing for the correlation between such intangibles. Thus, patents or trademarks that arise within the same firm in the same industrial sector within a period of one quarter (three months) are assigned to one point of observation – an idea. Around 75% of patents and more than 65% of trademarks represent just one intangible per idea. The final sample includes 212,052 patent ideas and 190,858 trademark ideas.

4.2. Tax Data

The tax rate is the main independent variable of interest. It was constructed by gathering information from a series of the International Bureau of Fiscal Documentation (IBFD) *Global Corporate Tax Handbook*[16] as well as the *IBFD Research Platform*[17]. We use the statutory corporate tax rates in the main specification, since these rates are usually levied on the income generated by intangible assets and are therefore relevant for tax-planning strategies of companies. In case an IP Box exists in a country and is applicable to a given intangible, the tax rate of an IP Box substitutes the regular corporate tax rate[18].

Moreover, the final tax rates used in the estimations account for the taxation under Controlled Foreign Company (CFC) rules[19]. These rules endeavour to hinder profit shifting by firms that are tempted to locate their assets in low-tax countries. According to CFC regulations, passive income of a subsidiary in a tax haven has to be taxed with the rate of its parent company. Passive income is defined differently in each country that implements the rules, but it typically refers to royalty payments and other income that is not associated with real

[16] See International Bureau of Fiscal Documentation (IBFD) (1990-2012), Global Corporate Tax Handbook, Amsterdam: IBFD.
[17] Available at: http://www.ibfd.org/
[18] Information on IP Boxes was obtained from Evers et al. (2014).
[19] Data on CFC rules were obtained from Karkinsky and Riedel (2012) and own research.

economic activity. Table 2 provides an overview of the CFC rules in countries that are relevant for our analysis. One can see that the strictness of the CFC regulations varies between countries. In addition to the standard requirements under which rules apply, some states have introduced a so-called "Black List", which usually contains tax havens. In contrary, Sweden has developed a "White List" that includes countries that are not considered to support profit-shifting activities. Since the European Court of Justice (ECJ) *Cadbury Schweppes*[20] case of 2006, the CFC rules are not applicable within the European Economic Area (EEA)[21].

Table 2. Countries with CFC Rules in Place

Country	Year of introduction	Conditions, under which CFC rules are binding
Austria	-	-
Belgium	-	-
Denmark	1995	Always binding
Finland	1995	Effective tax rate is <60% of Finnish tax or a country is on the "Grey List"
France	1980	Effective tax rate is <50% of French tax
Germany	1972	Effective tax rate is <25%
Ireland	-	-
Italy	2000	Effective tax rate is <50% of Italian tax or a country is on the "Black List"
Luxembourg	-	-
Netherlands	-	-
Norway	1992	Effective tax rate is <66% of Norwegian tax or a country is on the "Black List"[1]
Poland	-	-
Spain	1995	Effective tax rate is <75% of the Spanish tax
Sweden	1990	Effective tax rate is <55% of Swedish tax, except a country is on the "White List"
Switzerland	-	-
United Kingdom	1984	Effective tax rate is <75% of British tax
USA	1962	Effective tax rate is <75% of the US tax

Note: [1] The rules do not apply if a tax treaty exists. Since the ECJ "Cadbury Schweppes" case of 2006 the CFC rules do not apply within the EEA except for special cases.

The CFC rules apply to approximately 20% of intangible assets in our data sample. Incorporating these regulations into our analysis is of a great importance, since profits generated from patents and trademarks are typically classified as passive income and therefore have to be taxed according to the CFC rules, if they apply. Besides, accounting for

[20] Cadbury Schweppes plc and Cadbury Schweppes Overseas Ltd v. Commissioners of Inland Revenue, C-196/04 (see <http://curia.europa.eu/juris/liste.jsf?language=en&num=C-196/04> for more details).
[21] Denmark is the only exception in this case. For more information see Schmidt, P. (2014).

the parent company's taxation while calculating final tax rates, provides another source of variation in the main independent variable of interest.

4.3. Other Control Variables

In addition to tax rates, our empirical model also includes some other independent variables. For example, *Institutions* represents an overall quality of government institutions in a given country. It was constructed using data from the Heritage Foundation[22]. This variable denotes an average of the country's rankings on property rights, corruption index, business freedom, labour freedom, trade freedom, investment freedom, and financial freedom.

In addition, following Dischinger, Riedel (2011), Karkinsky, Riedel (2012), Ernst et al. (2014) and Griffith et al. (2014) we control for the market size in a country where an intangible is owned and try to capture its wealth. This is done by including respectively *Log(GDP)* and *Log(GDP/capita)* into the regression estimation. Data on *Log(GDP)* and *Log(GDP/capita)* were collected from the World Bank's *Development Indicators*[23]. *Endowment* captures the level of country *j*'s resources, which are required for patent and trademark development. This variable stands for the ratio of a country's total number of workers in the advertising and research areas in relation to its population. The countries with greater endowment in these types of human capital might attract the real economic activity of firms and as a result benefit from a greater number of intangibles. Table 3 demonstrates some descriptive statistics of the main variables used in the regression analysis.

Table 3. Descriptive Statistics of the Main Variables

Variable	Obs.	Mean	Std. Dev.	Min	Max
Tax Rate	6849470	33.76	8.19	0.00	45.00
Institutions	6849470	72.78	6.38	56.80	82.60
Log(GDP)	6849470	28.71	1.28	23.89	30.29
Log(GDP/capita)	6849470	10.53	0.21	8.62	11.38
Endowment	6849470	0.15	0.54	0.01	11.67

Note: The final sample includes 518,475 patent applications, which are assigned to 212,052 patent ideas and 396,447 trademark applications, which are assigned to 190,858 trademark ideas. *Tax Rate* stands for corporate income tax rate. It also accounts for the CFC rules and the tax rate of an IP Box if applicable. *Institutions* represents the indicator of a country's level of governance. *Log(GDP)* depicts the natural logarithm of total GDP. *Log(GDP/capita)* stands for the natural logarithm of country's GDP per-capita. *Endowment* denotes the ratio of a country's total number of workers in the advertising and research areas in relation to its population.

[22] Available at: http://www.heritage.org/index/
[23] Available at: http://data.worldbank.org/data-catalog/world-development-indicators

Following Griffith et al. (2014), country-, industry-, and firm-size fixed effects are included in the regression estimations. These variables should capture all the non-observed time-invariant heterogeneity across countries, industries, and firm sizes. For example, companies might prefer registering an intangible in a particular country because of its geographical or historical characteristics. Alternatively, firms in certain industries might face specific rules concerning intangibles' development and registration. Other kinds of restrictions or benefits could be relevant for companies of particular sizes. Such regulatory and operational peculiarities of each country, industry, and firm-size category could give a rise to an unobserved heterogeneity, which is captured by the corresponding fixed effects.

5. Results

5.1. Baseline Results

The outcomes of the regression analysis described in Section 3 are presented in Table 4. In all estimations, the intangible location choice is a dependent variable. As for the independent variables of interest, *Trademark is* a dummy that equals one if an intangible is a trademark and zero if it is a patent. Since the dataset includes both patents and trademarks, we create interactions between *Trademark* and each other control variable. Thus, we can see distinctively the separate effects of control variables on patents and on trademarks. The final sample includes 518,475 patent applications, which are assigned to 212,052 patent ideas and 396,447 trademark applications, which are assigned to190,858 trademark ideas. The results are shown separately for each industry and according to different firm sizes. All estimates include country-, industry-, and firm-size fixed effects[24].

According to Table 4, the mean marginal impact of a statutory corporate tax rate on the intangible location choice is negative and statistically significant across all industries and firm-size groups. The effect is greater for large firms as compared to small and medium companies. Moreover, we find the impact to be more profound in the electrical sector than in the chemical and engineering industries. Therefore, in line with Griffith et al. (2014) we argue that the large firms in the electrical industry are most responsive to tax changes. *Tax Rate(Std.Dev.)* denotes the standard deviation of the tax rate in country *j*, which is a random coefficient in all estimations, as equations 3 and 4 demonstrate. Its effect turns out to be statistically insignificant, which indicates that the correlation between different location choices does not play an important role in our sample.

[24] Detailed results on the fixed-effects' coefficients are not shown in the tables, but are available upon request.

The major contribution of this study lies in investigating the location choice not only for patents, but also for trademarks. The term *Tax Rate*Trademark* captures the effect of the tax rate change on trademarks. The impact of taxation on trademark location choice turns out to be negative and significant across all industries and company sizes. This implies that in case of a trademark, firms are more sensitive to the local taxation of royalty income than in the case of a patent. Interestingly, the additional negative impact of the tax rate on trademarks is smallest in case of the large firms of the electrical industry and largest among the large companies of the chemical and engineering sectors. The large companies of the electrical sector, therefore, show an almost equal treatment of patents and trademarks with respect to tax, while other enterprises differentiate more distinctively between the two types of intangible assets.

As for the other control variables, the higher quality of governance, as measured by *Institutions*, plays a positive role in choosing an intangible's location across almost all industry groups and firm sizes. This result is in line with Karkinsky and Riedel (2012), Griffith et al. (2014) and other previous studies that find a positive association between the quality of governance in a country and its number of patents. The large companies of the chemical sector seem to be an exception, since they appear to register more intangibles in countries with a lower quality of institutions. Almost across all industries and firm-size groups, there is no additional effect of *Institutions* in the case of trademarks, as the interaction term *Institution*Trademark* shows.

A positive significant coefficient on *Log(GDP)* in almost all categories implies that more patents and trademarks are located in economies with larger markets. The effect is usually greater in the case of trademarks, with the large firms of electrical industry being an exception. A negative coefficient on *Log(GDP/capita)* implies that more intangibles are located in less wealthy countries. This effect is almost uniform across all industries and firm-size groups. Moreover, it is generally more profound for trademarks than for patents, as the interaction term *Log(GDP/capita)*Trademark* shows. *Endowment,* which is represented by the ratio of a country's total number of workers in the advertising and research areas in relation to its population, turns out to have a positive and significant impact in almost all columns of Table 4. This implies that a greater share of human capital that is required for patent and trademark development positively affects the number of intangible ownerships in a given country. However, across almost all industries and firm-size categories, this factor seems to play a less important role in the case of trademarks.

Table 4. Estimated Parameters

Industry	Chemical		Engineering		Electrical	
Firm Size	Large	Non-Large	Large	Non-Large	Large	Non-Large
Tax Rate	-0.044***	-0.024***	-0.037***	-0.030***	-0.057***	-0.027***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Tax Rate(Std.Dev.)	4.01e-06	-1.67e-05	6.94e-05	1.53e-05	3.54e-05	3.84e-06
	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
*Tax Rate*Trademark*	-0.088***	-0.068***	-0.072***	-0.062***	-0.008***	-0.033***
	(0.004)	(0.002)	(0.004)	(0.002)	(0.003)	(0.001)
Institutions	-0.082***	0.055***	0.012*	0.011***	-0.008	0.026***
	(0.006)	(0.003)	(0.006)	(0.003)	(0.007)	(0.003)
*Institution*Trademark*	-0.007	0.001	-0.010	-0.013***	0.011	-0.007
	(0.010)	(0.005)	(0.009)	(0.004)	(0.009)	(0.005)
Log(GDP)	10.140***	-1.627***	2.334***	1.444***	24.140***	-3.366***
	(0.485)	(0.233)	(0.449)	(0.183)	(0.660)	(0.237)
*Log(GDP)*Trademark*	5.423***	1.340***	1.083*	0.663**	-23.090***	3.428***
	(0.767)	(0.382)	(0.635)	(0.301)	(0.801)	(0.355)
Log(GDP/capita)	-9.167***	0.272	-3.609***	-2.287***	-23.410***	4.006***
	(0.567)	(0.264)	(0.523)	(0.215)	(0.752)	(0.266)
*Log(GDP/capita)*Trademark*	-6.631***	-2.103***	-3.613***	-1.064***	20.700***	-4.823***
	(0.943)	(0.458)	(0.822)	(0.364)	(0.964)	(0.411)
Endowment	2.367***	0.216*	-0.144	0.532***	0.776***	0.659***
	(0.238)	(0.116)	(0.120)	(0.090)	(0.212)	(0.068)
*Endowment*Trademark*	0.244	-0.450***	0.381*	-0.566***	-0.936***	-0.914***
	(0.360)	(0.167)	(0.218)	(0.129)	(0.242)	(0.095)

Note: *** p<0.01, ** p<0.05, * p<0.1 The dependent variable is an intangible location choice in one of the 17 countries shown in Table 2. Country-, industry-, and firm-size fixed effects are included in all estimations. Estimation is based on 396,447 trademark applications and 518,475 patent applications. Large firms stand for companies with a total number of intangible applications above the 80th percentile in each industry. Non-Large are enterprises of all other sizes. *Tax Rate* stands for corporate income tax rate and also accounts for the CFC rules and the tax rate of an IP Box if applicable. *Trademark* is a dummy, which equals one if an intangible is a trademark and zero if it is a patent. *Institutions* represents the indicator of a country's quality of governance. *Log(GDP)* depicts the natural logarithm of total GDP. *Log(GDP/capita)* stands for the natural logarithm of a country's GDP per-capita. *Endowment* denotes the ratio of a country's total number of workers in the advertising and research areas in relation to its population.

The regression results of Table 4 support Hypothesis 1 of this study. Namely, they show that taxation has a significant negative impact on the location choice for both, patents and trademarks. However, these outcomes say little about the magnitude of the effects. In order to determine the scale of the impact and to address Hypothesis 2, we calculate the own and cross-country tax elasticities of patent and trademark location choices. This is implemented as follows:

$$e_{ijh} = \frac{\Delta P_{ij}}{\Delta Tax_{ih}} \frac{Tax_{ih}}{P_{ij}}, \tag{5}$$

where e_{ijh} is the elasticity of the probability that an intangible i is located in country j with respect to a marginal change in the tax rate in location h. Tax_{ih} denotes the statutory tax rate in country h that is levied on the profits generated by the intangible i[25]. P_{ij} represents the predicted probability that an intangible i will be located in country j[26]. Equation 3 describes the formulation of P_{ij} in more detail.

We aggregate the elasticities of the location choices that arise within the same country and report the corresponding findings in Table 5. Panel A demonstrates the outcomes for the patents and panel B shows the results for the trademarks. Following Griffith et al. (2014), we also take into consideration the issue of CFC rules. Namely, in the case where the CFC rules apply, a change in the tax rate of country h is irrelevant for the determination of the tax elasticity as calculated in equation 5, because the parent tax rate is levied on the income generated by an intangible anyway. In order to account for this, we exclude the cases in which the CFC rules apply from the calculation of the aggregated elasticities.

[25] ΔTax_{ih} equals the standard deviation of the residuals of Tax_{ih} divided by 1000. This implies that ΔTax_{ih} is close to the smallest possible change in the tax rate. Using a change of 1% instead does not alter the results.
[26] ΔP_{ij} is calculated through subtracting the predicted probabilities of the location choices before and after a tax change.

Table 5. Own and Cross-Country Elasticities of Location Choice with Respect to a Change in the Tax Rate

Panel A. Patents

	Austria	Belgium	Denmark	Finland	France	Germany	Ireland	Italy	Luxem-bourg	Nether-lands	Norway	Poland	Spain	Sweden	Switzer-land	UK	USA
Austria	-0.71	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.02	0.02	0.01	0.01	0.02	0.01
Belgium	0.00	-0.69	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Denmark	0.01	0.01	-0.69	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Finland	0.02	0.02	0.02	-0.51	0.02	0.02	0.01	0.02	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.02	0.01
France	0.01	0.01	0.01	0.01	-0.30	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Germany	0.24	0.28	0.24	0.18	0.28	-0.85	0.15	0.25	0.26	0.25	0.18	0.21	0.28	0.18	0.15	0.25	0.19
Ireland	0.00	0.00	0.00	0.00	0.00	0.00	-0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.07	0.09	0.07	0.06	0.09	0.09	0.05	-0.82	0.08	0.08	0.06	0.07	0.09	0.06	0.04	0.08	0.06
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.64	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	0.01	0.02	0.01	0.01	0.02	0.02	0.01	0.02	0.02	-0.60	0.01	0.01	0.02	0.01	0.01	0.02	0.01
Norway	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	-0.54	0.01	0.01	0.01	0.00	0.01	0.01
Poland	0.00	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	-0.54	0.01	0.00	0.00	0.00	0.00
Spain	0.02	0.03	0.02	0.02	0.03	0.03	0.01	0.02	0.02	0.02	0.02	0.02	-0.76	0.02	0.01	0.02	0.02
Sweden	0.02	0.03	0.02	0.02	0.03	0.03	0.01	0.02	0.02	0.02	0.02	0.02	0.03	-0.52	0.01	0.02	0.02
Switzerland	0.03	0.03	0.03	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.02	0.03	0.02	-0.32	0.03	0.02
UK	0.07	0.08	0.07	0.05	0.08	0.08	0.04	0.07	0.07	0.07	0.05	0.06	0.08	0.05	0.04	-0.71	0.05
USA	0.26	0.39	0.26	0.20	0.39	0.39	0.17	0.29	0.31	0.28	0.20	0.23	0.39	0.20	0.16	0.29	-0.60

Note: Elasticity represents a percentage change in the patent location relative to a percentage change in the tax rate. Each cell shows the elasticity of a patent location choice in the country in column 1 with respect to the tax change in country in row 1.

Panel B. Trademarks

	Austria	Belgium	Denmark	Finland	France	Germany	Ireland	Italy	Luxem-bourg	Nether-lands	Norway	Poland	Spain	Sweden	Switzer-land	UK	USA
Austria	-2.02	0.04	0.02	0.04	0.04	0.04	0.02	0.04	0.04	0.02	0.04	0.04	0.04	0.02	0.03	0.02	0.03
Belgium	0.02	-3.14	0.01	0.03	0.02	0.03	0.02	0.03	0.03	0.01	0.03	0.03	0.03	0.02	0.02	0.02	0.02
Denmark	0.03	0.03	-1.95	0.02	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.02	0.03	0.02	0.02	0.03	0.02
Finland	0.03	0.04	0.03	-1.21	0.04	0.04	0.02	0.04	0.04	0.03	0.02	0.03	0.04	0.02	0.02	0.04	0.03
France	0.12	0.16	0.12	0.08	-2.97	0.16	0.07	0.13	0.14	0.13	0.08	0.10	0.16	0.08	0.06	0.13	0.08
Germany	0.39	0.52	0.39	0.27	0.52	-2.72	0.25	0.43	0.46	0.42	0.27	0.34	0.52	0.27	0.23	0.43	0.28
Ireland	0.01	0.01	0.01	0.01	0.01	0.01	-0.78	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Italy	0.18	0.22	0.18	0.12	0.22	0.22	0.11	-2.37	0.20	0.19	0.12	0.15	0.22	0.12	0.09	0.20	0.12
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	0.05	0.06	0.05	0.04	0.06	0.06	0.03	0.06	0.06	-2.23	0.04	0.04	0.06	0.04	0.03	0.06	0.04
Norway	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-1.28	0.01	0.01	0.01	0.01	0.01	0.01
Poland	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-1.48	0.01	0.01	0.00	0.01	0.01
Spain	0.09	0.12	0.09	0.06	0.12	0.12	0.06	0.10	0.10	0.09	0.06	0.08	-2.80	0.06	0.05	0.10	0.06
Sweden	0.05	0.06	0.05	0.04	0.06	0.06	0.03	0.05	0.05	0.05	0.04	0.05	0.06	-1.22	0.03	0.05	0.04
Switzerland	0.06	0.06	0.06	0.04	0.06	0.06	0.04	0.06	0.06	0.06	0.04	0.05	0.06	0.04	-0.77	0.06	0.05
UK	0.16	0.19	0.16	0.10	0.19	0.19	0.10	0.18	0.18	0.17	0.10	0.14	0.19	0.10	0.09	-2.05	0.11
USA	1.16	1.57	1.16	0.70	1.57	1.57	0.67	1.31	1.36	1.26	0.70	0.96	1.57	0.70	0.57	1.31	-1.14

Note: Elasticity represents a percentage change in the trademark location relative to a percentage change in the tax rate. Each cell shows the elasticity of a trademark location choice in the country in column 1 with respect to the tax change in country in row 1.

Panel A of Table 5 presents the elasticities of the share of patents located in the country indicated in each column with respect to a tax rate change in every country shown in the rows. The diagonal values depict the own tax elasticities, which are negative in all locations. For example, the lowest own tax sensitivity of -0.05% is observed in Ireland and the highest one of -0.85% in Germany. This means that a one percent increase in the tax rate in Ireland leads to on average a -0.05% fall in the number of patents that are taking place in this country. A one percent rise in the tax rate of Germany results on average into a -0.85% decrease in its number of patents. The cross-country tax elasticities are positive, which implies that the alternative locations experience a positive change in their number of patents once one country increases its tax rate on royalty income.

Panel B of Table 5 shows the own- and cross-country tax elasticities in the case of trademarks. These values are substantially higher than the tax elasticities of patent location choices. For instance, a one-percent tax change in Switzerland leads to a -0.77% decrease in the number of trademarks in this state. On the other hand, if a tax rate of Belgium goes up by one percent, its number of trademarks will likely experience a -3.14% drop. There are a few reasons why some low-tax countries such as Ireland or Switzerland have rather low tax elasticities. First, the CFC rules often apply in these states because they usually are classified as tax havens by other countries. If this is the case, then a tax rate change in these countries do not attract additional intangible ownerships, because the tax rate of the parent company applies to the income from the intangible assets anyway. Secondly, there is a scaling issue. If the tax rate of a country is initially low, then its one-percent increase implies a smaller scale of change compared to a location with an originally higher tax rate.

In order to compare our results to the previous literature, we also calculate tax semi-elasticities, which represent the percentage change of the share of intangibles in a given country caused by a one percentage point change in the tax rate of this state. The average tax semi-elasticity of a patent location choice is -1.9%, whereas the average tax semi-elasticity of a trademark location equals -6.2%. These findings are in line with the Hypothesis 2 of our study, according to which trademarks are more sensitive to taxation than patents.

Table 6. Semi-Elasticities of Location Choice with Respect to a Change in the Tax Rate

	Patents	Trademarks
Austria	2.47	6.94
Belgium	1.94	8.72
Denmark	2.47	6.84
Finland	1.90	4.46
France	0.86	8.37
Germany	2.36	7.38
Ireland	0.30	4.52
Italy	2.46	7.03
Luxembourg	2.07	6.38
Netherlands	2.00	7.35
Norway	1.94	4.56
Poland	2.32	6.17
Spain	2.33	8.45
Sweden	1.89	4.43
Switzerland	1.48	3.46
UK	2.46	7.03
US	1.52	2.89

Note: Semi-elasticity represents a percentage change in the patent or trademark location relative to a unit (i.e. percentage point) change in the tax rate. For these calculations, the average tax rates of the whole period were used.

The semi-elasticity of patents that we obtain is very similar to the findings of the previous literature. For instance, Griffith et al. (2014) argue that the tax semi-elasticity of patent location choice lies between -0.5% and -3.9%. Karkinsky and Riedel (2012) find this value to lie in the range of -3.5% to -3.8%. The slight difference between earlier studies and our findings can be explained by the sample that we investigate. Our analysis focuses on companies that have both, patents and trademarks. These firms could behave differently to some degree regarding their profit-shifting strategies as compared to companies that have only patents. Besides, earlier studies concentrate only on the patent applications filled out at the European patenting office, whereas we analyse the US patent and trademark applications as well.

5.2 Robustness Checks and Extensions

In order to check the robustness of our baseline results, we perform a few tests and report the outcomes in Table 7 and Table 8. This part of the analysis is carried out using only non-large

firms of the engineering sector as a representative sample[27]. The dependent variable in all columns of Table 7 is a location choice of an intangible asset in one of the 17 countries shown in Table 2. Besides, all regressions of Table 7 include location fixed effects.

Column I of Table 7 repeats the baseline results, which are also shown in Table 4. Column II shows the same results after the exclusion of all the control variables except for the main independent variables of interest. One can see that this modification almost does not influence the main results, leaving the coefficient on the tax rate and the interaction between the tax rate and the *Trademark* dummy negative and statistically significant. Column III of Table 7 demonstrates the results of an estimation, in which the tax rate is slightly altered. In this specification, we do not account for the IP-Box regimes and the CFC rules while calculating the *Tax Rate*, but rather take the statutory corporate tax rate as a proxy for the tax rate. One can see that the coefficient on *Tax Rate* remains negative and statistically significant, but the magnitude of the effect decreases substantially. Interestingly, the standard deviation on the tax rate denoted by *Tax Rate(Std.Dev.)* turns out to be statistically significant. In a mixed logit regression, this implies that the randomization of the tax rate variable (see equation 4) plays a significant role.

The results of the next robustness test are shown in column IV of Table 7. Here the small firms are excluded from the estimation. Following Griffith et al. (2014), we define small companies as the ones whose total number of patents and trademarks lies below the 20th percentile in their industry. This modification has almost no effect on the baseline findings.

Column V of Table 7 shows the outcomes of the representative sample after including only the patent observations. Column VI does the same for the trademarks. One can see that the magnitude of the tax-rate effect is larger when the sample of trademarks is considered. Column VII of Table 7 mirrors the estimation shown in column VI, but accounts for one additional control variable. Namely, here we add the interaction term *Tax Rate*USPTO*, which captures the tax sensitivity of trademarks that were applied for at the USPTO. In our sample, approximately 50% of trademark applications were filled out at the US Patent and Trademark Office and the other half was applied for at the European office OHIM[28]. The positive coefficient on *Tax Rate*USPTO* implies that trademark applications filled out at the USPTO are less responsive to tax changes than their European counterparts are.

[27] This industry-firm-size category was chosen as a representative sample because it contains the largest number of observations as compared to other industry-firm-size groups. The results for other industry-firm-size types are in line with the outcomes obtained using the representative sample. They are also available upon request.

[28] A similar test with the sample of patents is not possible, because the data on the source of application is not available in case of patents.

Table 7. Robustness Tests applied to the Sample of Non-Large Firms of the Engineering Sector

	Baseline		Statutory CIT	WO Small Firms	Only Patents	Only Trademarks	
	I	II	III	IV	V	VI	VII
Tax Rate	-0.030***	-0.028***	-0.009***	-0.030***	-0.029***	-0.092***	-0.135***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.002)
Tax Rate(Std.Dev.)	1.53e-05	1.69e-05	0.0424***	-2.09e-06	2.49e-05	-1.77e-05	-5.40e-05
	(0.001)	(0.001)	(0.004)	(0.001)	(0.001)	(0.002)	(0.002)
*Tax Rate*Trademark*	-0.062***	-0.053***	-0.010***	-0.057***			
	(0.002)	(0.002)	(0.003)	(0.002)			
*Tax Rate*USPTO*							0.086***
							(0.002)
Institutions	0.011***		0.026***	0.011***	0.011***	-0.002	-0.000
	(0.003)		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
*Institution*Trademark*	-0.013***		-0.017***	-0.011**			
	(0.004)		(0.004)	(0.004)			
Log(GDP)	1.444***		0.459*	2.031***	1.444***	2.322***	1.719***
	(0.183)		(0.260)	(0.204)	(0.183)	(0.273)	(0.274)
*Log(GDP)*Trademark*	0.663**		-3.422***	0.229			
	(0.301)		(0.381)	(0.345)			
Log(GDP/capita)	-2.287***		-1.374***	-3.013***	-2.287***	-3.565***	-2.859***
	(0.215)		(0.295)	(0.243)	(0.215)	(0.324)	(0.325)
*Log(GDP/capita)*Trademark*	-1.064***		4.276***	-0.402			
	(0.364)		(0.449)	(0.421)			
Endowment	0.532***		0.424***	0.614***	0.532***	0.311	0.446**
	(0.090)		(0.091)	(0.109)	(0.090)	(0.197)	(0.196)
*Endowment*Trademark*	-0.566***		-0.523***	-0.826***			
	(0.129)		(0.135)	(0.155)			

Note: *** p<0.01, ** p<0.05, * p<0.1 The estimates are based on the sample of the non-large firms of the engineering sector, the results of the robustness checks for other firm categories are available upon request. The dependent variable is an intangible location choice in one of the 17 countries shown in Table 2. Location fixed effects are included in all estimations. The estimation is based on 98,966 trademark applications and 99,680 patent applications. In columns I-II and IV-VII, *Tax Rate* stands for corporate income tax rate and also accounts for the CFC rules and the tax rate of an IP Box if applicable. In column III, *Tax Rate* represents the statutory corporate income tax rate. *Trademark* is a dummy, which equals one if an intangible is a trademark and zero if it is a patent. *USPTO* equals one if a trademark's application was filled out at the USPTO and zero if it was at the EPO. *Institutions* represents the indicator of a country's quality of governance. *Log(GDP)* depicts a natural logarithm of total GDP. *Log(GDP/capita)* stands for the natural logarithm of a country's GDP per-capita. *Endowment* denotes the ratio of a country's total number of workers in the advertising and research areas in relation to its population.

Table 8 demonstrates the results of a few further robustness checks of the baseline findings. Similar to Table 7, this part of the study is based on the sample of non-large firms of the engineering sector.

As previously discussed, the mixed logit estimation is used in our baseline specification. Columns I - II of Table 8 demonstrate the outcomes of using some alternative multinomial logit models. The dependent variable in these estimations is, similar to the baseline specification, the location choice of a trademark or a patent in one of the 17 countries shown in Table 2. Column I reports the results of estimating a conditional logit model, in which the assumption of the independence of irrelevant alternatives holds. Hence, the alternative location choices in this model are assumed uncorrelated. This alteration, however, does not significantly influence the baseline findings.

Column II of Table 8 presents the results of the estimation using a nested logit model. According to Hensher et al. (2005), this model relaxes the IIA assumption by clustering similar alternative location choices into nests. We divide 17 locations of our baseline estimation into five clusters according to the geographical regions, in which they are situated. For example, consider a firm that wants to locate a patent in Sweden, but this country increases its statutory corporate tax rate. Then the company chooses an alternative location for the patent and we assume that it sees other Nordic countries as the preferred alternatives to Sweden. The rest of the locations become inferior options. Allowing for such a correlation between alternative locations slightly increases the magnitude of the impact of a tax rate on a location choice, as column II reveals.

Several previous papers on the patent location choice adopt other identification strategy than Griffith et al. (2014) and this study. For example, Karkinsky and Riedel (2012) perform analysis on the firm level using ordinary least squares, negative binominal, and other similar models. In order to compare our results with this literature, we also implement an alternative identification strategy and show the results in columns III and IV of Table 8. The dependent variable in these regressions is the total number of patents and trademarks owned by a firm in a given year.

Once again, the information on patent and trademark ownership is extracted from the data on patent and trademark applications by each firm. The main independent variables of interest are *Tax Rate*, *Trademark,* and their interaction term *Tax Rate*Trademark. Trademark* is a dummy variable, which equals one if a firm made at least one trademark application in a given year and zero otherwise. Column IV reveals the results of using the ordinary least

Table 8. Further Robustness Tests applied to the Sample of Non-Large Firms of the Engineering Sector

	Conditional Logit	Nested Logit	FE OLS	FE Poisson
	I	II	III	IV
CIT	-0.0298***	-0.0955***	-0.00703***	-0.00277***
	(0.000821)	(0.00164)	(0.00208)	(0.000923)
Trademark			1.437***	0.550***
			(0.112)	(0.0369)
*CIT*Trademark*	-0.0618***	-0.229***	-0.0161***	-0.00476***
	(0.00165)	(0.00441)	(0.00325)	(0.00108)
Institutions	0.0110***	0.0359***	0.0198**	0.00943***
	(0.00280)	(0.00433)	(0.00846)	(0.00339)
*Institution*Trademark*	-0.0131***	-0.00992		
	(0.00421)	(0.00666)		
Log(GDP)	1.444***	15.96***	0.919	0.311
	(0.188)	(0.367)	(0.615)	(0.247)
*Log(GDP)*Trademark*	0.663**	3.339***		
	(0.308)	(0.588)		
Log(GDP/capita)	-2.287***	-20.24***	-0.828	-0.407
	(0.221)	(0.497)	(0.850)	(0.323)
*Log(GDP/capita)*Trademark*	-1.064***	2.197***		
	(0.368)	(0.773)		
Endowment	0.532***	1.996***	0.205	0.0965
	(0.0959)	(0.187)	(0.276)	(0.104)
*Endowment*Trademark*	-0.566***	-0.162		
	(0.136)	(0.253)		
Firm Fixed Effects			Yes	Yes
Year Fixed Effects			Yes	Yes
Observations			82,823	81,652

Note: *** p<0.01, ** p<0.05, * p<0.1 The estimates are based on the sample of the non-large firms of the engineering sector, the results of the robustness checks for other firm categories are available upon request. In columns I-II, the dependent variable is an intangible location choice in one of the 17 countries shown in Table 2. In columns III-IV the dependent variable is a total number of patents and trademarks held by a firm in a given year. In columns I-II, the location fixed effects are included. Estimations are based on 98,966 trademark applications and 99,680 patent applications. *CIT* stands for corporate income tax rate and also accounts for the CFC rules and the tax rate of IP Boxes if applicable. In columns I and II, *Trademark* is a dummy, which equals one if an intangible is a trademark and zero if it is a patent; in columns III and IV, *Trademark* is a dummy, which equals one if there is at least one trademark in the total number of intangibles and zero otherwise. *Institutions* represents an indicator of country's level of governance. *Log(GDP)* depicts a natural logarithm of total GDP. *Log(GDP/capita)* stands for a natural logarithm of country's GDP per capita. *Endowment* denotes the ratio of country's total number of workers in the advertising and research areas to its population.

squares and column IV shows the outcomes of the Poisson maximum likelihood estimator. Firm and year fixed effects are accounted for in these regressions. As the findings suggest, the main effects remain negative and statistically significant under the new framework. The tax rate is negatively associated with the number of intangibles owned by a firm. According to the interaction term *Tax Rate*Trademark*, the effect is stronger when trademarks are considered.

Finally, Table 9 presents the outcomes of a few extensions to the baseline results. Here, we compare the statutory tax rate of a given subsidiary to the tax rates, which apply to its other group members. If the subsidiary is located in a low-tax country as compared to its affiliates, it has an incentive to hold more intangible assets. Therefore, the variable *Tax Difference* is the main independent variable of interest in the estimations of Table 9.

In columns I - II of Table 9, *Tax Difference* stands for the tax rate difference between the country of the subsidiary that holds an intangible and the country of its parent company[29,30]. Column I shows the results with only the main independent variables of interest, while column II adds some further controls. A negative coefficient on *Tax Difference* implies that subsidiaries, which are located in low-tax jurisdictions as compared to their parent firms, tend to own more patents and trademarks than the subsidiaries in high-tax countries. The effect is stronger in the case of trademarks than in the case of patents, as the interaction term *Tax Difference*Trademark* shows.

Columns III and IV of Table 9 show the results of including an alternative definition of *Tax Difference* into the estimation. Here, it represents the average tax-rate difference between the country of the subsidiary and the countries of all other group members. Column III shows the results with only the main independent variables of interest, while column IV adds further controls. Once again, the coefficient on *Tax Difference* turns out negative and statistically significant. This implies that a relative level of taxation in a country of a given subsidiary as compared to its group members plays an important role in the determination of the patent and trademark location choices within a company group. In addition, the effect of the tax differences with all affiliates (see columns III and IV) is slightly smaller than in the case of the tax difference with the parent firm only (see columns I and II).

[29] We consider a parent firm to own a subsidiary if its ownership share exceeds 50%. This ownership link is sufficiently large to facilitate profit shifting between two companies.

[30] Due to the data availability restrictions, the information about the ownership structure is only available for the year 2012. Therefore, in the regressions were these data are used we have to assume that the ownership structures remained constant in the years 1996-2012.

Table 9. Extended Analysis on the Sample of Non-Large Firms of the Engineering Sector

	Tax Difference with Parent		Tax Difference with Affiliates	
	I	II	III	IV
Tax Difference	-0.00480***	-0.00875***	-0.00459***	-0.00616***
	(0.00153)	(0.00216)	(0.00120)	(0.00175)
Tax Difference (Std.Dev.)	0.0235***	0.0424***	3.305***	3.971***
	(0.00651)	(0.00434)	(0.342)	(0.312)
*Tax Difference*Trademark*	-0.0324***	-0.0101***	-2.466***	-1.423***
	(0.00236)	(0.00336)	(0.168)	(0.266)
Institutions		0.0257***		0.0263***
		(0.00279)		(0.00282)
*Institution*Trademark*		-0.0166***		-0.0177***
		(0.00428)		(0.00430)
Log(GDP)		0.459*		0.346
		(0.260)		(0.290)
*Log(GDP)*Trademark*		-3.422***		-2.663***
		(0.381)		(0.443)
Log(GDP/capita)		-1.374***		-1.048***
		(0.295)		(0.277)
*Log(GDP/capita)*Trademark*		4.276***		3.861***
		(0.449)		(0.436)
Endowment		0.424***		0.419***
		(0.0910)		(0.0914)
*Endowment*Trademark*		-0.523***		-0.475***
		(0.135)		(0.135)

Note: *** p<0.01, ** p<0.05, * p<0.1 The estimates are based on the sample of the non-large firms of the engineering sector, the results of the robustness checks for other firm categories are available upon request. In all columns, the dependent variable is an intangible location choice in one of the 17 countries shown in Table 2. The location fixed effects are included; the estimations are based on 98,966 trademark applications and 99,680 patent applications. *Tax Difference* depicts the difference in the statutory tax rates either between the considered subsidiary and its parent company (columns I and II) or between the subsidiary and its affiliates (columns III and IV). *Trademark* is a dummy, which equals one if an intangible is a trademark and zero if it is a patent. *Institutions* represents an indicator of country's level of governance. *Log(GDP)* depicts a natural logarithm of total GDP. *Log(GDP/capita)* stands for a natural logarithm of country's GDP per capita. *Endowment* denotes the ratio of country's total number of workers in the advertising and research areas to its population.

6. Conclusions

The main goal of this paper is to analyse the strategic allocation of different types of intangible assets within a company group. According to Hypothesis 1 presented in Section 2, company groups register a greater number of intangibles at their subsidiaries located in countries with lower tax rates as compared to the affiliates in countries with higher tax rates. This idea has already been supported through numerous empirical studies such as Ernst and Spengel (2011), Karkinsky and Riedel (2012), Ernst et al. (2014), Alstadsæter et al. (2015), Böhm et al. (2015), and Dinkel and Schanz (2015). The main contribution of this study, however, lies in distinguishing between different types of intangible assets – patents and trademarks – and comparing their tax elasticities. For example, trademarks are less costly in terms of time and financial expenses to develop and register than patents. Therefore, according to Hypothesis 2, the tax elasticity of a trademark location choice is greater than the tax elasticity of a patent location choice.

In order to test the hypotheses empirically, we employ the Orbis database provided by the Bureau van Dijk. This database contains information on all patent and trademark applications carried out at the Office for Harmonization in the Internal Market, the European Patent Office, and the United States Patent and Trademark Office. The patent and trademark applications provide information on the companies that own these intangibles. This is how we determine the place of patent and trademark ownership within a company group.

Since the main goal of this analysis is to compare the tax elasticities of patents and trademarks, our final sample includes only companies that have filled out at least one patent and one trademark application in the period of 1996-2012. The final sample includes patent and trademark applications filled out by 31,682 subsidiaries of 23,782 parent firms. Both parent companies and subsidiaries are located in one of the following seventeen countries: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Poland, Spain, Sweden, Switzerland, the United Kingdom, and the US. In total, these enterprises have applied for 518,475 patents and 396,447 trademarks during the time of 1996-2012.

The main findings of the empirical analysis support the initial hypotheses of the study. We find a negative association between tax rates and intangible location choices. Moreover, the own tax elasticity of a trademark location choice is greater than the one of patents. According to our findings, on average a one percent increase in the tax rate leads to a decrease of -0.05%

to -0.85% in the number of patents and a -0.77% to -3.14% drop in the number of trademarks in this country.

Our findings are comparable to previous literature on the impact of taxation on patent location choices. For example, we use a similar identification strategy to Griffith et al. (2014), who determine the tax semi-elasticity of patent locations in fourteen countries. According to their results, the share of patents held in Luxembourg is the most sensitive to tax with a semi-elasticity of -3.9%, whereas in Germany it is the least elastic with respect to tax with a semi-elasticity of -0.5%. Our empirical analysis of seventeen countries shows the highest value of tax semi-elasticity of patent locations to equal -2.5% in Austria and Denmark and the lowest one to equal -0.3% in Ireland.

Furthermore, the results of this study are in line with the findings of Ernst and Spengel (2011), Karkinsky and Riedel (2012), and Ernst et al. (2014), who analyse the connection between country's taxation of royalty income and the quantity or quality of patents held in this state. The main difference between the empirical approach of these studies and the one used by Griffith et al. (2014) is that they carry out analyses on the firm level. By contrast, Griffith et al. (2014) along with this paper perform investigations on the level of an intangible through the application of a multinomial choice model. Despite different identification strategies, our results are still comparable to the ones found in this flow of literature. For example, Karkinsky and Riedel (2012) argue that a one percentage point increase in the tax rate on royalty income leads to a decrease of -3.5% to -3.8% in the number of patents in a given country. According to our findings, on average a one percentage point increase in tax rate on royalty income leads to a -1.9% drop in the number of patents and a -6.2% decrease in the number of trademarks in this country.

As for the policy implications of this study, a few conclusions can be drawn. First, companies appear to use intangible assets as an instrument of base erosion and profit shifting. Thus, effective international regulations are required in order to assure taxation in accordance with the real economic activity. Secondly, the differences between various types of intangible assets should not be ignored. The very nature of a trademark makes it more mobile within a company group than a patent. Therefore, a trademark has a higher potential to be used as an instrument of profit shifting. Indeed, according to our study, the trademark location choice appears to have greater tax elasticity than the location choice of a patent. Thus, regulations that aim at limiting the use of intangibles as an instrument of profit shifting would be more effective if they were intangible-specific.

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