International Profit Shifting within Multinational Enterprises: Empirical Evidence on the Key Channels and Countermeasures

Inauguraldissertation zur Erlangung des akademischen Grades eines Doktors der Wirtschaftswissenschaften der Universität Mannheim

vorgelegt von

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Mannheim, 2017

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Tag der mündlichen Prüfung: 7.12.2017

Acknowledgements

First of all, I would like to express my sincere gratitude to Prof. Dr. Christoph Spengel from the University of Mannheim, who supervised my thesis and contributed to it with great ideas, valuable suggestions, and helpful instructions. His guidance, motivation, patience, and immense knowledge helped me throughout my whole career as a PhD student and greatly contributed to my research. I could not have wished for a better advisor and mentor during these years. I am also gratefully indebted to Prof. Dr. Johannes Voget from the University of Mannheim for being the second supervisor of this thesis and for enhancing and improving it with countless great ideas, comments, and remarks. I would also like to sincerely thank Prof. Dr. Friedrich Heinemann from the Centre for European Economic Research (ZEW) for his endless support and guidance throughout my work in his team.

This thesis would not have been successfully completed without my co-authors – Katharina Nicolay, Hannah Nusser, Christoph Spengel, and Johannes Voget – who contributed to our joint research with hard work and great commitment. It was an enormous honor and a privilege for me to have met and worked with you and I am eternally grateful to you for this opportunity. Furthermore, I would like to thank my colleagues from both the department for Corporate Taxation and Public Finance at the ZEW and the Chair for Business Administration and Taxation II at the University of Mannheim. Thank you for the valuable comments on my research and a constant exchange of creative ideas and thoughts that highly contributed to my work and shaped this thesis. Moreover, I would like to acknowledge Prof. Dr. Michael Devereux and his team for such a warm welcome at the Oxford University Centre for Business Taxation. My research stay in Oxford not only enhanced my thesis but also made my time as a PhD student unforgettable.

Finally, I would like to express my profound gratitude to my family and friends for their faithful support and continuous motivation. This accomplishment would not have been possible without my dearest husband, Christian Pfeiffer, who was my prime source of inspiration and encouragement during the years of researching and writing this thesis.

Mannheim, August 2017 Olena Pfeiffer

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List of Abbreviations

Art.	Article
ATE	Average treatment effect
BEA	Bureau of Economic Analysis
Benelux	Belgium, the Netherlands, Luxembourg
BEPS	Base erosion and profit shifting
BERD	Business expenditure on research and development
Big 4	The four largest international accounting and professional services firms
CbC	Country by country
CCA	Cost contribution arrangement
CCCTB	Common consolidated corporate tax base
CCTB	Common corporate tax base
CFC	Controlled foreign company
CIT	Corporate income tax
Diff-in-Diff	Difference-in-difference
DTR	Double taxation relief
e.g.	For example (Latin: exempli gratia)
EATR	Effective average tax rate

EBIT	Earnings before interest and taxes
EBITDA	Earnings before interest, taxes, depreciation, and amortization
ECJ	European Court of Justice
Ed.	Editor
EEA	European Economic Area
EFTA	European Free Trade Area
EMTR	Effective marginal tax rate
EPO	European Patent Office
EU	European Union
EU15	A group of the EU member states prior to the accession of ten candidate countries on May 1, 2004
EuIPO	European Union Intellectual Property Office
EUR	Euro
FDI	Foreign direct investment
FE	Fixed effects
G20	A group of 20 major economies
GAAR	General anti-abuse rule
GDP	Gross domestic product
GLS	Generalized least squares
GMM	Generalized method of moments

GOP	Grand Old Party
IBFD	International Bureau of Fiscal Documentation
i.e.	That is (Latin: id est)
IIA	Independence of irrelevant alternatives
IP	Intellectual property
IV	Instrumental variable
MIDI	Microdatabase Direct Investment
MNE	Multinational enterprise
NID	Notional interest deduction
No.	Number
NPV	Net present value
OECD	Organization for Economic Co-Operation and Development
OLS	Ordinary least squares
PIT	Personal income tax
PPML	Poisson pseudo-maximum likelihood
PSM	Propensity score matching
R&D	Research and development
SME	Small or medium enterprise
SSC	Social security contributions
TP	Transfer pricing

USD	US dollar
USPTO	United States Patent and Trademark Office
VAT	Value-added tax
WHT	Withholding tax
WTO	World Trade Organization
ZEW	Centre for European Economic Research (German: Zentrum für Europäische Wirtschaftsforschung)

Country Abbreviations

Abbreviation	Country	Abbreviation	Country
AT	Austria	IS	Island
BE	Belgium	IT	Italy
BG	Bulgaria	LI	Liechtenstein
CH	Switzerland	LT	Lithuania
CY	Cyprus	LU	Luxembourg
CZ	Czech Republic	LV	Latvia
DE	Germany	MT	Malta
DK	Denmark	NL	Netherlands
EE	Estonia	NO	Norway
ES	Spain	PL	Poland
FI	Finland	PT	Portugal
FR	France	RO	Romania
GB	United Kingdom	SE	Sweden
GR	Greece	SI	Slovenia
HR	Croatia	SK	Slovakia
HU	Hungary	US	United States
IE	Ireland		

Chapter 1

Introduction

Nowadays large multinational enterprises (MNEs) economically outperform not only purely domestic companies but also entire countries. Dominating international business in cross-border investment and trade, multinationals constitute 69 of the 100 wealthiest economic entities in the world. The ten largest corporations, which include *Apple Inc.* and *Royal Dutch Shell plc*, earn more than 180 countries altogether, including Ireland, Greece, and South Africa.[1] It is therefore natural that individual countries and international organizations are becoming increasingly interested in the operations of multinational enterprises, their profits, and tax liabilities. In recent years, the taxation of MNEs has become one of the most debated topics, with accusations of large corporations strategically relocating profits from high-tax affiliates to the low-tax group members in order to minimize their consolidated tax liabilities. Examples include *Apple Inc.* allegedly paying an effective tax rate of 1% on its European profits[2] and *Royal Dutch Shell plc* shifting its main tax-residence to the benign tax climate of the Netherlands[3] and relocating its central brand management to low-tax Switzerland.[4]

The Organization for Economic Co-Operation and Development (OECD) has responded to the ongoing discussion on the taxation of multinational enterprises by releasing the Action Plan on base erosion and profit shifting (BEPS) in 2013.[5] This plan aims to prevent double non-taxation and low taxation of MNEs, which would ensure that corporate profits are taxed in accordance with the real economic activity and value creation. The European Commission has responded to the OECD by issuing its Anti-Tax Avoidance Package in 2016,[6] which supports the Action Plan on BEPS and focuses on providing a stronger and better-coordinated handling of tax abuse

[1] See Global Justice Now (2016).
[2] See European Commission (2016).
[3] See The Guardian (2009b).
[4] See Dischinger and Riedel (2011).
[5] See OECD (2013a).
[6] See COM (2016a).

within the European Union (EU). Policy makers and academics usually agree that the main channels of profit shifting include a strategic use of intra-firm transfer prices and related-party interest payments.[7] In addition, they stress the importance of hindering the use of intangible assets in profit shifting, as intellectual property (IP) can be relatively easily transferred within a corporate group and its uniqueness often hinders the determination of the true arm's length price.[8]

The main aim of this doctoral thesis is to contribute to the academic research on base erosion and profit shifting by empirically investigating the use of its individual channels and the effectiveness of countermeasures. The focus is on a strategic use of intangible assets for profit shifting between affiliates of multinational enterprises. The thesis consists of five self-contained chapters that enhance the existing empirical literature on BEPS and deliver valuable conclusions for tax policy considerations. The chapters provide a thoughtful and detailed contribution to the political and academic discussion on the substitution between profit shifting channels, the effectiveness of anti-avoidance legislation, as well as the use of bilateral royalty payments, different types of intangible assets, and fiscal incentives for profit shifting.

Chapter 2 reviews and summarizes various areas of corporate taxation that are relevant for this thesis, focusing on profit shifting by multinational enterprises and its main channels. The methodology of the chapter includes an analysis of descriptive statistics and a comprehensive review of the related empirical literature.

The chapter begins by examining corporate income taxation in Europe and the United States and comparing it with the taxation of personal income, consumption, and property. According to the findings of this analysis, corporate taxation constitutes a relatively small part of the total tax revenues in Germany and other OECD member states. Therefore, the reforms of the corporate tax system have to be substantial in order to have a sizable effect on total tax revenues. Furthermore, the analysis shows that there are vast differences in corporate taxation within the OECD. The descriptive statistics presented in this chapter and the reviewed empirical literature suggest that German and US multinational enterprises exploit these tax rate differentials to shift profits. Intangible assets appear to play an important role in tax minimizing strategies of multinational firms and are intensively used as a means of profit shifting. Finally, multiple

[7] See Dharmapala (2014) for a review of empirical literature on base erosion and profit shifting.
[8] See OECD (2013a), Action 8.

proposals on reforming the current tax system are analyzed in this chapter, whereby it is noted that some suggestions focus on improving the existing tax system, while others embrace its fundamental change.

Chapter 3[9] empirically contributes to the debate on base erosion and profit shifting, which has been on the international policy agenda for several years now. The main topics in this discussion include the use of intra-group interest and royalty payments as well as related-party trade to relocate profits within a multinational group in a tax minimizing manner. Anti-avoidance regulations have been introduced to limit cross-border shifting activities and the existing empirical literature analyzes the effectiveness of each type of countermeasures independently from one another. The main aim of this chapter is to examine whether firms substitute between profit shifting strategies and whether this implies interdependency between different anti-avoidance regulations.

To examine this effectively in our study, we employ a sample of European multinationals to analyze the variation of anti-avoidance legislation over time. According to our findings, a substitution occurs between profit shifting channels, which results in one set of regulations becoming ineffective if other rules remain unenforced. In order to strengthen our identification strategy, we examine a reform of thin capitalization regulations in France and this difference-in-difference approach confirms the substitution hypothesis. In addition, we compare the substitution between profit shifting channels in the case of IP-intensive firms and other companies. According to our results, IP-intensive firms demonstrate more aggressive shifting behavior because they are less restricted in conducting profit shifting. Since the arm's length price on the use of intangibles is often hard to determine, it can be more easily manipulated than transfer prices for tangible goods or intra-group interest payments, giving IP-intensive companies a leeway for profit shifting.

The aim of **Chapter 4**[10] is to empirically analyze the relationship between corporate taxation and the intensity of international royalty flows. Royalties set between third parties are determined by the significance of the technology or the magnitude of research expenses, whereas royalties transferred between related parties may deviate from their true price with the

[9] This is joint work with Katharina Nicolay and Hannah Nusser.
[10] This is joint work with Christoph Spengel and Johannes Voget. An earlier version of the paper has been circulated as a ZEW discussion paper (Dudar et al. (2015)).

aim of shifting profits from high-tax affiliates to low-tax group members of a multinational group.[11]

We empirically test the influence of taxation on royalty flows by using the OECD statistics on bilateral royalty payments between 3,422 country-pairs in the period between 1995 and 2012. In our benchmark analysis, we apply a Poisson pseudo-maximum likelihood estimator in a fixed-effects framework and subsequently test the robustness of our results using alternative identification strategies. According to our main findings, corporate taxation negatively affects royalty intensity, meaning that royalties tend to flow from high-tax to low-tax countries. Moreover, we find that the tax differentials, which measure a relative level of taxation in a recipient country compared to other potential royalty recipients, also have a significant influence on royalty payments. These findings support the hypothesis that multinational enterprises use royalties and license fees for profit shifting.

For tax policy considerations, this chapter analyzes potential outcomes of the ongoing work on profit shifting by the G20, the OECD, and the European Commission. To give an example, we find that reform suggestions of the OECD Action Plan on base erosion and profit shifting, such as the enforcement of the Nexus Approach or strengthening of anti-avoidance regulations, are likely to reduce the intensity of international royalty exchange.

Chapter 5[12] contributes to numerous empirical studies that have analyzed the influence of corporate taxation on the location of intangible assets. The previous literature has tended to focus on studying the impact of taxation on patent location choices and has assumed that they represent all other intangibles as well. This chapter complements earlier studies by estimating and comparing the tax elasticities of two different types of intellectual property – patents and trademarks. In comparison to patents, trademarks are generally easier to register and incur lower development costs. Their development does not typically require detailed documentation and the location of other intangibles in the same family is less likely to be a decisive factor, as can often be the case with patents. Therefore, we expect trademarks to be more responsive to changes in corporate taxation than patents.

[11] See Kopits (1976) for further details on this argument.

[12] This is joint work with Johannes Voget. An earlier version of the paper has been circulated as a ZEW discussion paper (Dudar and Voget (2016)).

We empirically test whether there is a difference in the tax elasticities of patents and trademarks by employing data on European and US patent and trademark applications in the period between 1996 and 2012. We apply the identification strategy of Griffith et al. (2014) and estimate a mixed logit model, which incorporates various observed and unobserved factors that determine location choices. According to our key findings, trademarks are more sensitive to changes in taxation than patents, which implies that there is a more intensive use of trademarks in tax planning in contrast to the use of patents. We also find empirical evidence which suggests that one of the explanations for different tax elasticities of patents and trademarks lies in a larger agglomeration of patents within their families compared to trademarks.

Chapter 6[13] provides a comprehensive analysis of various aspects of R&D tax incentives. It explains the economic justification behind the state support of research and development and summarizes its main types. In addition, it gives an overview of the existing R&D tax incentives in Europe and provides a thorough review of the empirical literature on the outcomes of fiscal incentives. Furthermore, the Devereux and Griffith model is used to determine the effective tax burden of multinational firms that reside in countries which implement R&D tax support and countries which do not. In line with Spengel and Elschner (2010) and Evers et al. (2015a), the model is developed further to reflect the potential use of R&D incentives for tax planning.

The hypothesis developed in the model is tested through an empirical estimation, where we employ the OECD data on international co-operation in patents. According to our main findings, there are at least two reasons why input-oriented R&D tax incentives, such as tax credits and tax super-deductions, constitute a more suitable instrument for fostering research and development in comparison to output-oriented incentives, such as IP Boxes. The first reason is the robust evidence found in the empirical literature which shows the positive effect introducing input-oriented tax incentives has on a firm’s innovative activity, whereas studies on output-oriented tax incentives are not able to support this argument. The second reason identifies that in accordance with our theoretical and empirical analyses, output-oriented R&D tax incentives may be used by multinationals for tax planning as opposed to their intended aim of fostering research and development.

Finally, **Chapter 7** concludes by summarizing the key findings of each chapter and draws policy implications relevant for the current political discussion on BEPS.

[13] This is joint work with Christoph Spengel.

The chapters of this doctoral thesis have been written in co-operation with multiple co-authors with the aim of being published in academic journals within the fields of public economics, taxation, and accounting. Table 1.1 acknowledges the co-authors and provides information on the current publication status chapter by chapter. It also highlights my own involvement and key contribution in each study.

Table 1.1 Joint Work within the Thesis: Co-Authors and My Own Contribution

Chapter	Co-Authors	Publication Status	My Contribution
Chapter 3. On the Interdependency of Profit Shifting Channels and the Effectiveness of Anti-Avoidance Legislation	K. Nicolay, H. Nusser	Under review in *The Journal of Accounting and Economics*	- A definition of the motivation of the study and its key contributions; - A review of previous studies and positioning of our paper in the literature; - Data collection and the preparation of the main dataset; - Panel data analysis, focusing on the part with interest payments as a dependent variable; - Primary development of the difference-in-differences analysis; - An interpretation of the empirical results and drawing conclusions and implications for future research and politics.
Chapter 4. The Impact of Taxes on Bilateral Royalty Flows	C. Spengel, J. Voget	Under review in *International Tax and Public Finance*	- Development of the idea behind the paper and its positioning in the literature; - Development of the conceptual framework and an explanation of the study's predictions; - Data collection, data preparation, and an elaboration of the identification strategy; - Regression estimations, including robustness checks and extended analysis;

			- An interpretation of the key findings, defining their contribution to the previous literature and drawing policy implications.
Chapter 5. Corporate Taxation and the Location of Intangible Assets: Patents vs. Trademarks	J. Voget	Prepared for a submission	- Preparation of the introduction which explains the aim of the study, its motivation, and contribution to the previous literature; - Derivation of the main hypotheses based on the review of prior literature and a qualitative analysis of the differences between patents and trademarks; - Development of the identification strategy, including a preparation of data and a definition of the variables used in an empirical analysis; - An empirical analysis, including baseline estimations, multiple robustness tests, and extensions to the study; - Drawing conclusions and policy implications.
Chapter 6. Tax Incentives for Research and Development and Their Use in Tax Planning	C. Spengel	Prepared for a submission	- Development of the idea behind the paper and a definition of its key contributions; - A qualitative analysis of the justification behind fiscal support of research and development; - An overview of the existing R&D incentives in Europe; - A review of the empirical literature on the effectiveness of R&D tax incentives; - A quantitative analysis of the effective tax burden with and without R&D tax incentives using the domestic and cross-border investment scenarios in the Devereux and Griffith model;

	- An empirical investigation, including data preparation and the development of the identification strategy; - An interpretation of the key findings and drawing of the conclusions.

Chapter 2

Corporate Income Taxation and Profit Shifting by Multinational Enterprises

2.1 Introduction

There is plenty of anecdotal evidence which suggests that multinational corporations undertake various profit shifting strategies with the aim of diminishing their tax liabilities.[14] One of the latest examples is the ongoing dispute between *Apple Inc.* and the European Commission, according to which Ireland granted undue tax benefits of up to 13 billion EUR to *Apple Inc*. The Commission has concluded that this treatment was selective and therefore illegal under the European Union (EU) state aid rules, because it allowed *Apple Inc*. to pay a substantially lower amount of tax than other businesses. Commissioner Margrethe Vestager argues that it allowed *Apple Inc*. to pay an effective tax rate of 1% on its European profits in 2003 and 0.005% in 2014.[15]

The media reports that governments are allegedly missing billions of euros in tax payments each year because of profit shifting.[16] While the precise amount of revenue losses remains largely unknown, the Organization for Economic Co-Operation and Development (OECD) estimates that the net global corporate tax revenues lost due to profit shifting may lie within a range between 4% and 10% of corporate tax revenues, or 95 to 230 billion EUR annually.[17,18] At the same time, multinational enterprises (MNEs) find numerous justifications for tax planning behavior. For instance, firms argue that they have a responsibility towards their shareholders to maximize profits. Aside from this, multinationals complain about double

[14] See Sullivan (2012) for an overview.
[15] See European Commission (2016).
[16] See Fortune (2016).
[17] See OECD (2015d), p. 102.
[18] Murphy (2012) argues that this figure may be even higher.

taxation of cross-border activities, which however is becoming rare with a growing number of multinational and bilateral tax treaties all around the world.

The issue of profit shifting by multinationals is becoming a growing concern for policy makers. Several international organizations, including the G20,[19] the European Commission,[20] and the OECD,[9] have recently argued against income shifting and have stressed the importance of taxation in place of value creation and real economic activity. For example, in 2013 the OECD developed an Action Plan on base erosion and profit shifting (BEPS),[21] which suggests some of the direct steps that the international community should take in order to close the loopholes in current regulations and amend the existing laws and regimes that facilitate profit shifting. According to the OECD, income shifting does not only harm governments and individual taxpayers by depriving them of substantial amounts of tax revenues, but it also distorts market competition by providing multinational firms with an unfair advantage against their purely-domestic counterparts,[22] as in the aforementioned example of *Apple Inc*. The European Commission responded to the OECD Action Plan by releasing the Anti-Tax Avoidance Package in 2016,[23] which aims to increase the transparency of corporate transactions and operations, to eliminate profit shifting, as well as to strengthen co-operation on tax matters within the EU.

The aim of this study is to provide a comprehensive analysis of different aspects of corporate taxation. The major topics therefore include the development of corporate tax rates over the years, the magnitude of profit shifting, the use of different channels to shift profits, as well as current suggestions for reforming the existing tax system. Particular attention is paid towards the issue of profit shifting by multinational enterprises via a strategic use of intellectual property (IP). The analysis is carried out with the help of numerous descriptive statistics and a review of the related empirical literature. As for the geographical focus of this study, Germany is the primary focus of the analysis and its statistics and trends are compared with other European countries and the United States.

The study is comprised as follows: section 2.2 addresses the significance of corporate taxation in the composition of total tax revenues. The revenues from corporate taxation in Germany, the

[19] See OECD/G20 (2014).
[20] See European Commission (2015a).
[21] See OECD (2013a).
[22] See OECD (2013a), p. 8.
[23] See COM (2016a).

EU15,[24] and the US are analyzed and compared with other types of tax revenues. In addition to this, the development of corporate tax rates is studied here and compared with the development of tax rates on personal income, consumption, and property. Section 2.3 focuses on the issue of profit shifting by multinational enterprises. This part of the study defines concepts such as tax planning, tax avoidance, tax evasion, and profit shifting and explains the key channels used by multinationals to shift income. The focus is on shifting with the help of intangible assets. Furthermore, section 2.4 summarizes the main ideas on reforming the existing international tax system in order to hinder profit shifting and eliminate its other inefficiencies. Finally, the last section presents the key findings of the study and draws the main conclusions and policy implications.

2.2 Corporate Income Tax

This chapter begins with an analysis of general reasons for taxing corporate income and goes on to compare the development of corporate income tax (CIT) rates with the development of tax rates on personal income, consumption, and property. The focus of the analysis is on corporate income taxation in Germany, the EU15, and the US.

2.2.1 Corporate Income Taxation

In 1909 the United States enacted its first uniform Corporate Tax Act, which introduced an excise tax on the privilege of doing business in corporate form.[25] This tax on the profits of corporations is considered a predecessor of the modern corporate income tax, which is nowadays levied in all countries around the world (with the exemption of a few tax havens). Germany was among the first European countries to enact a uniform corporate income tax in 1920. In the current tax system, profit is taxed primarily in the country in which it is generated (referred to as a source country). The United States is the only high-income country that seeks to add an additional layer of tax when the profit is repatriated to an American parent company, which introduces an element of a residence-based taxation. However, as Devereux (2008) notes, the sums raised from an additional layer of tax in the United States are usually rather small.

[24] The EU15 includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the UK.

[25] According to Keightley and Sherlock (2014), the US made a few unsuccessful attempts to introduce a uniform corporate taxation in the 19th century. However, the Supreme Court claimed these initiatives to be unconstitutional.

Hence, the author concludes that in the current tax system the international taxation of profit is levied primarily on a source basis.

Corporate income taxation serves several goals. For example, it ensures the integrity of the tax system and spurs transparent documentation of annual accounts and business transactions of all corporations.[26] In addition, along with revenues from other tax bases, corporate income taxation contributes to a country's total tax revenues, which in turn constitute an important part of the overall government revenues. German tax revenues including social contributions amounted to around 85% of the total government revenues in 2012. This share is approximately the same in other European countries and is equal to 80% in the United States.

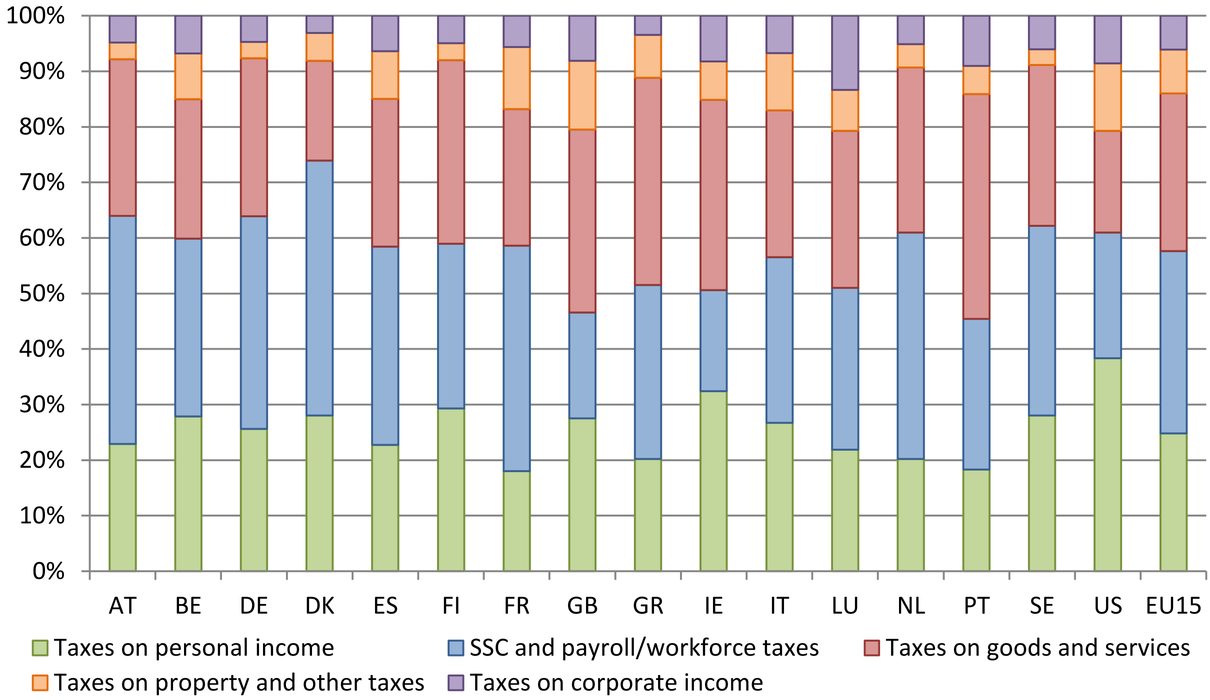
In most countries, tax revenues result from various federal and local taxes on income, property, and consumption. Income taxation can be split into taxation of individuals and companies. The first category usually includes a personal income tax (PIT) and social security contributions, whereas the second one typically comprises a corporate income tax, a business tax, and other taxes on income of corporations. Property may be taxed via a real estate tax or a wealth tax. Consumption is often taxed with the help of excise taxes, a value-added tax (VAT), or a sales tax.

Figure 2.1 reflects the composition of total tax revenues in countries of the EU15 and the US. According to this figure, German personal income tax combined with social security contributions amounts to more than 60% of the country's total tax revenues. The second most important source of tax revenues in Germany appears to be consumption, as the VAT levied around 30% of the country's total tax revenues in 2012. In contrast, the revenues from corporate income taxation add up only to around 5% of the total tax revenues. Property taxes account for an even smaller portion of total revenues. The given composition of tax revenues has remained stable in Germany since the mid-1970s. According to Figure 2.1, the structure of tax revenues in countries of the EU15 is similar to the German one. In these countries, personal income taxation and social security contributions along with consumption taxes constitute the most important sources of tax revenues. In line with Germany, the revenues from the CIT and property taxation are relatively small compared to other types of taxes. However, in countries such as Luxembourg, Portugal, and the UK the share of corporate tax revenues to the total tax revenues amounts to around 10%. This difference is partly due to the share of the legal forms

[26] More information on the functions of the corporate tax system is given in section 2.4.2.4.

of companies that reside in each country. For example, in Germany around 70% of all firms are sole proprietors or business partnerships, which do not pay corporate income tax.[27] By contrast, in the United Kingdom this share lies below 30%.[28]

Figure 2.1 Composition of Total Tax Revenues, 2012



Notes: Data comprises tax revenues on the federal, state, and local levels. Taxes on property and other taxes include recurrent taxes on immovable property, recurrent taxes on net wealth, estate, inheritance, and gift taxes, taxes on financial and capital transactions, non-recurrent taxes on property, other taxes on property, as well as taxes on payroll and workforce. Country codes and the corresponding country names are in the list of country abbreviations. SSC stands for social security contributions. EU15 denotes an average of the EU15 members. Source: OECD Stat, database *Revenue Statistics – Comparative Tables*.

Furthermore, Figure 2.1 demonstrates that in the US, similarly to European countries, personal income taxation plays a rather important role in the composition of total tax revenues. However, the share of consumption taxation is a little lower and the portion of corporate income and property taxation is higher than in countries within the EU15. For example, while the CIT accounts for 5% of total tax revenues in Germany and on average 6% in the EU15, its share in the US reaches 10%. Thus, the United States seems to rely slightly more on corporate income taxation than European countries in the composition of its total tax revenues.

[27] See Federal Statistical Office (2017).
[28] See Office for National Statistics (2017).

2.2.2 The Development of Tax Rates

This section analyzes the development of corporate income tax rates and compares them to the development of taxes on personal income, consumption, and property in different countries. Germany is the central focus of this analysis and is compared with the US and the EU15-average along with some other high-tax and low-tax European countries such as Belgium, France, Ireland, Luxembourg, the Netherlands, Switzerland, and the UK.

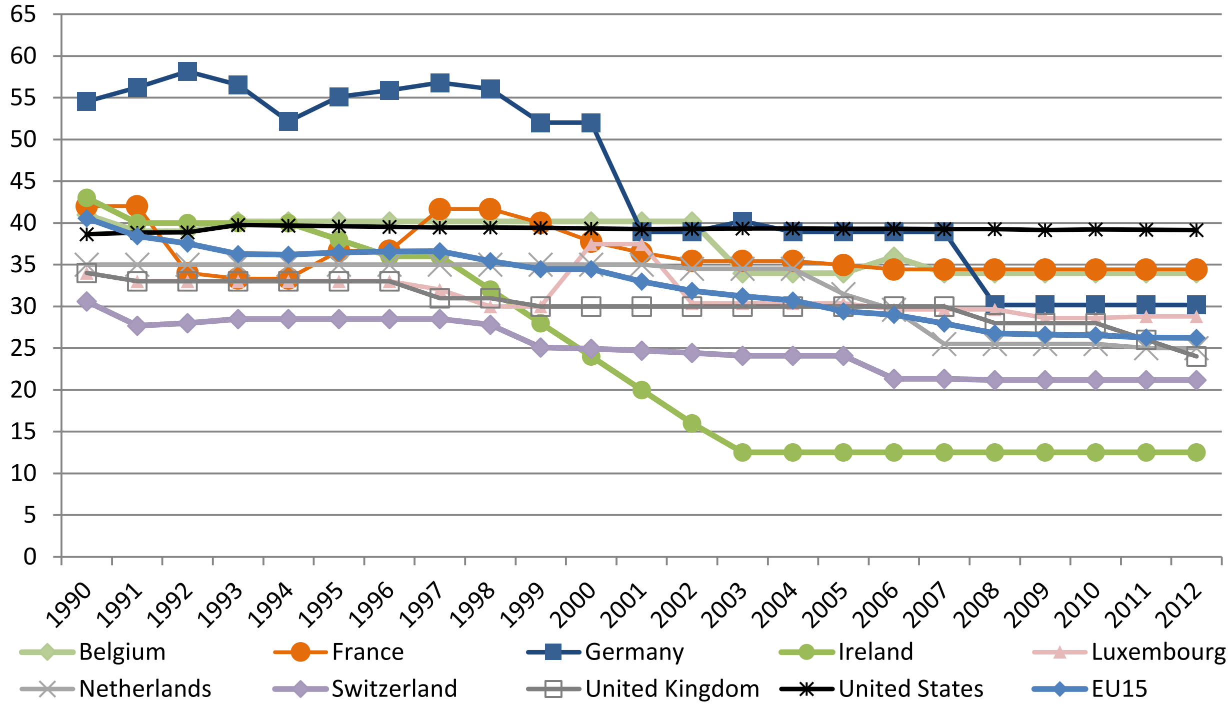
Figure 2.2 illustrates the development of corporate income tax rates in Germany and other countries over the past two decades. In several OECD member states, corporate income taxation is levied not only on a federal but also on a local level. Figure 2.2 presents statistics on a combined CIT rate which incorporates all federal and local business income tax rates. Since local business taxes usually vary within countries, the combined CIT rates presented in Figure 2.2 are calculated for countries' economic centers. According to Figure 2.2, statutory corporate income tax rates have been declining rapidly over the past years. For instance, the combined corporate income tax rate in Germany decreased from 55% in 1990 to around 30% in 2012. In the EU15 it declined gradually from an average of around 41% in 1990 to 26% in 2012. By contrast, the American CIT rate remained at a rather constant level since its sharp fall at the end of the 1980s.

As Devereux and Sørensen (2006) note, in many OECD countries a decrease in the CIT rate was accompanied by a simultaneous broadening of the corporate tax base. Therefore, when analyzing the development of corporate income tax rates, it is important to consider changes in both the statutory and the effective rates. Figure 2.3 presents statistics on the development of the effective average tax rates (EATRs) in Germany, the United States, and other countries since 1990. These rates were calculated at the Centre for European Economic Research (ZEW) following the Devereux and Griffith (1999) approach.[29] EATR measures an effective tax burden of a hypothetical investment decision, which flows into five assets such as buildings, machinery, patents, financial assets, and inventories. The project is financed with the help of retained earnings, debt, and new equity. As a result, the Devereux and Griffith (1999) model includes various aspects of a country's tax system. For example, it not only incorporates

[29] See ZEW (2016).

statutory corporate income tax rates but also includes important tax base regulations and non-income taxes.[30]

Figure 2.2 Statutory CIT Rates Including Surtaxes, 1990-2012, %



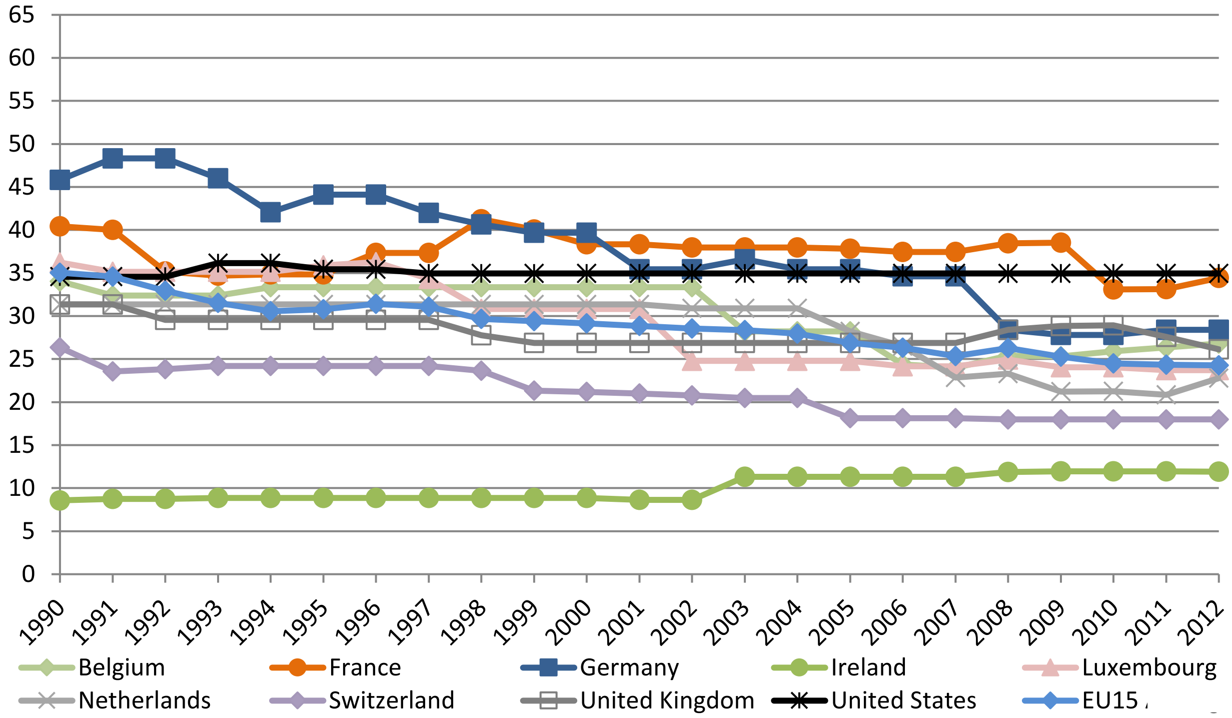
Notes: The combined CIT tax rate is the sum of an adjusted federal government CIT rate and a local rate. The local tax rate is based on the taxation in a country's economic center. The adjusted federal government rate represents the net tax rate where the central government provides a deduction with respect to local income taxes. For Luxembourg no data on surtaxes is available for 1990-1999. EU15 denotes an average of the EU15 members. Source: OECD Stat, database *Corporate Income Tax*.

According to Figure 2.3, effective average tax rates have decreased in most countries under analysis since 1990. However, their decline is smaller than the fall of the statutory corporate income tax rates presented in Figure 2.2. For example, while Germany's EATR decreased from approximately 45% in 1990 to around 28% in 2012, the average tax burden of the EU15 lost 10 percentage points during this time and the US tax rate remained almost unchanged. The findings show that Ireland is the only country which has experienced a small increase in the effective tax burden. According to Norregaard and Khan (2007), some Irish industries, such as the manufacturing sector and international trading services, have benefited from a reduced corporate income tax rate of 10% before 2003. The remainder of the corporate sector was taxed at a much higher rate. As an example, Figure 2.2 shows that the standard CIT rate in Ireland in

[30] These taxes include taxes on real estate, property, wealth, etc.

the 1990s amounted to around 40%. Since the Devereux and Griffith model calculates an effective tax burden for a manufacturing company, the reduced rate was applied to the calculations prior to 2003. The Irish tax reform of 2003 harmonized the corporate income tax rate for all sectors setting it at 12.5%, which resulted in a slightly higher EATR in the Devereux and Griffith model but a lower statutory CIT rate in Figure 2.2.

Figure 2.3 Effective Average Corporate Tax Rates, 1990-2012, %

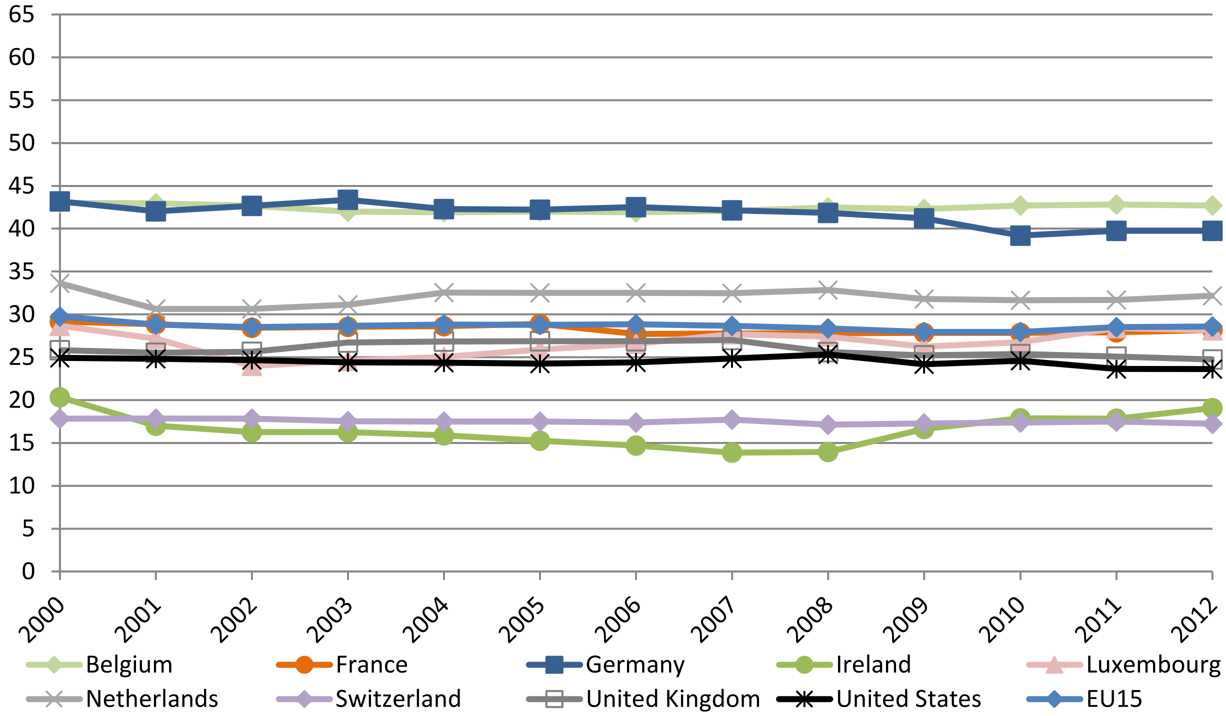


Notes: The calculation is based on the model developed by Devereux and Griffith (1999). It measures the effective taxation of a corporation that undertakes a hypothetic investment in five predefined economic goods such as intangible assets, industrial buildings, machines, financial assets, and inventories. The project is financed by the means of retained earnings, borrowed capital, and new equity capital. EU15 denotes an average of the EU15 members. Source: ZEW (2016).

Furthermore, Figure 2.3 divides the countries under analysis into low-tax and high-tax countries. Hence, the effective tax burden of countries such as Ireland, Switzerland, the Netherlands, and Luxembourg is below the EU15-average in 2012 and that is why they can be considered low-tax countries. By contrast, the EATRs of France, Germany, the UK, and the US exceed the EU15-average and can therefore be classified as high-tax countries.

While the statutory and effective corporate income tax rates have decreased over the past years, taxes on personal income, consumption, and property have remained mostly unchanged. To illustrate this point further, Figure 2.4 shows the development of average tax rates on personal income in Germany and other countries. A comparison of the previously mentioned countries shows that Germany had one of the highest average PIT rates in Europe in 2012. For example, the average personal tax rate was equal to approximately 17% in Switzerland, 19% in Ireland, and 24% in the UK. These rates are substantially lower than the German average PIT of almost 40%. Moreover, Figure 2.4 shows that the personal income tax rate in the US is equal to 24%, which is subsequently lower than the German PIT rate and is also below the EU15-average. Therefore, Germany can be considered a country with a relatively high level of taxation not only in terms of corporate taxation but also in terms of personal income taxation.

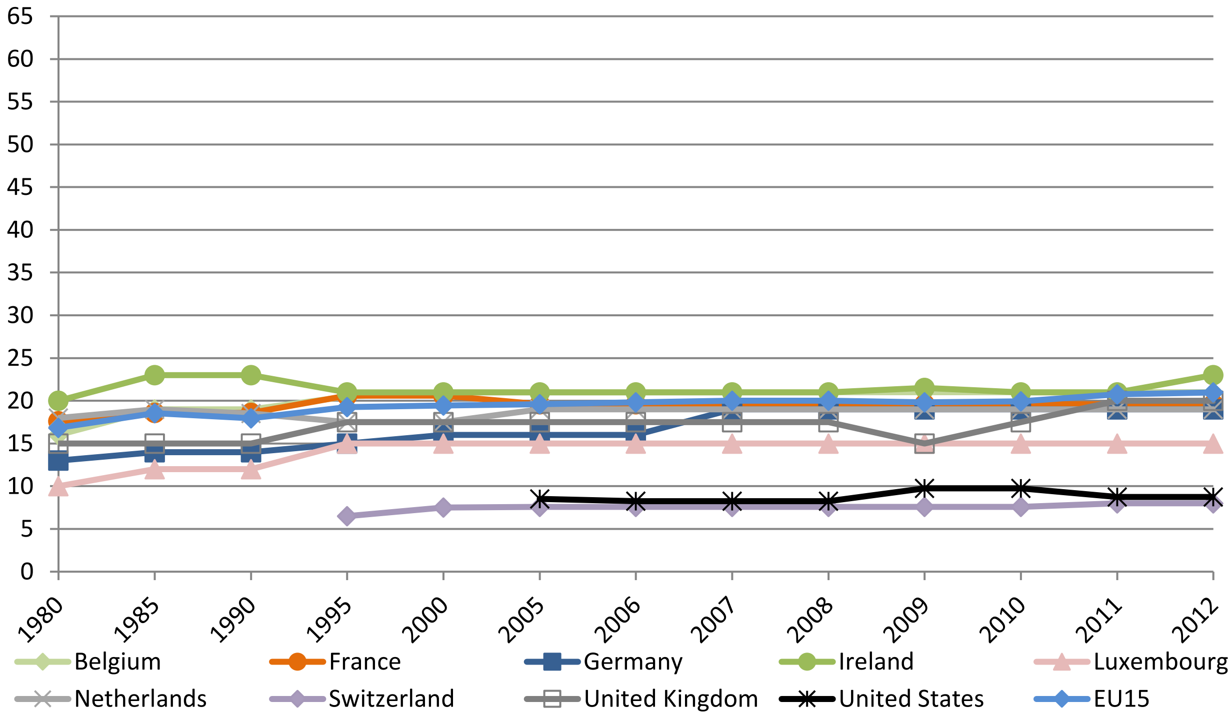
Figure 2.4 All-In Average PIT Rates, 2000-2012, %



Notes: Average personal income tax rates (including social contributions) for single persons without children, calculated using the average wage. The results are derived from the OECD Taxing Wages framework (elaborated in the annual publication Taxing Wages). EU15 denotes an average of the EU15 members. Source: OECD Stat, database *All-in Average Personal Income Tax Rates at Average Wage by Family Type*.

Figure 2.5 demonstrates the development of the consumption tax rates during the past few decades in Germany and other countries under analysis. In contrast to income taxation, the harmonization of the consumption tax has been on the European Union agenda since the early years of its existence. As early as in 1967, the European Commission issued its first value-added tax directive,[31] aiming to harmonize consumption taxation in the EU. The European Commission introduced its sixth VAT directive a decade later,[32] which empowered member states to choose their rates of VAT while regulating the minimum rate that could be set. These directives, along with additional work from the European Union, have led to the harmonization and stabilization of the VAT rate in the EU. The German standard VAT rate of 19% was slightly below the EU15-average of 21% in 2012. It is worth mentioning that while in European countries consumption tax rates are usually uniform on the national level, the US sales tax rates vary from state to state. The development of the sales tax rate in Los Angeles, California is given in Figure 2.5 as an example and it appears to be lower than the consumption tax rates in most European countries. When comparing the taxation of personal income with the taxation of consumption in Europe and the United States, it is evident that they tax income more heavily than consumption.

Figure 2.5 Standard VAT Rates, 1980-2012, %

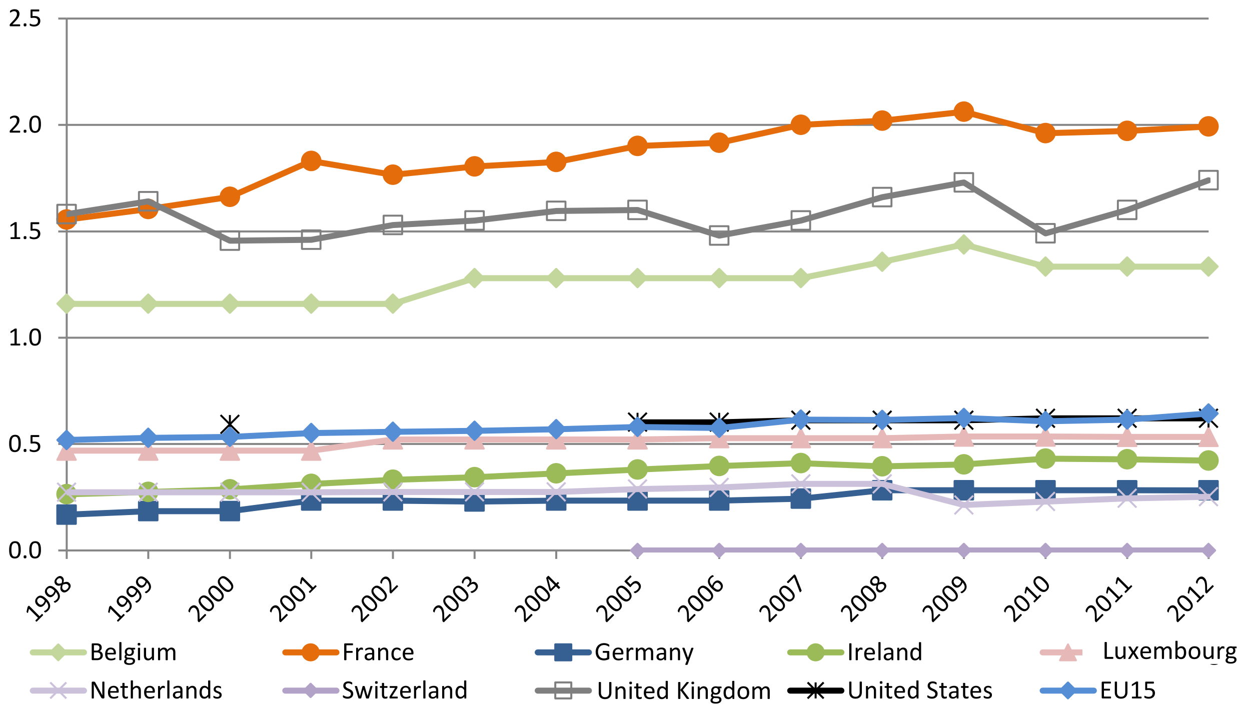


Notes: The combined sales tax rate of Los Angeles, CA has been taken as an example for the United States. Due to a lack of data, the EU15-average does not contain Finland, Greece, Portugal and Spain in the years 1980 and 1985; for the same reason the EU15-average excludes Finland in 1990. EU15 denotes an average of the EU15 members. Sources: OECD Stat, database *Consumption Tax Rates* and the California State Board of Equalization.

[31] See European Commission (1967).
[32] See European Commission (1977).

Property taxation can be implemented by the means of recurrent and non-recurrent taxes on immovable property, net wealth, inheritance, and gifts. However, taxes on inheritance and gifts usually have generous tax allowances and most European countries and the United States do not currently have any net wealth taxes. Luxembourg is one of the exceptions, since its resident firms are subject to a 0.5% wealth tax on their net asset value. As for a real estate tax, most OECD countries split it into a federal and a local real estate tax, which leads to its variation on the local level within individual countries. Figure 2.6 shows the development of combined real estate tax rates (including real estate taxation on federal and local levels) in economic centers of different countries in the period between 1998 and 2012. According to this figure, the taxation of real estate in Germany has been lower than in the EU15 and the United States during the whole period of observation. While a real estate tax rate is under 1% in Germany, the Netherlands, Ireland, Luxembourg, and the US, it reaches almost 2% in the economic centers of France and the UK. Furthermore, similarly to the tax rates on personal income and consumption, real estate tax rates have remained rather constant in Germany, the EU15, and the US since the 1990s.

Figure 2.6 Effective Real Estate Tax Rates, 1998-2012, %



Notes: The effective real estate tax rate includes both federal and local tax rates. The local tax rate is based on the taxation in a country's economic center. EU15 denotes an average of the EU15 members. Sources: ZEW (2016), International Bureau of Fiscal Documentation (1995-2012).

In summary, Figures 2.2-2.6 show that the statutory and effective corporate income tax rates have declined in most countries since the end of the last century, whereas the taxation of personal income, consumption, and property has remained rather constant during this period. To illustrate this finding more clearly, consumption and real estate tax rates in Germany have increased slightly between 2000 and 2012. At the same time, the all-in average personal income tax rate has decreased by 8%. The statutory corporate income tax rate has experienced the most striking development falling by 41% between 2000 and 2012, with the effective average corporate tax rate decreasing by 28% during this period. According to Devereux (2008), a fall in corporate income tax rates is commonly attributed to countries that attempt to undercut each other in a tax competition in order to attract inward investment. The author argues that the decrease in tax rates might also be triggered by other reasons, such as a growing belief among policy makers that high tax rates are not appropriate. However, Devereux (2008) observes that in this case personal income tax rates would have strongly decreased as well, following the same pattern as corporate income tax rates. Figure 2.4 shows that this scenario does not represent the actual development of the PIT rates over the last couple of years. Thus, a growing competition for mobile firms, capital, and profits along with decreasing competition over individuals subject to personal taxes might be one of the factors which led to falling corporate income tax rates over the past couple of years.[33]

Despite the declines in statutory and effective corporate income tax rates, in 2012 the German effective corporate tax burden of 28% was still higher than the EU15-average and significantly exceeded the EATRs of Ireland, Switzerland, Belgium, Luxembourg, the Netherlands, and most Eastern European countries. Multinational enterprises that operate in several high-tax and low-tax countries might exploit such differences in corporate income tax rates for base erosion and profit shifting in order to minimize their consolidated tax liabilities. This issue has been analyzed in numerous empirical and theoretical studies and is the primary focus within the next section.

[33] See Bretschger and Hettich (2005) for empirical evidence on the international tax competition (also known as a "race to the bottom").

2.3 Multinational Enterprises and Profit Shifting

Nowadays most countries apply a territorial or source-based corporate tax system.[34] According to this approach, profit is taxed in the country where it is generated. However, it is not always straightforward where profits originate from, especially in the case of multinational enterprises. MNEs consist of multiple units that allow them to spread their operations, such as production, marketing, sales, treasury, research and development (R&D), and many others, all around the world. The operations of multinational groups may therefore involve numerous locations and Devereux (2008) argues that this gives MNEs an opportunity to choose where to locate their taxable profits.

The previous section has shown that corporate income tax rates differ substantially across countries. Multinational enterprises are aware of these differences and may prefer to locate their profits in low-tax countries rather than the high-tax ones in order to minimize their overall tax liabilities. This section defines tax planning, tax avoidance, and tax evasion and explains the notion of profit shifting. Furthermore, it analyzes some descriptive statistics and summarizes the findings of the empirical literature on profit shifting behavior of multinational enterprises. The chapter concentrates on MNEs, even though domestic firms might use tax saving strategies as well. In addition, the focus is on the activities of German and US multinationals in several low-tax and high-tax European countries.

2.3.1 Tax Havens and Tax Reducing Strategies

2.3.1.1 Tax Havens

Tax havens are countries that have low or no tax rates and therefore enable multinational firms to carry out profit shifting.[35] According to the OECD (1998), tax havens are characterized not only by low tax rates but also by a lack of effective exchange of information and no transparency in the operation of legislative or administrative provisions. The OECD created an initial list of uncooperative tax havens in 2000,[36] which included Andorra, Liechtenstein, Monaco, Liberia, and a few other countries. These countries have since been subject to international pressure to

[34] After Japan and the UK moved to a source-based tax system in 2009, the US remained the only major economy that applies worldwide taxation, under which American companies are taxed on the income they earn in foreign countries in addition to the income they earn at home. See Business Roundtable (2011) for more information.
[35] See OECD (1998), p. 21-22.
[36] See OECD (2017b).

increase their transparency and to exchange information on tax issues, which has resulted in no jurisdiction currently being on the list. Even though the OECD definition of a tax haven takes other aspects of a tax system besides the tax rates into consideration, Gravelle (2015) argues that economists might define any low-tax country which has the aim of attracting capital as a tax haven.[37] Therefore, a tax haven could be defined as any country which has low or non-existent taxes, as suggested by the author.

Even within Europe, the vast differences in corporate taxation enable countries to be divided into low-tax and high-tax countries. For instance, the Benelux countries (Belgium, the Netherlands, and Luxembourg), Ireland, and Switzerland either have low corporate income tax rates or offer favorable tax regulations that allow multinationals to lower their global tax bases. To give an example, Luxembourg, the Netherlands, and Belgium have relatively high statutory corporate income tax rates, as Figure 2.2 illustrates. However, tax regulations in the Netherlands allow (or have permitted in the past) multinational enterprises to implement tax avoidance strategies, such as the *Double-Dutch with an Irish Sandwich*.[38]

Furthermore, multinational corporations that reside in Belgium are entitled to generous tax deductions and tax exemptions and are able to benefit from the notional interest deduction (NID).[39] Multinational enterprises in Luxembourg may negotiate a special tax arrangement with the local tax authorities. The European Commission considers these arrangements to be in breach of the EU state aid rules, since they give certain companies an unfair advantage against their competitors.[40] All of these special tax regulations and arrangements may reduce the tax liability of firms located in Luxembourg, Belgium, or the Netherlands to nearly zero. In comparison, France, Germany, and the United States have relatively high CIT rates (see Figure 2.2) and do not offer special treatment for multinational enterprises, which is why they might be considered high-tax countries.

[37] See Gravelle (2015), p. 2.
[38] This tax avoidance technique involves sending profits from one Irish company to a Dutch affiliate and finally to a second Irish company with headquarters in a tax haven. The loophole in the Irish tax legislation that enabled this strategy was closed in 2015. However, companies with established business structures were allowed to benefit from the old system until 2020.
[39] NID allows a tax-free return on qualified equity and is therefore especially attractive for new companies with high equity investments.
[40] See European Commission (2015b).

2.3.1.2 Tax Planning

Tax planning aims to organize tax affairs of a firm in the most effective way using various methods within the boundaries of the law. According to Russo (2007), the need for tax planning might arise, for example, when a multinational experiences double taxation. The OECD (2015e) defines double taxation as the imposition of comparable taxes in two or more countries on the same taxpayer, the same tax base, and in the same period of time.[41] According to the OECD, double taxation is harmful, as it hinders international exchange of goods and services and a free movement of capital.[42] In addition to avoiding double taxation, tax planning can be used to exploit a tax saving potential of the existing business activities of a multinational firm. For example, a company might opt for a declining balance method instead of a linear depreciation of tangible and intangible assets if this step brings a temporary or a permanent tax advantage.

2.3.1.3 Tax Avoidance

A more harmful form of tax planning is called aggressive tax planning or tax avoidance. According to the European Commission (2012), "aggressive tax planning consists in taking advantage of the technicalities of a tax system or of mismatches between two or more tax systems for the purpose of reducing tax liability."[43] Its objective is to use the loopholes in the existing laws and regulations in order to minimize a multinational's overall tax liability. Even though tax avoidance is legal, lawmakers still do not welcome it, arguing that it takes unfair advantage of legal provisions in a way that differs from their originally intended use.[44] Examples of tax avoidance include a deduction of the same loss in multiple countries or a situation in which income that is not taxed in a source country is exempt in the country of residence, which results in double non-taxation. Campbell and Helleloid (2016) describe diverse tax avoiding strategies used by *Starbucks Corp.* for the minimization of its tax liability in the UK. According to the authors, the firm manipulated its transfer prices on transactions with its affiliates in the Netherlands and Switzerland to shift income generated in the UK abroad. Gravelle (2015) notes that if such manipulations of transfer prices cannot be overturned

[41] See OECD (2015e), p. 7.
[42] It is important to note that double taxation is becoming rare nowadays with an increasing number of bilateral and international tax treaties all around the world.
[43] See European Commission (2012), p. 2.
[44] See OECD (2017a).

in court, for example because of a lack of evidence to establish the arm's length price, this kind of behavior can be considered lawful.

Sandmo (2005) argues that the simplistic definition of tax avoidance fails to distinguish between tax avoiding activities of MNEs and an impact taxation has on demand and supply via relative price effects. As an example, a multinational might decide to construct a factory in a low-tax jurisdiction to take advantage of low foreign corporate tax rates. An individual might choose to take a train instead of a flight because of increasing taxes on air travel. Even though these decisions could be classified as tax avoidance, Sandmo (2005) argues that such price effects should be distinguished from the active tax avoiding behavior of multinational enterprises.

2.3.1.4 Tax Evasion

The main distinction between tax evasion and tax avoidance is in the legality of the taxpayer's actions. Sandmo (2005) sees tax evasion as a managerial decision not to fully report taxable corporate profits in order to reduce tax payments. Since tax evasion always involves the concealment of income from tax authorities, Deak (2004) argues that it is often connected with the informal economy and is associated with crimes such as money laundering, tax fraud, or false accounting. According to Gravelle (2015), an example of tax evading behavior could include setting up a secret bank account in a tax haven without reporting the interest income. The line between legal tax avoidance and illegal tax evasion is often very thin. For instance, if it were possible to prove that the transfer prices used by *Starbucks Corp.* in the aforementioned example were too high or too low, the company's behavior could be classified as a form of tax evasion rather than tax avoidance.

2.3.2 Profit Shifting

The OECD defines profit shifting as "an allocation of income and expenses between related corporations or branches of the same legal entity […] in order to reduce the overall tax liability of the group or corporation."[45] Depending on the degree to which a profit shifting activity lies within the boundaries of law, it might be considered a tax evading, tax avoiding, or tax planning behavior. Further analysis does not distinguish between legal and illegal profit shifting

[45] See OECD (2017a).

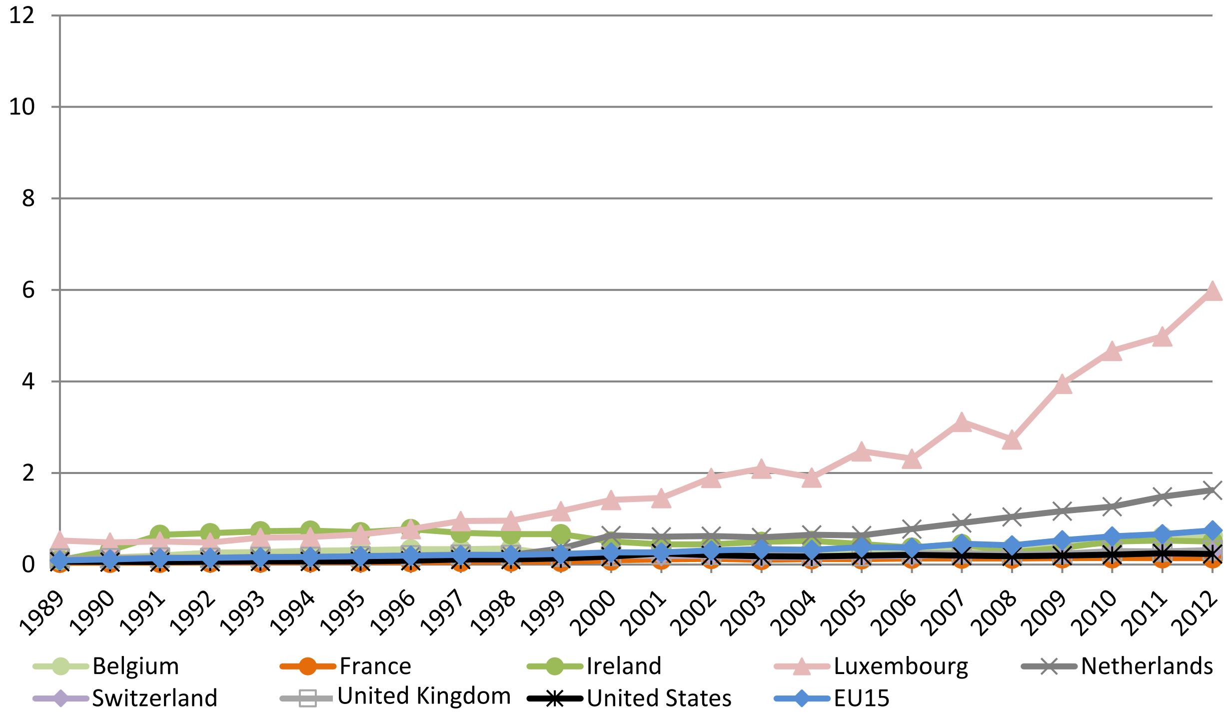
activities; however, this separation is important and should be kept in mind, as explained in section 2.3.1.

In order to establish whether multinational enterprises engage in profit shifting activities, researchers often analyze whether or not firms invest more in low-tax countries in comparison to their high-tax counterparts. Further analysis of whether these investments are proportional to the real business activity which occurs in these countries is also carried out. Feld and Heckemeyer (2011) give a thorough overview of numerous studies that empirically assess the impact of taxation on the location and magnitude of foreign direct investment (FDI). The authors conduct a meta-analysis and find a tax semi-elasticity of FDI to equal 2.5 (in absolute terms), which confirms that high taxation discourages multinationals to invest and expand their business and that a low level of taxation has an opposite effect. By contrast, Heckemeyer and Overesch (2013) conduct a meta-analysis of the literature on profit shifting and find a tax semi-elasticity of reported profits to equal 0.8 (in absolute terms). Comparing these two findings, corporate taxation appears to have a more profound effect on the real investment than on profit shifting of MNEs. Indeed, according to the Eurostat,[46] German and American multinationals have been substantially increasing their FDI in European low-tax countries. For example, the FDI stock of German multinationals in the Netherlands amounted to 18% of their total foreign direct investments in 2012, while the share of German FDI in Luxembourg totaled 9%. In the case of US corporations, the corresponding shares add up to 14% in the Netherlands and 8% in Luxembourg. In order to see whether these investments might have a tax planning rationale, Figures 2.7 and 2.8 show statistics on German and American capital invested abroad per employee, following the approach introduced by Spengel (2003).

According to Figure 2.7, German capital invested in high-tax countries such as France and the US is proportional to the number of employees in these countries. However, in the case of some low-tax countries such as Luxembourg and the Netherlands, the invested capital is much larger than the number of employees who work at the subsidiaries of German multinationals in these countries. This suggests that the capital invested by German multinationals in some low-tax European states might not correspond to their real business activity in these countries. Comparing Figures 2.7 and 2.8, it is apparent that the US has increased its investment in European low-tax countries on an even larger scale than Germany. As indicated by Figure 2.8,

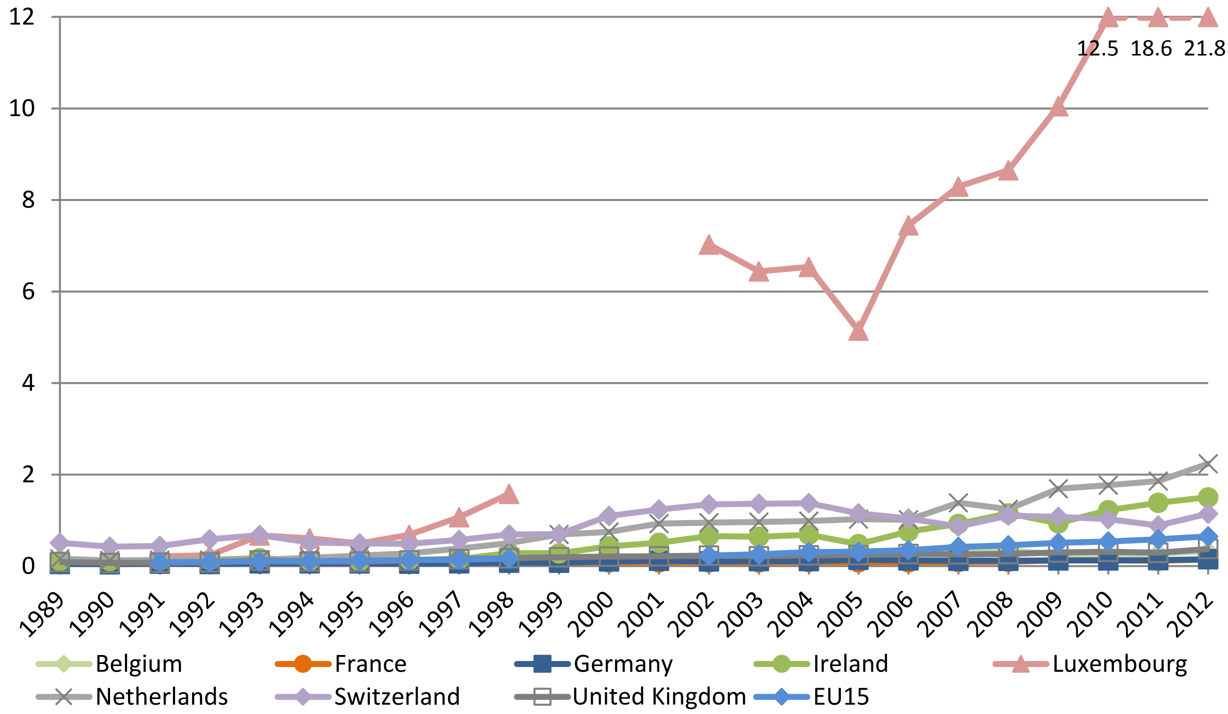
[46] See Eurostat (2017).

Figure 2.7 German Capital Invested Abroad per Employee, 1989-2012, Million EUR



Notes: EU15 denotes an average of the EU15 members except for Germany. Source: Bundesbank, database *Investiertes Kapital aus Deutschland pro im Partnerland Beschäftigtem für Verschiedene Steueroasen*.

Figure 2.8 US Capital Invested Abroad per Employee, 1989-2012, Million EUR

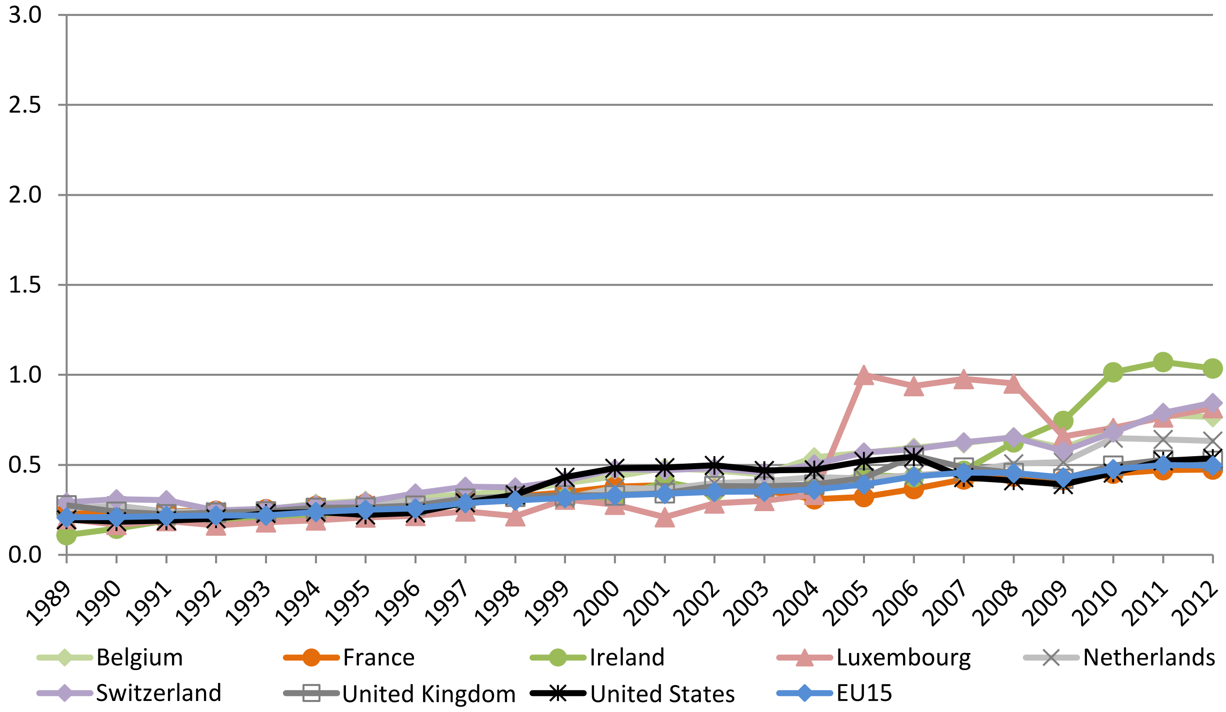


Notes: No data for Luxembourg between 1999 and 2003. EU15 denotes an average of the EU15 members. Source: OECD Stat, database *Outward Activity of Multinationals by Country of Location*.

American capital invested abroad per employee has risen rapidly in Luxembourg since the mid-1990s. The capital invested by American firms in the Netherlands, Ireland, and Switzerland substantially exceeds the number of persons they employ in these countries as well. However, the situation seems to be different in high-tax countries such as France, Germany, and the UK, where US corporations appear to invest as much capital as the number of workers they employ.

In order to track the signs of profit shifting, the lucrativeness of German and US investments in low-tax and high-tax countries could also be compared. Hence, Figures 2.9 and 2.10 display statistics on the turnover per employee of the subsidiaries of German and American multinationals in various countries. Figure 2.9 illustrates that German subsidiaries in Luxembourg, Ireland, and Switzerland have reported an increasing turnover per employee ratio over the past few years. In comparison, the corresponding ratio for German subsidiaries in the US, France, and the EU15 appears to be significantly lower.

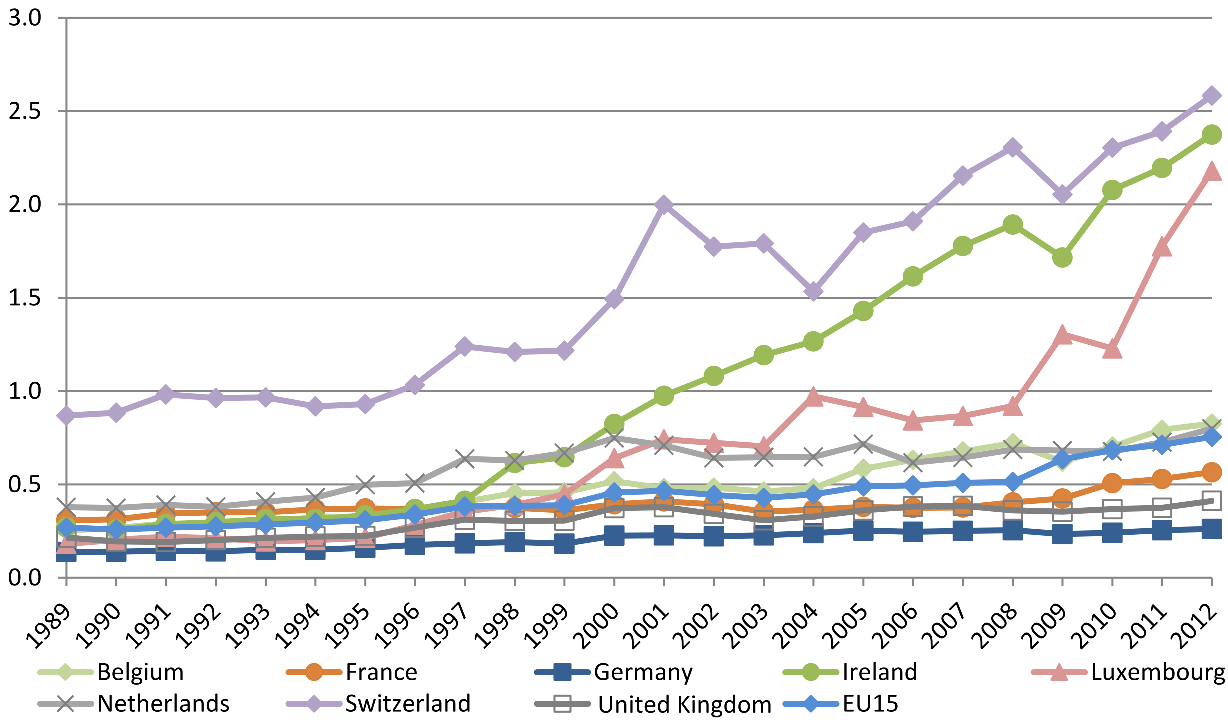
Figure 2.9 Turnover per Employee of the Affiliates of German Multinationals, 1989-2012, Million EUR



Notes: EU15 denotes an average of the EU15 members except for Germany. Source: Bundesbank, database *Investiertes Kapital aus Deutschland pro im Partnerland Beschäftigtem für Verschiedene Steueroasen*.

Figure 2.10 illustrates the ratio of turnover per person employed at the subsidiaries of US multinationals in several European countries. The difference between the development of this ratio in low-tax and high-tax jurisdictions is even more striking than in the case of German MNEs (see Figure 2.9). For instance, in 2012 the subsidiaries of US multinationals in Switzerland, Luxembourg, and Ireland reported three times as much turnover per employee as their counterparts in France, Germany, and the UK. Interestingly, the ratio of turnover per employee by the affiliates of American multinationals also appears to be slightly higher in Belgium and the Netherlands than in France, Germany, and the UK. This is not surprising, since although Belgium and the Netherlands have relatively high corporate income tax rates, they still offer some beneficial tax schemes that may facilitate profit shifting, as described in section 2.3.1.1.

Figure 2.10 Turnover per Employee of the Affiliates of US Multinationals, 1989-2012, Million EUR



Notes: EU15 denotes an average of the EU15 members. Source: OECD Stat, database *Penn World Table 9.0*.

Figures 2.7-2.10 demonstrate that German and American multinationals not only undertake more capital-intensive investments in low-tax countries but also report a higher turnover per employee in these countries than in high-tax jurisdictions. Aside from this, the tendency to invest capital and generate higher returns in low-tax countries seems to be stronger in the case of the US than that of Germany, at least in the low-tax countries under analysis. However, these figures can only point to a correlation between tax rates and foreign activity of multinational companies. In order to argue in favor of or against any causal links, one has to take a look at the findings of the empirical literature.

There are numerous empirical studies that employ accounting data to estimate the impact of corporate taxation on the reported pre-tax profits of affiliates of multinational companies. One of the first analyses in this field are those conducted by Grubert and Mutti (1991) and Hines and Rice (1994), who find that tax rate differentials between foreign subsidiaries of American multinationals and their parents influence reported profits of the subsidiaries. According to the authors, this demonstrates that US parent firms shift their profits to low-tax subsidiaries. Huizinga and Laeven (2008) find evidence which suggests that profit shifting occurs not only between a parent and its subsidiaries but also among subsidiaries. Heckemeyer and Overesch (2013) conduct a meta-analysis of studies in this field of research and provide a consensus estimate of the tax rate elasticity of reported pre-tax profits. The authors argue that a one percentage point increase in an international tax differential that can be used for tax arbitrage leads to a -0.8% fall in the affiliate's reported profits.

A few empirical studies on profit shifting use alternative identification strategies than the approach described above. For example, Egger et al. (2010) and Finke (2013) identify profit shifting behavior by comparing profits and corporate tax payments of multinational and national enterprises. According to their findings, multinational firms pay significantly less taxes than their purely domestic counterparts. Dharmapala and Riedel (2013) use another alternative estimation approach which compares the distribution of a parent's earnings shocks among low-tax and high-tax subsidiaries. The authors argue that once a parent experiences an exogenous income shock, its low-tax group subsidiaries are likely to report more profits, while profits of the high-tax affiliates remain unchanged.

In summary, there is abundant empirical and theoretical literature on profit shifting by multinational enterprises that includes studies based on different data samples, time periods, countries of observation, and identification strategies. Almost all of them identify a negative connection between corporate income taxation and reported profits of the affiliates of multinational firms, which points to the existence of profit shifting by MNEs.

2.3.3 Channels of Profit Shifting

Fuest et al. (2013) argue that profits earned in high-tax countries can be channeled to low-tax group entities via financial and non-financial strategies. The first category includes issuing internal debt, which leads to intra-firm interest payments. The second group comprises trade in goods and services between related parties and the resulting exchange of transfer prices. Furthermore, Dharmapala (2008) and Dharmapala (2014) note that a strategic location of intellectual property plays an important role in profit shifting, especially in the case of IP-intensive firms.[47] This chapter analyzes the key profit shifting channels showing relevant descriptive statistics and reviewing the main findings of the empirical literature.

2.3.3.1 Internal Debt

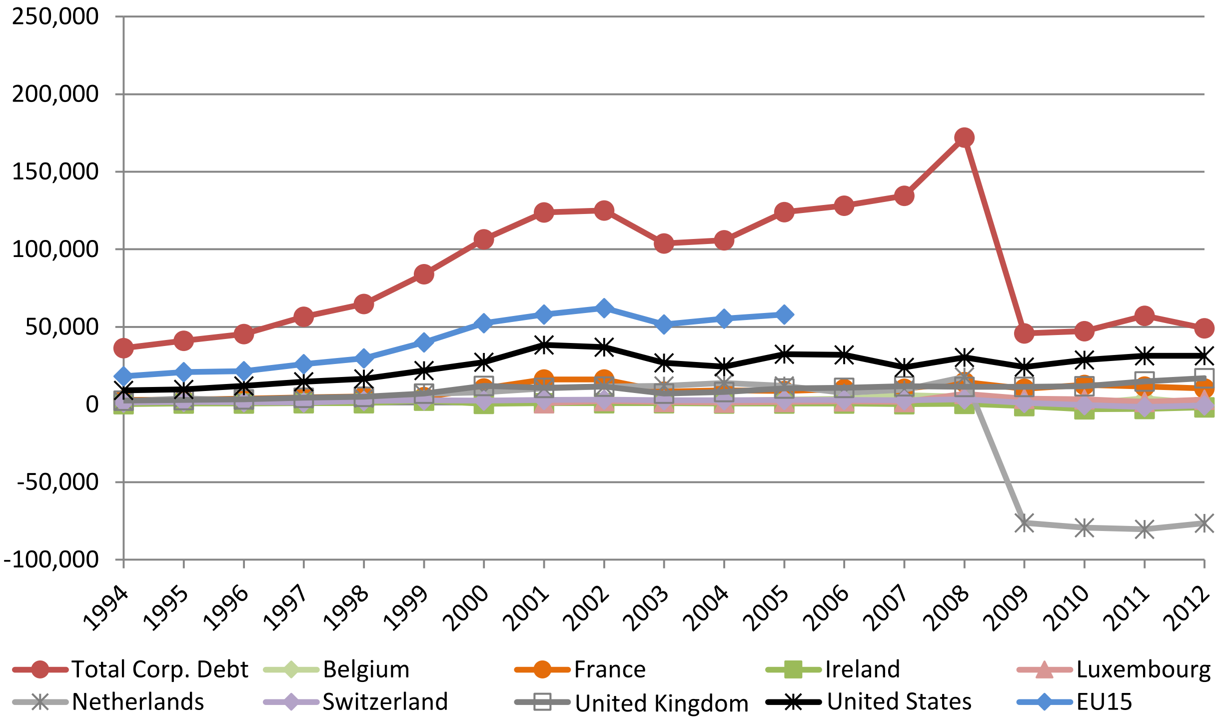
A strategic use of intra-affiliate debt is one of the main profit shifting channels, as Fuest et al. (2013) note. Schreiber (2013) observes that the cost of debt (which is an interest payment) is deductible from a company's profits for tax purposes. By contrast, the cost of equity (which is a dividend payment) is non-deductible in most countries. This asymmetry between the tax treatments of debt and equity financing gives a multinational firm an incentive to finance activities of its high-tax affiliates using debt issued by the low-tax subsidiaries. In addition to manipulating the level of internal debt, a multinational might also strategically adjust intra-firm interest payments that are transferred from a high-tax to a low-tax country to lower its consolidated tax liability.[48]

In order to track a potential use of internal debt as a means of profit shifting, one could look at the methods used by German and US multinationals to finance their foreign direct investments. FDI is usually financed by either retained earnings or debt and the payments typically flow from an investor to an investee; however, it can also be the case that payments flow vice versa. Figure 2.11 presents statistics on the debt financing of German outward foreign direct investments in some high-tax countries such as France and the US and low-tax countries such as members of the Benelux Union, Ireland, and Switzerland. According to Figure 2.11, the overall stock of German net foreign corporate debt decreased by almost three quarters and

[47] In addition, there are several further profit shifting channels, such as tax treaty shopping or hybrid-mismatch arrangements. However, they remain less researched due to the unavailability of data needed for empirical analysis.
[48] However, it should be noted that the interest rate on intra-group loans can be directly compared with the market interest rate, which limits the manipulation of intra-group interest payments.

reached 172 billion EUR in 2008. Interestingly, it remained positive during the whole period of observation in countries such as France, the UK, and the US. However, in low-tax countries such as the Benelux Union, Ireland, and Switzerland it was either equal to zero or even reached negative values in some years. This implies that during this period German enterprises were borrowing either as much or even more from their investees in low-tax countries than what they were lending to them.

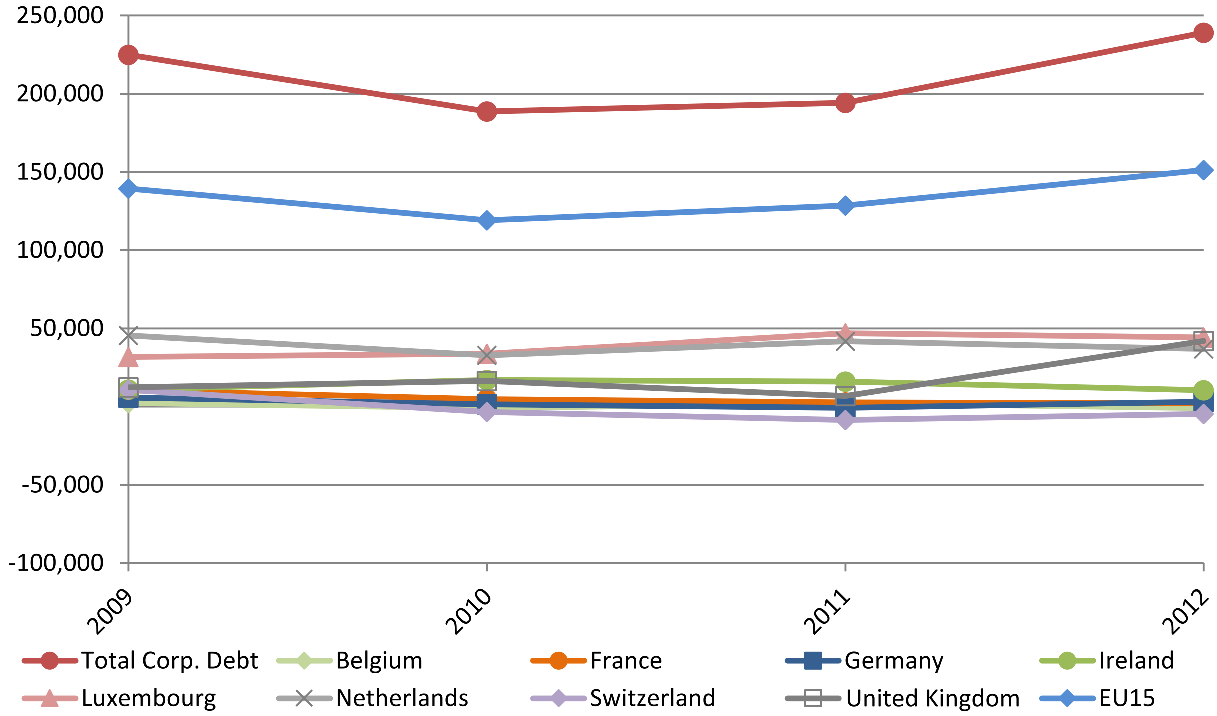
Figure 2.11 German Stock of Net Foreign Corporate Debt, 1994-2012, Million EUR



Notes: No data available for Luxembourg before 2001. This data is based on the FDI statistics, which implies that the debt is given by a German parent to the direct investment enterprise in a foreign country. EU15 denotes an average of the EU15 members except for Germany. Source: Eurostat, database *EU Direct Investment Positions, Breakdown by Country and Economic Activity [bop_fdi_pos]*.

Figure 2.12 presents statistics on the recent development of the US stock of net foreign corporate debt in high-tax countries such as France and Germany along with low-tax countries such as members of the Benelux Union, Ireland, and Switzerland. Even though Figure 2.12 only covers the period between 2009 and 2012, it is evident that US companies appear to be less indebted in low-tax countries than in their German counterparts (see Figure 2.11). However, the share of US foreign corporate debt in Switzerland is negative, which implies that American enterprises acquire more loans from Swiss companies than vice versa. To summarize, Figures 2.11 and 2.12 show that German and American multinationals are more indebted with respect to their low-tax affiliates than the high-tax ones, which supports the findings of the empirical literature on this topic.

Figure 2.12 US Stock of Net Foreign Corporate Debt, 2009-2012, Million EUR



Notes: No data available before 2009. This data is based on the FDI statistics, which implies that the debt is given by a US parent to the direct investment enterprise in a foreign country. EU15 denotes an average of the EU15 members. Source: Bureau of Economic Analysis, database *U.S. Direct Investment Position Abroad on a Historical-Cost Basis by Account for Selected Countries*.

A large body of empirical literature analyzes the strategic use of intra-affiliate debt for profit shifting. These authors usually regress the affiliates' intra-firm interest payments or internal debt holdings on the statutory corporate tax rate or the tax differential with respect to other group members. For example, Desai et al. (2004) use this approach to analyze the capital structures of foreign affiliates of US multinational corporations. They find that higher local tax rates lead to higher debt-to-assets ratios of affiliates of multinational firms, with internal borrowing (as opposed to external borrowing) being particularly sensitive to taxes. Mintz and Weichenrieder (2005) confirm these findings using a sample of German MNEs. The authors argue that, in comparison to other companies, the leverage of wholly owned subsidiaries of multinational firms is more sensitive to changes in tax rate differentials and less sensitive to macroeconomic effects, such as changing interest rates. The findings of studies in this field of research point to a tax semi-elasticity of debt that ranges between 0.2 and 1.7 (see as examples:

Huizinga et al. (2008), Buettner and Wamser (2013), Overesch and Wamser (2014)). These results suggest that a one percentage point increase in a local statutory tax rate leads to an increase of 0.2% to 1.7% in an affiliate's internal debt. Feld et al. (2013) conduct a meta-analysis of the empirical literature on the use of debt as a means of profit shifting and argue that the affiliate's debt-to-assets ratio rises by 0.3 percentage points if its host country's marginal tax rate increases by one percentage point.

2.3.3.2 Intra-Firm Trade

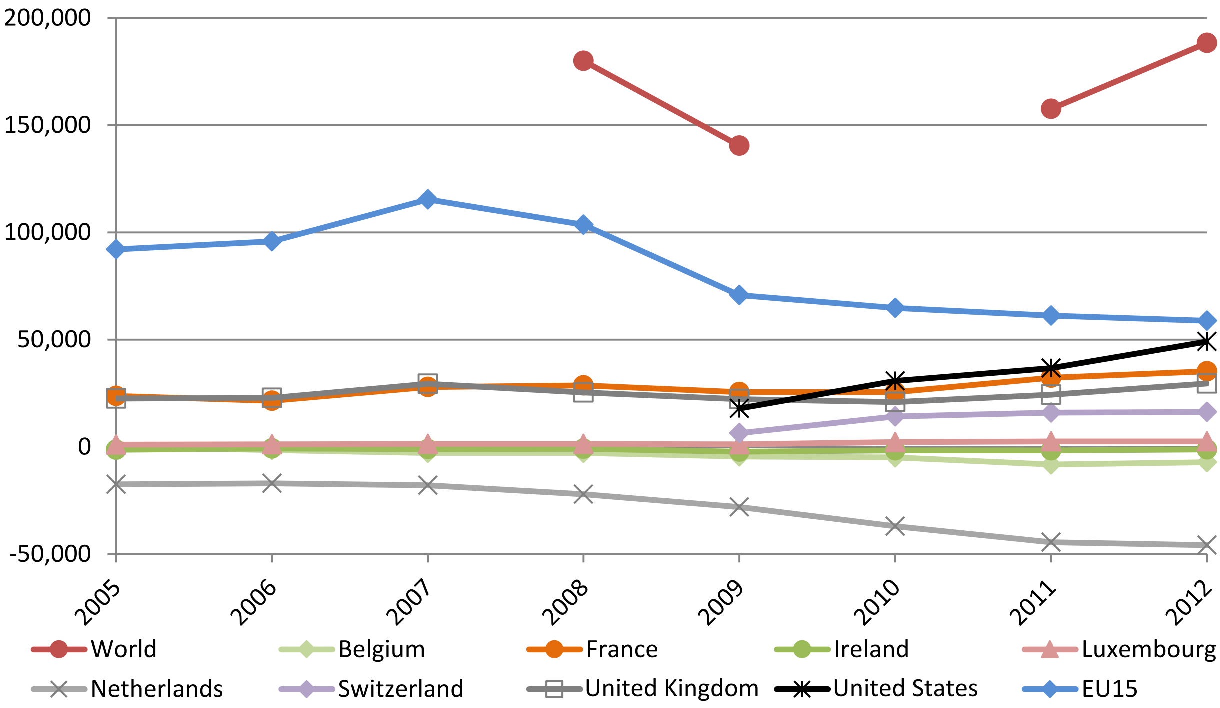
Hines (1997) claims that business operations of multinational enterprises typically entail numerous transactions between affiliates located in different countries. The prices attached to these transactions are known as transfer prices. According to the OECD, transfer prices used in intra-firm trade should be at arm's length or, in other words, they should correspond to the prices that would have been used in the transactions with third parties.[49] However, Miller and Oats (2014) argue that firm-specific transfers often lack comparable transactions in the market and therefore multinationals have a considerable leeway in establishing their transfer prices. According to the authors, this makes intra-firm trade the main non-financial instrument used by multinationals to shift profits. Hence, an MNE might set higher prices for goods and services transmitted from a low-tax subsidiary to a high-tax one. As a result, the tax base of a low-tax subsidiary would increase and the tax base of the high-tax affiliate would decrease. This would eventually diminish an overall tax liability of the group. The same reasoning applies to setting prices at too low of a level when goods and services are provided by a high-tax affiliate to the low-tax one. In addition to manipulating transfer prices, a multinational might strategically adjust trade volumes by artificially increasing exports from its low-tax affiliates to high-tax group members and decreasing the intra-firm trade in the opposite direction.

In order to see whether multinational enterprises trade differently with their low-tax partners than with their high-tax ones, Figures 2.13 and 2.14 present statistics on the balance of trade (exports minus imports) of German and American enterprises with companies in several European countries. In the case of Germany, the statistics on total trade between corporations

[49] For more information on the arm's length principle see the OECD (2010).

are shown, whereas in the case of the US, the data on total intra-firm trade is used.[50] Figure 2.13 presents the balance of trade between German enterprises and companies located in low-tax countries such as the Benelux Union, Ireland, and Switzerland as well as high-tax countries such as France, the UK, and the US.

Figure 2.13 Balance of Trade of German Enterprises with Other Countries, 2005-2012, Million EUR



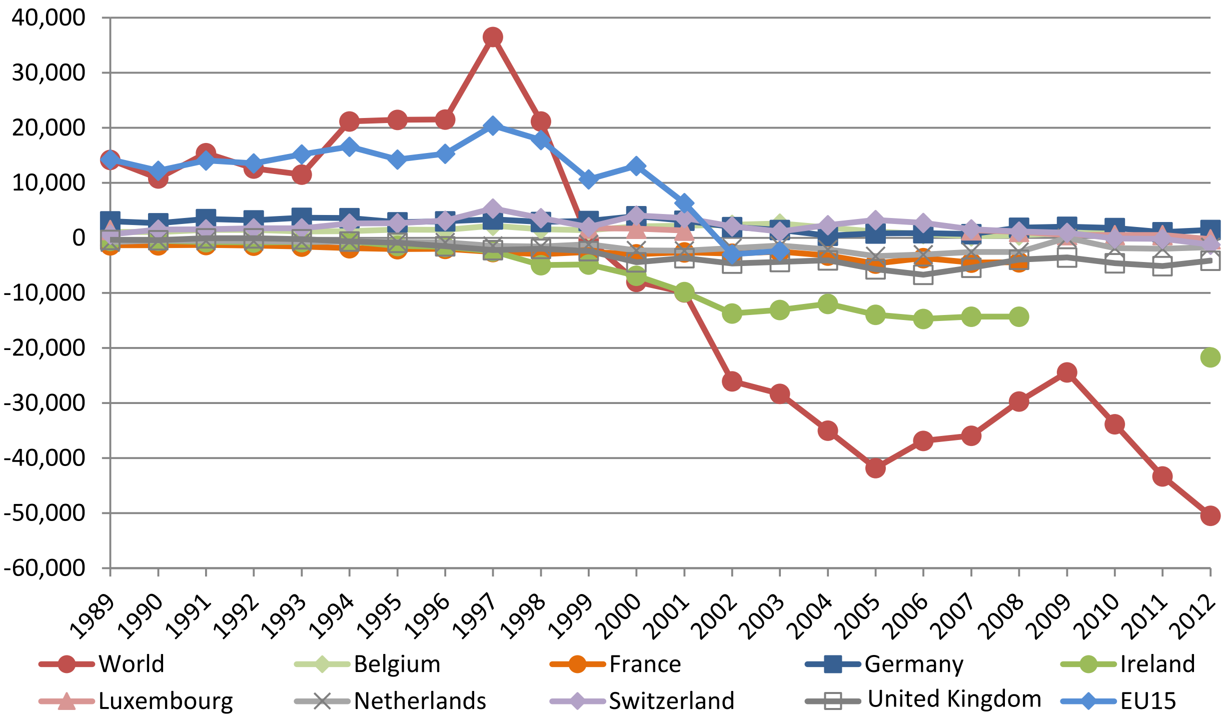
Notes: Data for Switzerland and the US is available only from 2009 onwards. EU15 denotes an average of the EU15 members except for Germany. Sources: OECD Stat, database *TEC by Partner Zone and Country* and *Penn World Table 9.0.*

According to Figure 2.13, German firms had a negative balance of trade with Dutch companies in 2012 and the years prior to this, which implies that German enterprises imported more from the Netherlands than what they exported to there during this period of time. Furthermore, German balance of trade with the US and France appears to be higher than its counterpart with Switzerland or Luxembourg. Hence, German companies seem to have a lower balance of trade (and therefore larger amounts of imported goods and services) with low-tax countries than with the high-tax countries under analysis.

[50] This implies that the US data shows trade only between affiliated companies, whereas the German statistics do not distinguish between trade with affiliated and non-affiliated firms. The difference in the data type is due to the data availability constraint.

Figure 2.14 presents statistics on the balance of trade of American multinationals. It shows not just the balance of trade between enterprises but rather the balance of intra-firm trade, which is defined as trade between related companies. As evident from the figure, the total balance of US intra-firm trade has been declining in the last couple of years, which means that American enterprises have imported more from their foreign affiliates than what they have exported to them. As an example, the US balance of intra-firm trade with Ireland reached its record low of -21,716 million EUR in 2012, which means that the US-based companies imported more goods and services from their Irish affiliates than what was exported to them.

Figure 2.14 Balance of Intra-Firm Trade of US Enterprises with Other Countries, 1989-2012, Million EUR



Notes: Data is not available for Ireland in 2009-2011 and France in 2009-2012. EU15 denotes an average of the EU15 members. Sources: OECD Stat, database *Outward Activity of Multinationals by Country of Location* and *Penn World Table 9.0*.

Figures 2.13 and 2.14 depict a certain correlation between taxation and the balance of trade of German and American corporations with foreign firms. However, in order to investigate a potential causal link, the findings of the empirical literature must be analyzed. Empirical studies on a strategic use intra-firm trade as a means of profit shifting compare the impact of corporate taxation on the prices and volumes of related-party and third-party trade (see as examples: Lall (1973), Clausing (2003), Bernard et al. (2006), Davies et al. (2017), and Flaaen (2017)).

According to the findings of this literature, a one percentage point increase in the corporate tax rate leads to a decrease between -0.5% and -1.9% in intra-firm transfer prices. Davies et al. (2017) use detailed data on French firms to investigate the role of intra-firm trade in profit shifting and confirm these results. Furthermore, the authors argue that the negative effect of taxation on transfer prices is mostly due to the profit shifting behavior of large multinational enterprises that have affiliates in tax havens and is probably not caused by medium and small enterprises that have subsidiaries in non-tax havens only.

Moreover, there are studies that attempt to draw a comparison of the two major profit shifting instruments – internal debt and intra-firm trade – and to establish their significance for multinational firms. The interest rate on intra-group loans can be directly compared with the market interest rate, which limits profit shifting by means of internal debt. At the same time, Overesch and Schreiber (2010) observe that there is a large degree of discretion in setting transfer prices on group-specific transactions. Hence, there are good reasons to believe that transfer pricing (especially with respect to licensing of intangible assets, which is discussed in the next section) represents the predominant route used by multinationals to shift profits. The empirical evidence on this issue comes from several individual studies and one meta-analysis. For example, the results of Dharmapala and Riedel (2013) find a larger magnitude of shifting via debt financing[51] in comparison to shifting via transfer pricing. By contrast, the empirical estimation conducted by Grubert (2003) points to approximately equal shares of the two shifting channels. Heckemeyer and Overesch (2013) carry out a meta-analysis of the existing empirical studies on profit shifting and compare the relative importance of different shifting channels. The authors come to the conclusion that multinationals use for profit shifting intra-firm trade to a greater extent than intra-firm debt. Heckemeyer and Overesch (2013) suggest that transfer pricing accounts for around 70% of overall profit shifting activities, while intra-firm debt accounts for approximately 30%.

[51] However, it is important to note that their estimation strategy does not allow for a distinction between the use of internal and external debt for profit shifting.

2.3.4 The Role of Intangible Assets in Profit Shifting

2.3.4.1 Intangible Assets: Definition and Attributes

The European Commission defines an intangible asset as "[…] an identifiable non-monetary asset without physical substance."[52] The examples of intangible assets include brand names, publishing titles, trademarks, patents, customer lists, recipes, formulae, models, designs, prototypes, copyrights, know-how, and other non-physical assets. Intangibles may result from a research and development process, which is defined by the OECD as "[…] creative work undertaken on a systematic basis in order to increase the stock of knowledge […] and the use of this stock of knowledge to devise new applications."[53] In addition, intangibles might arise from a firm's marketing or operating activities as well as from its work in the literary or artistic fields. Since the creation of intangible assets usually triggers substantial costs, owners of the resulting intellectual property protect their assets with intellectual property rights. These rights grant the owners either temporary or a permanent permission to control and manage the use of their intangible assets.

Numerous empirical and theoretical papers have studied the importance of intangible assets for a firm's financial performance, productivity, and competitiveness. In addition, various authors have tried to estimate social returns from IP, arguing that intangibles play an important role not only for their owners but also for other market agents, such as competitors and customers. For example, Hall et al. (2010) give a detailed overview of the literature on private and social returns from research and development. According to the authors, most studies in this field empirically estimate the Cobb-Douglas production function of a firm augmented with knowledge capital, which represents intangible assets resulting from R&D. Hall et al. (2010) conclude that the private returns of developing and using knowledge capital are between 20% and 30%. In addition, the authors argue in favor of even higher social returns, which however appear to be more variable and are measured imprecisely in many studies. Moreover, Aw et al. (2011) find that a firm's innovative activity contributes directly to its productivity. According to the authors, R&D investment raises future productivity by 4.8% when undertaken alone and by 5.6% when combined with a growing participation in export markets. Furthermore, Crass and Peters (2014) conduct an empirical analysis using panel data on German companies. Their

[52] See EU Commission (2011a), p. 3.
[53] See OECD (2002), p. 30.

conclusion indicates that both R&D-related IP and intangible assets resulted from branding and marketing activities increase a firm's performance.

Intangible assets are not only crucial for boosting a firm's productivity and financial performance, but they may also be used by multinational enterprises for profit shifting. This is due to the high mobility and uniqueness of intangible assets. Fuest et al. (2013) argue that intangibles are highly mobile within a multinational firm, especially in comparison to human capital and physical assets. This implies that an intangible can be relatively easily relocated from a high-tax affiliate, which developed it, to a low-tax group member, which receives royalties afterwards. Endres and Spengel (2015) summarize a few techniques that MNEs may use to strategically locate and relocate their intangibles. For instance, a multinational might implement a contract R&D project, under which one affiliate conducts research and development while another one agrees to bear the financial risks and consequently becomes the owner of the resulting IP. A cost sharing agreement would lead to equivalent outcomes. Alternatively, an affiliate in a high-tax country might develop and subsequently sell an intangible asset to a low-tax group member. Nevertheless, this step could potentially not only trigger a high selling price but an exit tax as well. Finally, an MNE might decide to carry out its real R&D activity at an affiliate in a low-tax country.

Furthermore, the owner of an intangible asset is entitled to receive royalties from companies that use its IP. According to the international tax regulations, royalty fees have to be at arm's length, which is similar to the transfer prices set in intra-firm trade, as described in section 2.3.3.2. However, the true price for the use of intangibles is often hard to determine. Bartelsman and Beetsma (2003) argue that there often exists no comparable third-party market if one affiliate develops or produces IP-intensive intermediate goods and other group members use them afterwards. Dischinger and Riedel (2011) suggest that this triggers a concern that multinationals may shift profits earned in high-tax countries to the intangible-holding low-tax affiliates by overstating the arm's length royalties.

To summarize, intangible assets not only play an important role in boosting a firm's productivity and profitability but also combine a few attributes that make them exceptionally suitable for profit shifting. Thus, a multinational may either strategically allocate its IP among affiliates or set intra-firm royalties above or below the true price in order to minimize its consolidated tax liability. The next section looks for descriptive and empirical evidence on the role of intellectual property in tax minimizing strategies of multinational enterprises.

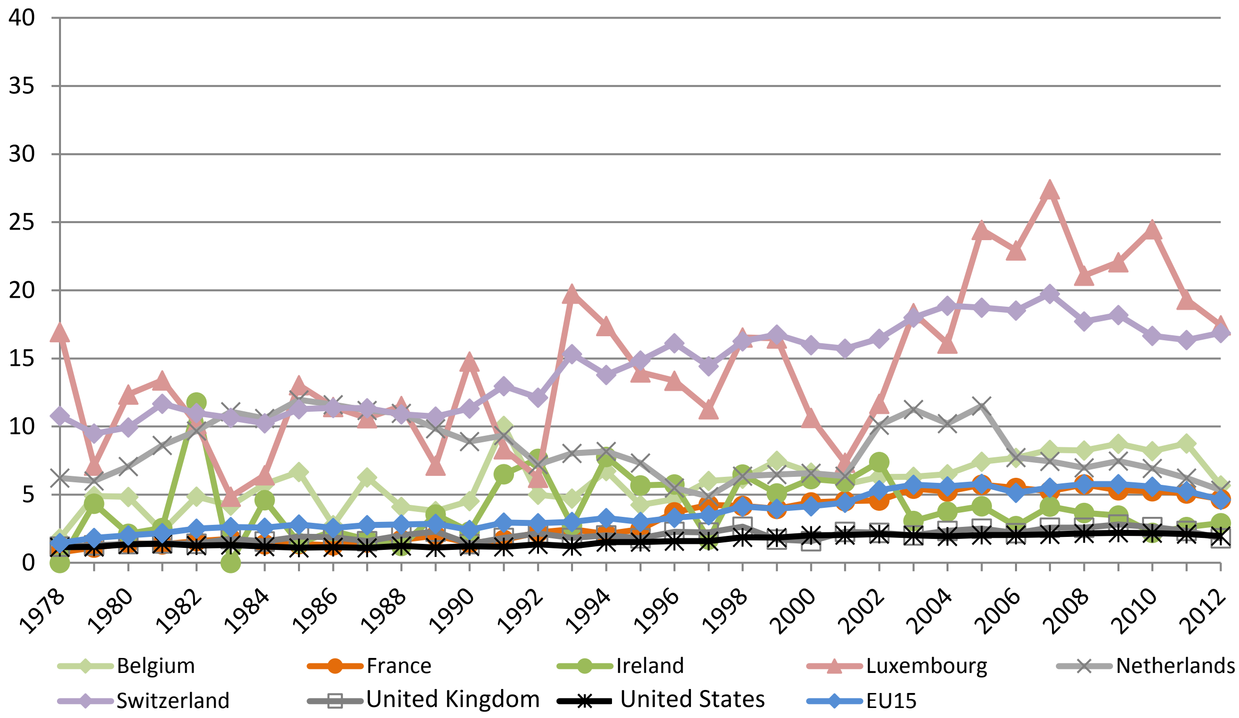
2.3.4.2 Intangible Assets and Profit Shifting

There is plenty of anecdotal evidence on the use of intangible assets for profit shifting. For example, *Microsoft Corporation* has been accused of strategically relocating a considerable part of its patents to Ireland.[54] According to the media, *Microsoft Corporation* has established an Irish subsidiary *Round Island One Ltd.* to channel its profits from intellectual property and other assets to tax havens. The subsidiary remained almost unknown to the public but quickly became one of the biggest companies in Ireland with gross profits of around nine billion EUR in 2004. Similarly, the world's largest spirits producer *Diageo plc* has been blamed for a tax-motivated relocation of its famous trademarks, such as *Johnnie Walker Scotch*, *J&B Rare*, *Gilbey's Gin* – brands worth hundreds of millions of euros.[55] *Diageo plc* has allegedly received a generous tax relief from the Dutch tax authorities on income generated by the firm's intangible assets, which allowed the company to stack up profits from its famous trademarks virtually tax-free.

As described in the previous section, the unique attributes of intangible assets allow multinationals to use them for profit shifting in at least two ways. First, multinationals may strategically locate or relocate intangible assets to low-tax affiliates and therefore change the direction of royalty payments. This can be done through either a contract R&D project or a sale of an intangible from one affiliate to another, even though the latter strategy might trigger not only a high selling price but an exit tax as well. Secondly, MNEs may overstate or understate the level of intra-firm royalties and therefore alter the amount of royalty payments. In order to establish the magnitude of strategical location or relocation of intangible assets, Figures 2.15 and 2.16 present descriptive statistics on the international co-operation in patents. For example, Figure 2.15 shows data on foreign countries, in which companies register intangible assets originally developed in Germany. This figure identifies that almost 20% of all patents registered in Luxembourg and Switzerland in 2012 had been invented in Germany. Furthermore, patents invented in Germany correspond to more than 5% of all patents held in the Netherlands and in

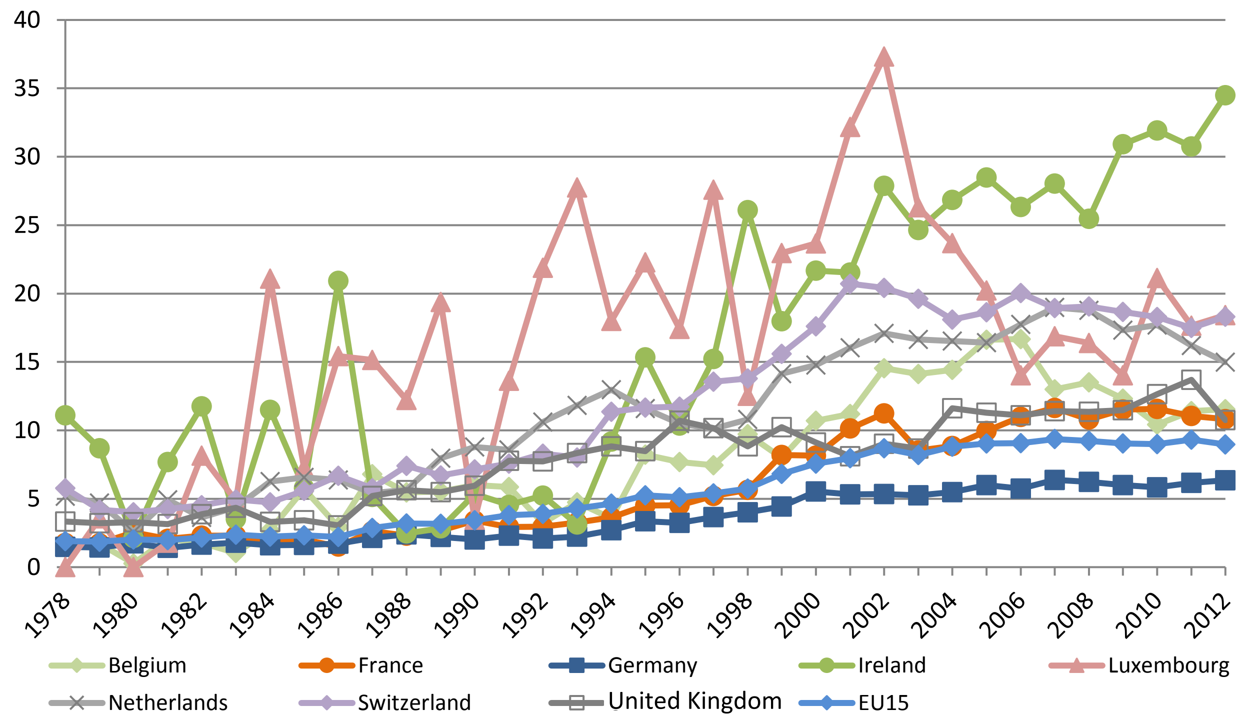
[54] See Simpson (2005) for more information on the alleged profit shifting strategies of *Microsoft Corporation.*
[55] See The Guardian (2009a).

Figure 2.15 Share of Domestic Patents Invented in Germany, 1978-2012, %



Notes: EU15 denotes an average of the EU15 members except for Germany. Source: OECD Stat, database *International Co-Operation in Patents*.

Figure 2.16 Share of Domestic Patents Invented in the United States, 1978-2012, %



Notes: EU15 denotes an average of the EU15 members. Source: OECD Stat, database *International Co-Operation in Patents.*

Belgium. At the same time, the share of German inventions in the composition of total patent registrations is under 2% in the US and the UK.

Figure 2.16 presents comparable statistics for the United States. According to this figure, in 2012 around 35% of all patents held in Ireland had been invented in the US and notably the share of American patents registered in Ireland has been steadily increasing since the 1990s and continues to grow. Furthermore, more than 15% of all patents registered in Switzerland, Luxembourg, and the Netherlands have been created in the United States, whereas the share of American inventions in the total number of patents is substantially smaller in high-tax Germany or France and is rather low in other members of the EU15.

The anecdotal evidence along with descriptive statistics presented in Figures 2.15 and 2.16 point to a correlation between taxation and the location of intangible assets. In order to see the statistical significance of this issue, the evidence from the empirical studies has to be analyzed. Huizinga et al. (2008) and Dischinger and Riedel (2011) employ firm-level accounting data and investigate IP intensity of multinational enterprises in different countries. The authors find that low-tax affiliates of MNEs tend to have a higher intangibles-to-total-assets ratio than their high-tax counterparts. To quantify these results, Dischinger and Riedel (2011) conclude that on average a one percentage point decrease in the average tax differential between the given subsidiary and other group affiliates raises its IP investment by around 1.7%. The authors argue that this result is observed even after controlling for a subsidiary's size and after taking into account a dynamic investment pattern.

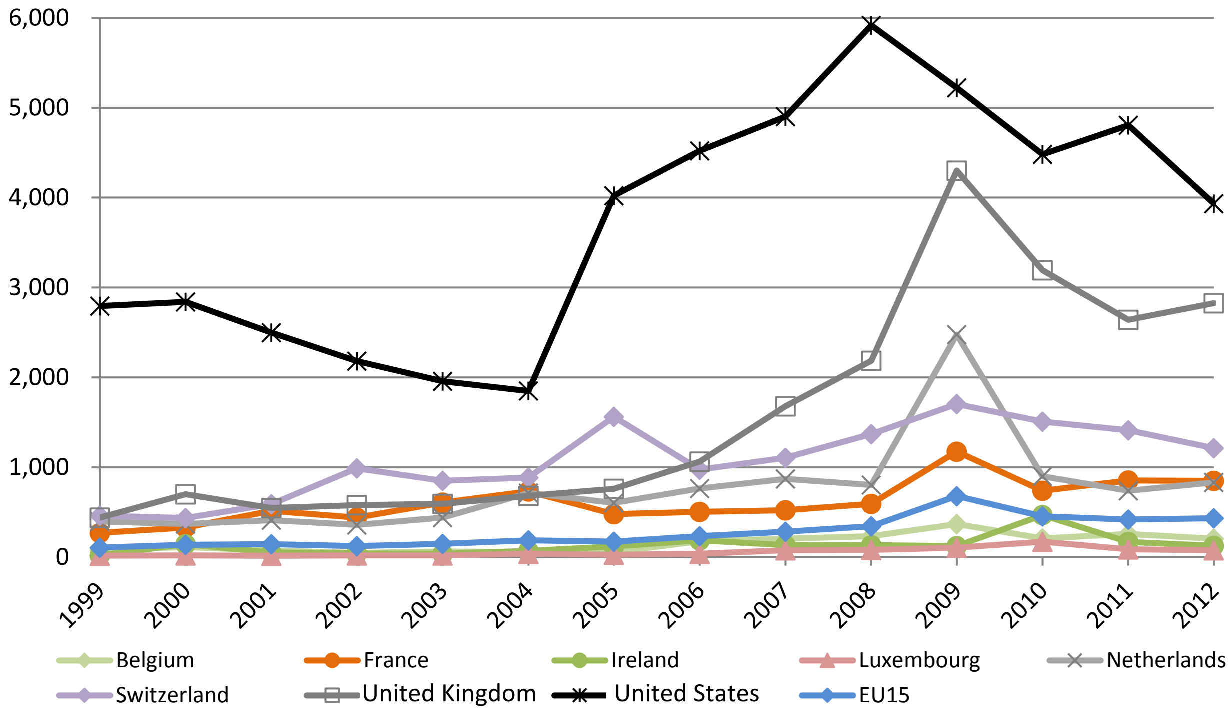
Ernst and Spengel (2011), Karkinsky and Riedel (2012), Griffith et al. (2014), Alstadsæter et al. (2015), Böhm et al. (2015), Dinkel and Schanz (2015), and Bradley et al. (2015) investigate the association between corporate taxation and the location of intangible assets using an identification strategy that differs from Huizinga et al. (2008) and Dischinger and Riedel (2011). They employ data on patent applications at international patent registration offices. This data contains information about the patents' legal owners that apply for an international protection of their inventions. According to these studies, there is a negative association between a statutory corporate tax rate and the ownership of patents at MNE affiliates. For example, Griffith et al. (2014) argue that increasing a statutory corporate tax rate by one percentage point leads to a drop in patent applications in the given country by between -0.5% and -3.9%. In addition, Ernst et al. (2014) argue that the quality of patents also plays an important role in the determination of their location. According to the authors, intellectual property of high quality and value is more sensitive to changes in taxation than other intangible assets. Dudar and Voget (2016) compare the sensitivity of location choices for patents and trademarks. The authors replicate the results obtained by Griffith et al. (2014) for patents and conduct a corresponding estimation for trademarks. They find that trademarks are almost twice as elastic to changes in taxation as patents. Dudar and Voget (2016) explain this result by a more mobile nature of trademarks compared to patents and point to a need for adjusting anti-avoidance legislation in accordance with the individual characteristics of various types of intangible assets.

Another approach to analyzing the use of intangible assets as a means of profit shifting is to look at the international flows of royalty payments, which are fees paid for the use of IP. As explained above, multinationals have an incentive to overstate royalty payments flowing from high-tax to low-tax affiliates in order to shift profits to group members in low-tax countries and consequently minimize their overall tax liabilities. In addition to this, the data on royalty payments reflects information about the strategic location or relocation of intangible assets within corporate groups, since the more intangibles an affiliate owns (and the higher their quality is), the greater amount of royalty payments it receives. Figure 2.17 shows the development of royalty outflows from Germany to other European countries and the US during the past few years. According to this figure, the greatest shares of royalty payments flow from Germany to the US and the UK. However, it is worth noting that royalties transferred to Switzerland and the Netherlands are also above the EU15-average.

Figure 2.18 shows royalty outflows from the US to some low-tax and high-tax European countries. The development of these payments is even more striking than the statistics on German royalty outflows presented in Figure 2.17. For example, Figure 2.18 shows that in 2012 a greater share of royalties was flowing from the US to Switzerland than to France or Germany. The amount of royalty flows to Ireland also exceeds the EU15-average and seems to have been growing rapidly over the last few years.

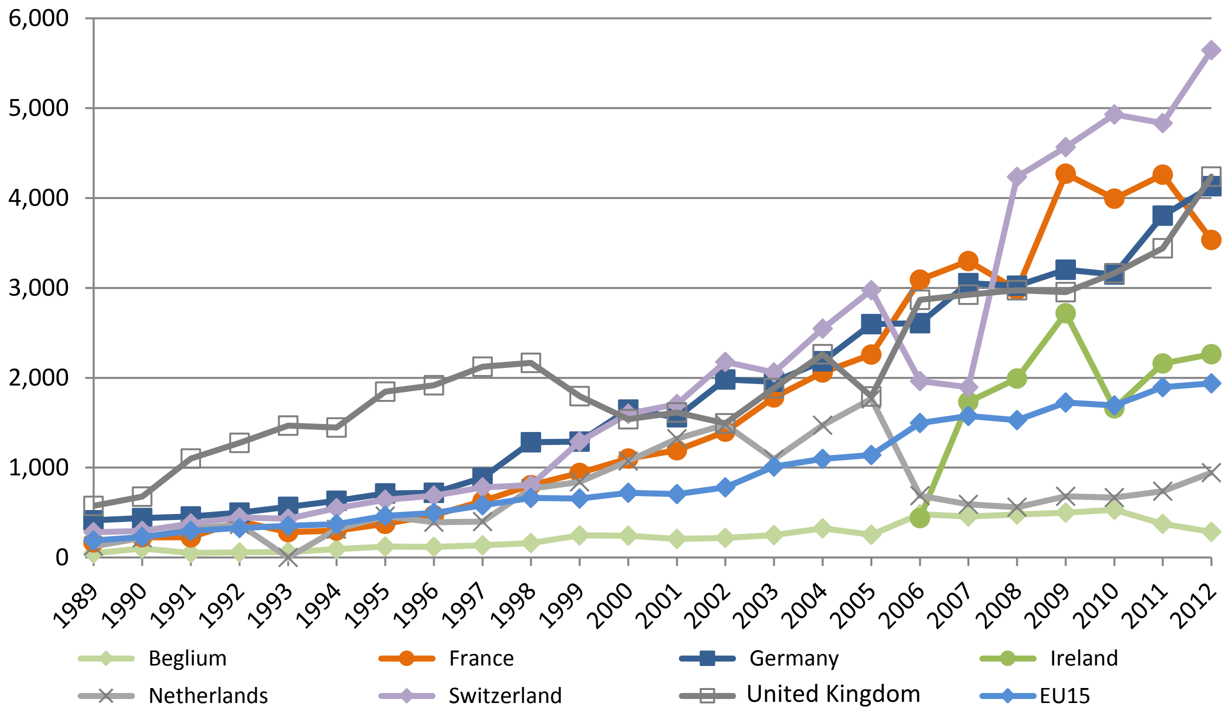
According to Figures 2.17 and 2.18, there is a negative association between statutory corporate tax rates and the direction and amount of German and US royalty payments. There are also several empirical studies that investigate a causal link between corporate taxation and bilateral royalty flows. For instance, Hines (1995), Collins and Shackelford (1998), and Dudar et al.

Figure 2.17 German Outflows of Royalty Payments, 1999-2012, Million EUR



Notes: EU15 denotes an average of the EU15 members except for Germany. Source: OECD Stat, database *EBOPS 2002 – Trade in Services by Partner Country*.

Figure 2.18 US Outflows of Royalty Payments, 1989-2012, Million EUR



Notes: No data for Luxembourg. No data for Ireland before 2006. EU15 denotes an average of the EU15 members. Source: OECD Stat, database *EBOPS 2002 – Trade in Services by Partner Country*.

(2015) analyze the impact of corporate taxation on bilateral international royalty flows. Hines (1995) uses data on royalties transferred from the affiliates of US multinationals to their parents. The author concentrates on estimating the impact of taxation on royalty intensity, which he defines as a ratio of royalty outflows in relation to the total sales of a paying affiliate. According to Hines (1995), a 10% reduction in the withholding tax rate on royalties stimulates additional royalty payments which equal 0.1% of sales. Dudar et al. (2015) conduct a similar type of analysis estimating bilateral royalty payments that flow between 3,660 country-pairs during the period between 1990 and 2012. In line with Hines (1995), the authors find evidence for a negative influence of taxation on the direction and amount of royalty flows. Dudar et al. (2015) also argue that an enforcement of strict anti-avoidance rules is likely to reduce an international exchange of royalty payments.

In addition to the literature on IP location choices and bilateral royalty payments, there are also studies that investigate the overall profitability of IP-intensive firms in low-tax and high-tax countries. For example, Grubert (2003) uses the 1996 Treasury files to gather accounting information on the parents of US multinational corporations and their manufacturing subsidiaries. In the first part of his analysis, the author evaluates the association between taxation and a firm's profitability taking into account the presence of intangible assets at each company. Grubert (2003) finds that IP-intensive affiliates in low-tax countries report significantly more profits than other group members. In the second part of his analysis, Grubert (2003) examines the data on intercompany transactions and argues that IP-intensive subsidiaries engage in a greater volume of related-party transactions than other affiliates. According to the author, a greater number of transactions gives these firms more opportunities to shift profits. Desai et al. (2006) employ panel data on American multinationals from 1982 to 1999 to identify the types of companies that are active in tax havens. The authors find that the IP-intensive US multinationals are most likely to invest in tax havens. Desai et al. (2006) argue that tax haven operations facilitate tax avoidance of IP-intensive companies not only by allowing them to shift taxable income out of high-tax jurisdictions but also by reducing the burden of home country taxation on foreign income.

In summary, a large body of empirical literature investigates the role of intellectual property in profit shifting. These studies apply various identification strategies analyzing either the location choices for IP, flows of royalty payments, or attributes and activities of IP-intensive firms. They come to the conclusion that multinational enterprises use intangible assets as an important instrument of profit shifting.

2.4 Reforming the International Tax System

The previous section presented an overview of the empirical literature and analyzed descriptive statistics that point to profit shifting behavior of multinational firms. It concluded that a strategic use of intra-firm trade and internal debt constitute two major channels of profit shifting. Furthermore, it was argued that intellectual property plays an increasingly important role in profit shifting as well, because intangible assets are highly mobile and their true value is often difficult to determine. Over the past few years, these issues have gained importance in the tax policy agenda of individual countries and international organizations. Policy makers call for closer international co-operation in reforming tax laws and regulations in order to eliminate profit shifting and other inefficiencies of the current tax system. While some of these reform proposals aim to fix loopholes in the existing system, others discuss fundamental changes of the established principles and rules. This section summarizes the major reform suggestions which aim to eliminate profit shifting and analyzes them with the help of the related empirical and theoretical literature.

2.4.1 Fixing the Existing System

In recent years, both the OECD and the European Union have developed international-level initiatives to combat profit shifting. The OECD Action Plan on base erosion and profit shifting (2013)[56] aims to prevent double non-taxation and low taxation that result from income shifting. The focus of this plan is on strengthening the existing regulations and creating new ones to ensure that profits associated with the use and transfer of tangible and intangible assets are allocated in accordance with the value creation and not apart from it. The European Commission presented its Anti-Tax Avoidance Package in 2016[57] as a response to the OECD Action Plan on BEPS as well as to the demands from the European Parliament, several member states of the EU, and the general public that required a stronger EU-wide handling of corporate tax abuse. In line with the OECD Action Plan on BEPS, the Anti-Tax Avoidance Package aims

[56] See OECD (2013a).
[57] See COM (2016a).

to prevent aggressive tax planning, increase transparency, and create a fairer environment for businesses that reside within the European Union. It includes four documents such as an Anti-Tax Avoidance Directive,[58] a Communication on an External Strategy for Effective Taxation,[59] an amendment to the Directive on country-by-country reporting,[60] and a recommendation on tax treaties.[61]

While the BEPS initiative comprises fifteen Actions, this part of the study concentrates only on those which are most relevant for profit shifting channels and mechanisms discussed in the previous section. In addition, this section discusses the relevant suggestions of the Anti-Tax Avoidance Package, focusing on measures included in the Anti-Tax Avoidance Directive, which coincides with the Action Plan on BEPS in several aspects.

2.4.1.1 Strengthening Anti-Avoidance Legislation

One of the key suggestions of the OECD Action Plan and the EU Anti-Tax Avoidance Directive involves strengthening the anti-avoidance legislation, which includes thin capitalization or earnings stripping regulations, transfer pricing rules, and other regulations. In some countries, anti-avoidance legislation is non-existent or not fully effective because of its insufficient enforcement. Action 4[62] of the OECD Action Plan on BEPS addresses income shifting via an excessive related-party debt financing. The OECD (2015c) recommends an implementation of interest barriers that limit the deductibility of net interest and economically equivalent payments at the level of a debt-financed firm. According to the OECD (2015c), interest payments should only be tax deductible to the extent of a fixed ratio of earnings before interests, taxes, depreciation, and amortization (EBITDA) (a country should be able to choose a ratio ranging from 10% to 30% of EBITDA). Moreover, the Action Plan argues in favor of an opportunity to carry forward unexploited expenses and/or interest capacity. The EU Anti-Tax Avoidance Directive also addresses the issue of interest deduction limitation, with the aim of discouraging artificial debt arrangements designed to minimize tax liability. In line with the OECD Action Plan, the rule suggested by the European Commission limits the amount of interest that a taxpayer is entitled to deduct in a tax year. However, the Commission suggests limiting the

58 See COM (2016d).
59 See COM (2016b).
60 See COM (2016c).
61 See COM (2016e).
62 See OECD (2015c).

deductibility of interest expenses based on a taxpayer's gross operating profit instead of the EBITDA.

Furthermore, Actions 8-10[63] of the OECD Action Plan comprise a comprehensive set of amendments and reform suggestions for the existing transfer pricing rules. First, the OECD (2015b) confirms the arm's length principle as a guiding concept in intra-firm trade and stresses the importance of its enforcement. Secondly, it provides a revision of the OECD Transfer Pricing Guidelines (2010),[64] which serve as a foundation for transfer pricing management in OECD countries. Here, the OECD (2015b) emphasizes that the outcomes of transfer pricing should reflect the actual place of value creation and should not be influenced by taxation. The new provisions clarify several aspects of transfer pricing, such as an identification of the actual transaction undertaken, the control of a risk, the circumstances in which a transaction may be disregarded for transfer pricing purposes, MNE group synergies, and other previously disputed issues. In addition, Action 13[65] of the OECD Action Plan has introduced new guidelines on transfer pricing documentation requirements, which highlight the importance of increased transparency with respect to international operations of MNEs.

Action 3[66] of the OECD Action Plan provides recommendations on an implementation of controlled foreign company (CFC) rules. It gives details on the main building blocks for designing effective CFC regulations, including a definition of a controlled foreign company, CFC exemptions and threshold requirements, as well as a definition, computation, and attribution of CFC income, and prevention and elimination of double taxation. The OECD (2015f) stresses that CFC rules do not have to be uniform across countries and thus the recommendations provide a certain degree of flexibility for countries to implement the rules that are consistent with their policy objectives. The EU Anti-Tax Avoidance Directive also discusses the importance of an enforcement of CFC rules within the European Union. The Commission acknowledges that almost half of the EU member states have already implemented CFC rules. However, it also argues that the differences in these regulations among countries enable multinationals to circumvent their application. Therefore, the Commission suggests

[63] See OECD (2015b).
[64] See OECD (2010).
[65] See OECD (2015g).
[66] See OECD (2015f).

providing member states with a common pattern for the implementation of CFC rules in order to achieve their standardized usage in Europe.[67]

Moreover, the EU Anti-Tax Avoidance Directive suggests two further anti-avoidance measures. First, the Commission recommends a switchover clause, which aims to shift away from the exemption method towards the tax credit approach in the case of taxation of income received by a resident firm from an entity resident in a low-tax country. This approach would prevent a double non-taxation of cross-border transactions that currently arises in some cases due to an application of the exemption method in both countries. Secondly, the Commission suggests an implementation of the general anti-abuse rule (GAAR) to counteract aggressive tax planning when other rules do not apply. The Commission argues that tax planning schemes are very elaborate and evolve faster than tax legislation. A GAAR would enable a relatively quick response to abusive tax practices despite an absence of specific anti-avoidance rules. In addition, the Commission provides a recommendation on tax treaties, which suggests an introduction of general anti-abuse rules into tax treaties. However, the Commission does not provide details on this suggestion and therefore several authors including Dourado (2016) criticize the general anti-abuse rule, arguing that it is too vague.

Some aspects of the reforms suggested within the scope of the OECD Action Plan on BEPS and the EU Anti-Tax Avoidance Directive have been studied in the empirical literature. These studies conclude that anti-avoidance regulations may indeed hinder profit shifting if enforced properly. For example, many countries have already implemented thin capitalization or earnings stripping rules, which regulate the amount of interest payments on corporate debt that a company is allowed to deduct for tax purposes.[68] Weichenrieder and Windischbauer (2008), Overesch and Wamser (2010), Büttner et al. (2012), Buslei and Simmler (2012), and Blouin et al. (2014) have analyzed the effectiveness of this type of anti-avoidance legislation. They find that strict thin capitalization or earnings stripping rules are effective in eliminating excessive internal-debt financing and help in hindering profit shifting.

[67] See Ginevra (2017) p. 125-131 for a further analysis of the CFC rules changes proposed within the framework of the EU Anti-Tax Avoidance Directive.

[68] Thin capitalization rules are regulations that forbid the tax deduction of interest payments to related parties based on a specified debt-to-equity ratio. Earnings stripping rules restrict tax deductibility comparing interest payments with a certain fraction of a firm’s earnings before interest, taxes, depreciation, and amortization. Furthermore, some countries have introduced a mixture of the two kinds of rules. For more information on different thin capitalization and earnings stripping rules see Mardan (2017).

Furthermore, numerous empirical studies have analyzed the impact of an introduction or an enforcement of transfer pricing regulations on the use of related-party trade for profit shifting. Here, it has been shown that the strictness of transfer pricing regulations plays an important role in determining their overall effectiveness. Zinn et al. (2014) give a worldwide overview of these rules and show that they differ significantly in their strictness and the scope of implementation. To give an example, some countries simply introduce the arm’s length principle into their national law, while others enforce transfer pricing documentation regulations. Furthermore, transfer pricing documentation has to be either ready for a submission upon request from the tax authorities or needs to be automatically submitted on a yearly basis. Bartelsman and Beetsma (2003), Klassen and Laplante (2012), Lohse and Riedel (2013), Beer and Loeprick (2015), and Saunders-Scott (2015) have shown that strengthening transfer pricing regulations effectively decreases the use of intra-firm trade for profit shifting.

Finally, Ruf and Weichenrieder (2012) analyze the effectiveness of controlled foreign company rules. The authors evaluate the 2001 tax reform in Germany and conclude that German CFC rules are effective in restricting artificial investments in low-tax countries. Voget (2011) examines the influence of CFC rules on the strategic relocation of multinationals’ headquarters. The author employs data on 140 MNEs that have relocated their headquarters in recent years and compares them to a control group of 1943 multinationals that did not relocate. Voget (2011) finds that the presence of CFC legislation increases the probability of a relocation of headquarters and explains this outcome through a reduced possibility of deferring taxes and shifting profits within the group once CFC rules are introduced.

In order to analyze the overall impact of anti-avoidance legislation, one has to consider not only its effect on profit shifting but also its influence on real investment. Ruf and Schindler (2015) argue that anti-avoidance rules in general and thin capitalization restrictions in particular increase a country’s cost of capital and might adversely affect its inbound investment. According to the authors, an introduction or tightening of anti-avoidance regulations might have a positive effect on tax revenues and a negative effect on real investment, which is why the overall effect is theoretically ambiguous. Mintz and Weichenrieder (2010) argue that investors might in addition regard anti-avoidance rules as a signal of a future tax increase, which could have a further negative influence on real investment. Buettner et al. (2016) conduct an empirical analysis of the influence of thin capitalization and transfer pricing rules on investment activities of multinational firms. The authors find that an introduction or an enforcement of thin capitalization rules exert adverse effects on foreign direct investment and employment in high-tax countries. By contrast, the authors do not find transfer pricing rules to have a statistically significant impact on either FDI or employment. Therefore, Buettner et al. (2016) confirm that the introduction of strict anti-avoidance rules in the European Union might prove to be less effective if one takes into consideration their influence on real investment in addition to their impact on profit shifting.

2.4.1.2 Increasing Transparency and Co-Operation

Along with enforcing anti-avoidance rules that concern specific profit shifting channels, the OECD and the EU Commission also argue in favor of increasing an overall transparency of business transactions and operations with the help of additional sets of rules. For example, according to the OECD Action Plan on BEPS, the existing international treaties and domestic laws are not always capable of efficiently grasping the complex structures of multinational enterprises. Therefore, Action 13[69] argues in favor of introducing country-by-country (CbC) reporting, which requires large multinational enterprises to annually report detailed accounting information for each tax jurisdiction in which they do business. This information includes but is not limited to data on revenues, profits, taxes paid, employees, capital, retained earnings, and assets. In addition, multinationals are required to identify each affiliate within the group as a resident of a particular tax jurisdiction and to indicate the specific type of business it conducts. Starting from 2016 country-by-country reports have to be filled by the ultimate parents of large multinational enterprises and shared between jurisdictions in which a multinational operates. The Anti-Tax Avoidance Package of the European Commission also includes an amendment on country-by-country reporting, which aims to increase transparency in tax-related matters and puts into focus the implementation of CbC reporting in the European Union.

A recent case-study analysis by Johannesen and Larsen (2016) evaluates the effectiveness of country-by-country reporting in countries and industries, in which it has already been introduced. The authors conclude that this type of disclosure rules increases the shifting costs for MNEs and consequently decreases their rents from profit shifting, which leads to an overall fall in profit shifting. By contrast, Evers et al. (2015b) argue that country-by-country reporting cannot be regarded as a convincing measure to combat international income shifting because

[69] See OECD (2015g).

its benefits are largely uncertain and its costs appear to be significant. According to the authors, country-by-country reporting is likely to trigger substantial compliance costs for firms. The size of these costs will in turn depend on whether companies can easily retrieve the required data from their accounts or whether they have to generate it from scratch. Hence, it remains unclear whether the introduction of CbC reporting in the European Union will have an overall positive effect on the region's welfare.

In addition to increasing the transparency of multinationals' operations within the European Union, the EU Anti-Tax Avoidance Package stresses the importance of fostering international co-operation and communication on tax matters with the third countries. On that account, the Commission provides a recommendation on an external strategy for effective taxation. This proposal presents a stronger and more coherent EU approach on working on tax matters with third countries.

2.4.1.3 The Role of Intangible Assets

The OECD Action Plan on BEPS addresses the strategic use of intellectual property in several Actions. For instance, Action 8[70] provides guidance on identifying intangibles for transfer pricing purposes, characterizing transactions involving intangibles, determining arm's length conditions, and clarifying several other issues on transfer pricing of transactions involving intangible assets. In addition, Action 8 gives guidance on the cost contribution arrangements (CCAs), which are contractual arrangements between firms that share contributions and risks associated with a joint development of intellectual property. Moreover, the OECD Action Plan on BEPS addresses harmful tax practices that involve intangible assets. To give an example, Action 5[71] introduces a so-called Nexus Approach, according to which an application of a preferential tax treatment with respect to income from intangible assets should be dependent on the level of real research and development carried out in the country where the IP is located. Starting from 2015 the Nexus Approach requires all existing and new IP Boxes to apply only to self-developed and not to the acquired intangibles. Furthermore, the Anti-Tax Avoidance Directive of the European Union suggests an exit taxation of tangible and intangible assets in the case of their relocation. This recommendation is especially relevant in the case of

[70] See OECD (2015b).
[71] See OECD (2015a).

intellectual property because intangible assets are usually very mobile and can be relatively easily relocated within a multinational group, as described in section 2.3.4.1. According to the Commission, assets transferred abroad have to be taxed on their incorporated unrealized profits.

As discussed in section 2.4.1.1, several empirical studies have found evidence for the effectiveness of transfer pricing rules. Since royalties paid for the use of intangible assets are transfer prices, these rules apply to royalty payments as well. Beer and Loeprick (2015) investigate the impact of an enforcement of transfer pricing regulations on the profitability of IP-intensive firms, and contrary to their expectations, find that an introduction of documentation requirements has no observable effect on high-tax subsidiaries of multinational firms with high IP intensity. The authors conclude that transfer pricing rules are less effective in curbing profit shifting of IP-intensive subsidiaries compared to firms active in other sectors. Dudar et al. (2015) find that multinational enterprises may use IP Boxes that apply to the acquired intangibles but not IP Boxes that apply exclusively to self-developed intellectual property for profit shifting. Therefore, they argue that an implementation of the Nexus Approach might be an effective step in hindering the strategic use of intangible assets.

2.4.2 Fundamental Change of the Current Tax System

The OECD Action Plan on base erosion and profit shifting along with the EU Anti-Tax Avoidance Package try to combat profit shifting within the traditional framework of international taxation. However, there are also more fundamental reform suggestions that aim to change the overall structure of the current tax system and its key principles. As Cerioni (2016) argues, the fundamental reform proposals provide solutions that deprive initiatives such as the Action Plan and the Anti-Tax Avoidance Package of their own purpose. Devereux (2004) argues that profit shifting is only one of several inefficiencies that the current tax system yields. According to the author, besides leading to double taxation or double non-taxation, the existing rules trigger high administrative and compliance costs. Compliance costs may contribute to the distortion of a firm’s decisions regarding its location, organizational form, and other aspects of international business. Administrative costs arise from the complexity of the current tax system. Moreover, Devereux and Vella (2014) argue that the current tax system is prone to competition between governments, which constitutes its another weakness. The authors observe that tax competition has not only led to progressively reduced corporate tax rates but is also gradually leading to progressively reduced tax bases. This section analyzes several suggestions for fundamental changes of the existing tax system that attempt to eliminate all (or several) of its inefficiencies, including profit shifting.

2.4.2.1 Formulary Apportionment

According to Avi-Yonah and Benshalom (2011), formulary allocation refers to solely allocating income between affiliates of a multinational firm via an allocation formula, instead of trying to determine a market price of the relevant related-party transactions that produced the income.[72] As a result, formulary apportionment tries to approximate the actual degree of economic activity that a multinational undertakes in each jurisdiction. The authors argue that the formula should only include factors that are robust against manipulation, otherwise multinationals would be given an incentive to shift the factors between locations. As stated by Avi-Yonah and Benshalom (2011), a company's fixed assets, payroll, and sales are generally assumed to represent real economic activity of a firm and therefore suit the idea behind formulary apportionment.

Formulary apportionment is already used at the subnational level to apportion income between the local tax authorities within Canada, the US, Switzerland, and Germany.[73] The European Commission has considered a reform leading to formulary apportionment in the European Union and has made a proposal for a Council Directive on the common consolidated corporate tax base (CCCTB) in 2011.[74] This proposal suggests a single set of rules for the computation of taxable profits of multinational companies that operate in several EU member states.[75] The Commission relaunched this initiative releasing a new draft in 2016. The draft acknowledges difficulties connected with an immediate introduction of the CCCTB and proposes a two-step approach instead. The first step includes an establishment of mandatory rules for a common corporate tax base (CCTB). The second step comprises an EU-wide consolidation of group accounts, consequently using a formula to allocate profits among member states.

Bettendorf et al. (2010) explore the impact of introducing the CCCTB regime in the EU using an applied general equilibrium model. The authors conclude that this initiative is unlikely to yield substantial welfare gains in Europe and there are several reasons for such an outcome.

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[72] See Avi-Yonah and Benshalom (2011), p. 380.
[73] See McLure (2002) and Mayer (2009) for more information.
[74] See European Commission (2011b).
[75] See Spengel (2008) for a detailed analysis of this proposal.

The first reason is that corporate tax revenues constitute a relatively small portion of the total tax revenues in most EU countries, as section 2.2 shows. Hence, the increase in corporate tax revenues should not be expected to drastically change the welfare of member states. A second reason is that a consolidation of the corporate tax base does not seem to affect the cost of capital and therefore does not solve the key distortion in marginal investment choices. Furthermore, if corporate tax rates across the EU members are not harmonized, multinationals may still use the tax differentials between countries to shift profits. Indeed, Bettendorf et al. (2010) stress that a simulation with the assumption of full harmonization of tax rates leads to greater welfare gains than an estimation without an assumption of tax harmonization.

2.4.2.2 Destination-Based Tax

Devereux (2004) argues that the international taxation literature distinguishes mainly between taxation on a source basis (where goods are produced) and a destination basis (where they are sold). A most prominent example of the destination-based taxation is a value-added tax. Auerbach et al. (2017) suggest that a value-added element of the destination-based corporate taxation should, similarly to VAT, leave exports untaxed and only tax imports. In addition, the authors propose a so-called cash-flow element to the destination-based CIT. The idea is to give companies an immediate relief on all expenses, including capital expenses, and taxing revenues as they accrue.

The Republican Party has issued a tax reform plan for the United States in 2016.[76] Among other suggestions, this plan proposes to move towards destination-based cash flow taxation of businesses that reside in the US.[77] Patel and McClelland (2017) evaluate the impact of replacing the current US corporate tax system with a destination-based cash flow tax. The authors conclude that this plan seems promising because it would make the US tax system simpler, provide incentives for growth, and result in fewer distortions of firm location choices. However, Patel and McClelland (2017) point out a list of issues that remain to be resolved for a successful implementation of this reform. For example, the plan is ambiguous on topics such as the treatment of partnerships, the treatment of losses, as well as transition rules under a destination-

[76] See Grand Old Party (GOP) (2016).
[77] See Pomerleau (2016).

based tax. According to the authors, resolving these issues will be crucial in determining the feasibility of an implementation of a cash flow tax in the United States.

Bond and Devereux (2002) evaluate an introduction of a universal destination-based corporate tax and argue that it would bring several advantages. First, this tax would be neutral with respect to a multinational's decision on where to locate production. Secondly, it would remove many of the current system's inefficiencies, including the need to set transfer prices and an opportunity to deduct intra-firm interest payments. Furthermore, Auerbach et al. (2017) argue that a universal destination-based tax system would provide long-term stability, since countries would have an incentive to adopt it: either to gain a competitive advantage over countries with a source-based taxation or to avoid a competitive disadvantage relative to countries that have already implemented destination-based corporate taxation. Auerbach et al. (2017) also claim that this system would be resistant to tax competition among countries. Fuest et al. (2015) conclude that a universal implementation of a destination-based tax requires a high degree of international coordination and a willingness for reform. This might be hard to achieve given the fact that some countries benefit under the current system. Auerbach and Holtz-Eakin (2016) also express concerns of whether a destination-based tax would be in line with the current legal framework of the World Trade Organization (WTO) and bilateral tax treaties between countries.

2.4.2.3 Residence-Based Tax

Devereux (2008) summarizes the concept of residence-based taxation, under which income earned by an investor (which may be a company or an individual) would be taxed by the country in which the investor resides. According to Devereux (2004), residence-based taxation can take at least two following forms: the ultimate individual shareholders could be taxed in accordance with their residence or firms could be taxed based on their place of residence.

Devereux (2004) analyzes this reform idea and argues that residence-based taxation could distort a firm's decision on locations if a company is mobile. If a company is not mobile, a residence-based corporate income tax could distort the capital ownership neutrality. Furthermore, the author argues that tracing tax liability back to the ultimate shareholder would be virtually impossible due to high administrative costs resulting from tracking an individual's worldwide income. In addition, Devereux (2008) suggests that corporation taxes based on residence would need to be completely harmonized across countries in order for production efficiency to be realized. The author concludes that this is clearly unlikely, unless corporation taxes are competed down to zero.

2.4.2.4 Eliminating or Lowering Corporate Income Tax Rate in the US

The link between personal and corporate income taxation is a topic that European policy makers discuss very rarely, as Devereux (2008) notes. However, there has been a discussion within academia on the abolishment of corporate income tax in order to focus on the shareholder taxation[78] instead. Even though this reform suggestion is unlikely to be implemented even in the long run, the reasons for keeping CIT are still worth mentioning. For example, section 2.2 demonstrates that corporate taxation generates less tax revenues than other major types of taxes. However, it represents a stable source of revenues, since its share in the total tax revenues of Germany and other countries under analysis has remained steady over the past few decades. Aside from this, the share of corporate income tax is more significant in the composition of total tax revenues of low-income countries than the high-income ones.[79] In addition to the collection of revenues, there might be other reasons for taxing corporate income. For example, Zucman (2014) argues that the absence of a CIT might prompt individuals to incorporate and keep their profits within corporations in order to avoid paying personal income taxes. As a result, corporation tax serves as a back-up for personal income tax and a scenario without CIT triggers the need for an anti-avoidance rule, as Devereux (2008) notes. This rule would prevent small businesses and individuals from evading personal income tax by incorporating their profits, although it might be costly to develop and manage. However, Devereux (2008) suggests that the costs of establishing this reform and enforcing anti-avoidance regulations might still be smaller than the compliance and administrative costs that arise from the complexity and inefficiency of the current system. In addition, corporate taxation spurs transparent documentation of annual accounts and business transactions of all corporations, which in turn increases transparency and accountability of the economy as a whole. Therefore, corporate income tax fulfills several administrative and regulative goals besides tax revenue generation.

[78] For example, Grubert and Altshuler (2016) analyze three plans for shifting the tax on corporate income to the personal level.

[79] See OECD (2017c) for data and Abramovsky et al. (2014) for a detailed analysis of corporate income taxation in low-income countries.

Fehr et al. (2013) formulate and assess a model which simulates an abolishment of the US corporate income tax. The authors argue that in the case of no changes in corporate tax rates in other regions, eliminating corporate taxation in the US and replacing it with wage or consumption taxes can increase US domestic investment, output, real wages, and economic growth. However, the economic outcomes for other regions outside the US as well as an overall welfare effect seem to be more ambiguous and might even be negative. This is due to the fact that capital investments are expected to flow from abroad to the US, which as a capital tax-free country, puts all other countries at a disadvantage.

Bärsch et al. (2017) analyze the newest tax reform suggestion in the United States, which was published by the Republican Party in April 2017. Among different changes to the US corporate tax system, this plan considers lowering the statutory CIT rate to 15% and moving from the worldwide to territorial tax system. According to Bärsch et al. (2017), this tax reform would lead to fundamental changes in the international corporate taxation, in particular with respect to the activities and transactions between the United States and Germany. For example, the authors predict that the reform will have an impact on both the financing of business activities and the tax planning strategies of German and US corporations. Bärsch et al. (2017) expect an increase in German direct investment in the US as well as a shift of profits from Germany to the US, following the implementation of this reform.

2.4.2.5 The Role of Intangible Assets

The fundamental reform suggestions do not usually place an emphasis on the use of intangible assets for profit shifting but instead try to improve an overall efficiency of the current tax system. However, several proposals would have a direct impact on the application of intangible assets. For example, the formulary apportionment proposal suggested by the European Commission does not include intangible assets into the formula, since they are highly mobile and can be strategically relocated between affiliates. Röder (2012) analyzes this aspect of the reform suggestion and argues that nowadays intangible assets play an ever-growing role in the generation of income. Thus, their exclusion from the formula is very likely to cause arbitrary results. Even though the Commission states that intangibles are indirectly included in the apportionment formula via researchers’ salaries and tangible assets used for research, Röder (2012) argues that there is no meaningful correlation between the value of assets used for creating intangibles and the salaries of research staff. On that account, the author opposes the idea of leaving intangible assets out of the formula.

Other fundamental reform proposals such as a destination-based tax system, a residence-based tax system, or an integration of corporate and income taxation would eliminate the opportunity for using intellectual property as a means of profit shifting. For example, Bond and Devereux (2002) argue that a destination-based tax system would remove the need to set transfer prices, which are difficult to determine and are thus often misused in transactions that involve intangible assets.

2.4.3 Comparative Analysis of Reform Suggestions

Policy makers and academics have developed various reform suggestions which aim to eliminate profit shifting by multinational firms. Some of these suggestions include minor alterations to the existing tax system, whereas others embrace fundamental changes. For example, the OECD Action Plan on BEPS and the EU Anti-Tax Avoidance Package attempt to increase the transparency of cross-border operations of multinationals enterprises, raise the effectiveness of anti-avoidance legislation, and improve the efficiency of tax administration. Empirical literature in this field of research shows that anti-avoidance rules might indeed be effective in hindering profit shifting if implemented properly. However, the Action Plan and the Anti-Tax Avoidance Package do not address the fundamental inefficiencies of the current tax system and therefore it remains unclear whether or not new loopholes for profit shifting will arise once the old ones are closed. In addition, these reform suggestions add complexity to the existing tax system, which is already rather complicated. Aside from this, their implementation and enforcement most likely come at a cost of additional compliance expenditure for firms and administration expenses for governments. Furthermore, Dourado (2016) argues that some measures in the EU Anti-Tax Avoidance Package may contribute to a “race to the bottom” scenario between countries. According to the author, some proposed measures such as a switchover clause and CFC rules take a country’s tax rate as a benchmark for defining the regulations and may therefore intensify the tax competition between countries. Furthermore, Ginevra (2017) notes that the OECD and the Commission stress the importance of giving a certain degree of flexibility to all countries that implement the anti-avoidance legislation. However, the author argues that the flexibility may give rise to legal uncertainty, overly complicated implementation patterns, and even inconsistent taxation of the participating countries. Moreover, the interaction of individual policies within the scope of the Action Plan and the Anti-Tax Avoidance Package remains largely unanalyzed and hence its total outcomes are uncertain.

Fundamental reform suggestions, such as an introduction of a destination-based corporate tax system or formulary apportionment, aim to hinder profit shifting and to solve other inefficiencies of the current tax system, such as its complexity, high administrative and compliance costs, tax competition between countries, and other issues. However, these proposals are likely to contradict the existing double taxation treaties and the WTO rules, which makes their implementation rather difficult. In addition, the success of these reforms would depend on the participation of countries and the intensity of collaboration between them. For example, even if the EU implements the CCCTB proposal, it might still prove inefficient if other countries outside of the European Union do not co-operate. The need for international collaboration also arises within the framework of the OECD Action Plan and the EU Anti-Tax Avoidance Package. However, the extent of needed co-operation and its intensity certainly rises with the magnitude of changes suggested by the reforms.

2.5 Conclusion

The main aim of this study is to comprehensively analyze different aspects of corporate taxation, focusing on the issue of profit shifting by multinational enterprises. With the help of the study, a few important conclusions can be drawn. First, corporate tax revenues represent a rather small part (between 5% and 10%) of total tax revenues in most high-income countries and this trend has remained unchanged for years. Fixing the international tax system in order to eliminate profit shifting by multinationals could increase this share; however, changes in tax regulations have to be substantial in order to lead to a sizable increase in corporate tax revenues.

Secondly, the statutory and effective corporate tax rates have been falling rapidly in Germany over the past few decades. However, in comparison to several other European countries, such as members of the Benelux Union, Ireland, and Switzerland, Germany can still be considered a high-tax country. European low-tax countries either have low tax rates for corporations or offer tax regulations and arrangements that facilitate tax-minimizing strategies of MNEs.

Thirdly, there is plenty of descriptive and empirical evidence that supports the existence of profit shifting by multinational enterprises. However, the magnitude of profit shifting found in empirical literature appears to be smaller than the estimations claimed by policy makers, such as the OECD which argues that the net global corporate tax revenues lost due to profit shifting may lie between 95 to 230 billion EUR annually. For example, Heckemeyer and Overesch (2013) conduct a meta-analysis and find a tax semi-elasticity of reported profits to equal 0.8 (in absolute terms). At the same time, the meta-analysis of Feld and Heckemeyer (2011) indicates that a tax semi-elasticity of FDI equals 2.5 (in absolute terms). According to these findings, corporate taxation appears to have a more profound effect on the real investment than on reported earnings of MNEs. Furthermore, the descriptive analysis of this study points to a more vivid profit shifting behavior of US multinationals compared to German MNEs.

Finally, there are numerous reform suggestions which aim to eliminate base erosion and profit shifting. While the OECD Action Plan on BEPS and the EU Anti-Tax Avoidance Package aim to fix loopholes in the existing tax system, a few initiatives that are more ambitious suggest fundamental changes. Thus, the main goals of the Action Plan and the Anti-Tax Avoidance Package lie in increasing transparency of cross-border operations of multinational enterprises, raising the effectiveness of anti-avoidance legislation, and improving the efficiency of tax administration. Even though empirical literature has confirmed the effectiveness of the suggested measures in hindering profit shifting, they might still exert a negative impact on other areas of economic cooperation, such as real investment. For example, Buettner et al. (2016) confirm that an introduction or an enforcement of thin capitalization rules have an adverse effect on FDI and employment in high-tax countries. More fundamental reform suggestions include an introduction of the CCCTB scheme or an implementation of the destination-based corporate taxation. Rather than merely solving the problems of the current tax system, they attempt to redesign it and eliminate all of its inefficiencies, including profit shifting. All reform suggestions require intensive co-operation not only between the EU or the OECD member states but also with the third countries and the degree of needed co-operation rises with the scope of changes proposed by a reform. Therefore, reforming the international tax system might prove to be difficult, especially considering that some countries benefit from the status quo. In addition, a successful implementation of the reforms does not guarantee an increase in the overall welfare of the EU or OECD countries. This is because CIT accounts for a relatively small share of government revenues in most countries, the tax elasticity of the reported profits of MNE affiliates is also rather small, and some reforms might even exert a negative effect on real investment, which diminishes their overall success.

Chapter 3

On the Interdependency of Profit Shifting Channels and the Effectiveness of Anti-Avoidance Legislation

3.1 Introduction

The issue of base erosion and profit shifting (BEPS) has been on the international policy agenda for several years now. The key element of this discussion comprises the use of intra-group interest payments and transfer prices by multinational enterprises (MNEs) to strategically reallocate profits within a group in a tax minimizing manner. In view of the induced revenue losses and distortions in the competition between multinational and domestic firms, many countries have unilaterally implemented measures to limit profit shifting. In particular, they have introduced different forms of interest deduction restrictions[80] and transfer pricing regulations.[81] In its final reports on BEPS, the Organization for Economic Co-Operation and Development (OECD) also recommends the implementation of anti-avoidance regulations to restrict multinationals' tax planning opportunities.[82]

Previous studies have shown that anti-avoidance rules that restrict the tax deductibility of interest payments indeed affect the financing behavior of multinational firms (see as examples: Weichenrieder and Windischbauer (2008), Overesch and Wamser (2010), Buettner et al. (2012)). Another strand of empirical research suggests that transfer pricing regulations are effective in reducing the tax sensitivity of reported earnings before interest and taxes (EBIT)

[80] Interest deduction restrictions include thin capitalization rules, which limit interest deductibility based on a firm's debt-to-equity ratio, and earnings stripping regulations, which limit interest deductibility based on a company's earnings before interest, taxes, depreciation, and amortization.
[81] Zinn et al. (2014) give an overview of the existing transfer pricing rules. According to the authors, these rules range from an informal enforcement of the arm's length principle to a requirement to annually disclose detailed transfer pricing documentation.
[82] See OECD (2015c).

(see as examples: Bartelsman and Beetsma (2003), Lohse and Riedel (2013), Saunders-Scott (2013), Beer and Loeprick (2015)). While earlier studies separately analyze the effectiveness of either interest deduction rules or transfer pricing regulations, the literature remains mostly silent on the relationship between these two countermeasures and their mutual effect on BEPS. In order to evaluate the combined effectiveness of the two types of anti-avoidance legislation, it is crucial to know whether the restriction of one profit shifting channel is substituted by the intensified use of the remaining channels or whether they achieve an overall reduction in shifting behavior.

To the best of our knowledge, Saunders-Scott (2015) appears to be the only study that addresses the issue of substitution between profit shifting channels. The author obtains evidence that suggests interest deduction rules affect the reported EBIT and goes on to conclude that there exists a substitution of profit shifting using intra-group interest payments by profit shifting via the transfer pricing channel once interest deduction rules have been introduced. Expanding on the research conducted by Saunders-Scott (2015), we investigate this relationship further by providing a few valuable contributions: first, we test whether multinationals substitute the use of internal debt by manipulating transfer prices and whether they substitute manipulating transfer prices by the use of internal debt. Secondly, in addition to investigating the influence of one set of rules on profit shifting in the presence of the other set of regulations, we also analyze the mutual effect of different anti-avoidance regulations on a multinational's behavior by including a triple interaction into our baseline specification. Estimating the mutual effect of multiple anti-avoidance rules is crucial, as it enables us to predict the changes in the total profit shifting activity and the consequences this has on investment and real economy once several anti-avoidance regulations have been implemented simultaneously. Thirdly, we compare the substitution between profit shifting channels in the case of intellectual property (IP)-intensive firms and companies of other sectors. IP-intensive firms are less restricted in conducting profit shifting, because the arm's length price on the use of intangibles is often hard to determine and can therefore be more easily manipulated than transfer prices for tangible goods or intra-group interest payments.[83] Finally, as opposed to analyzing the impact of the introduction of interest deduction restrictions and transfer pricing rules on profit shifting, we consider the strictness of these regulations and their level of enforcement instead.

[83] See Dischinger and Riedel (2011), p. 691-692.

Our identification strategy includes two empirical approaches. We take our first approach by using a firm-level panel on European companies in the period between 2004 and 2012 to exploit the variation in tax rates and the strictness of anti-avoidance regulations across countries and years. With the help of this data, we analyze both the impact of restricting interest deduction rules on shifting through the transfer pricing channel and an influence of strengthening transfer pricing regulations on the use of the debt channel. The second empirical method is based on a quasi-experimental setting in France in the year 2007, where thin capitalization rules were strengthened for one group of firms while remaining unchanged for the other group. As transfer pricing rules remained constant in France during our period of observation, this reform provides an appropriate setting in order to investigate the substitution of shifting via the debt channel by shifting via the transfer pricing channel. According to our main findings, the substitution between profit shifting channels exists in the case where the debt channel is substituted by the use of intra-firm trade and in the case where intra-firm trade is substituted by the use of debt. In addition, we find that interest deduction limitations are not effective in reducing total profit shifting activity if no strict transfer pricing rules are in place. Therefore, the combination of the two sets of regulations and their level of enforcement determine the effectiveness of a country's anti-avoidance legislation in hindering profit shifting. Finally, we establish that IP-intensive firms substitute between profit shifting channels more aggressively than other types of companies.

The paper is structured as follows: section 3.2 discusses related literature on profit shifting channels and anti-avoidance rules. Section 3.3 goes on to present the theoretical model and outlines the main hypotheses, with section 3.4 providing the main data sources and defining variables used in empirical estimations. In section 3.5, we explain our two empirical approaches in detail, which enables us to present the key findings of the panel data analysis and the quasi-experimental estimation in section 3.6. The final section summarizes our main findings and concludes.

3.2 Literature Review

The conceptual framework in the profit shifting literature has been established by Grubert and Mutti (1991) and Hines and Rice (1994). These authors find that low-tax affiliates of multinational firms report higher profits than their high-tax counterparts. Huizinga and Laeven

(2008) contribute to this literature by concluding that the reported profits of affiliated companies are influenced by the corporate taxation that they face, as well as the international tax differences between affiliates and parent companies and between affiliates in different host countries. Heckemeyer and Overesch (2013) provide a comprehensive survey of this strand of literature and qualitatively and quantitatively analyze 25 empirical studies on profit shifting in both public economics and accounting research. They reach the conclusion that on average a one percentage point increase in the tax differential between a firm and its foreign affiliates reduces its reported profits by around -0.8%, holding other factors constant. While most studies on profit shifting use corporate income tax (CIT) rates as a source of identification, Dharmapala and Riedel (2013) examine exogenous earnings shocks at the parent level and investigate their impact on low-tax and high-tax multinational subsidiaries. The authors find a tax-motivated increase in the reported profits of low-tax group members in response to a parent's earnings shock and no changes in the profitability of the high-tax affiliates.

Furthermore, numerous empirical studies focus on analyzing single profit shifting channels. According to this strand of literature, multinationals shift income earned in high-tax countries to low-tax entities via debt financing or via non-financial transactions, such as intra-group transfers of goods and services and licensing of intellectual property. With regard to debt financing, Desai et al. (2004) apply a firm-level dataset provided by the Bureau of Economic Analysis (BEA) to show that multinationals use intra-company loans to diminish tax payments of subsidiaries in high-tax locations. Desai et al. (2004) argue that a one percentage point increase in the statutory tax rate increases internal debt of US foreign affiliates on average by 1%, holding other factors constant. Huizinga et al. (2008) find a comparable effect for the sample of European firms and Buettner and Wamser (2013) confirm these results for the affiliates of German multinationals. These outcomes are also in line with Newberry and Dhaliwal (2001) who identify a positive relationship between the likelihood of US multinationals issuing bonds to a foreign subsidiary and the existence of foreign tax credit limitations that restrict the use of domestic interest deductions.

As for the use of intra-firm trade as a channel of profit shifting, Clausing (2001, 2006) shows that taxation significantly influences the intra-group trade flows between US firms and their foreign affiliates. For example, Clausing (2006) argues that on average a one percentage point increase in a country's statutory corporate income tax rate is associated with a -1.9% drop in the intra-group trade between affiliates in this country and their parent companies. Clausing

(2003) finds that tax rate changes influence both the magnitude of intra-group trade and the prices used in intra-group transactions. Bernard et al. (2006) employ a dataset that tracks US exports during the 1990s to examine how prices set by MNEs vary across arm's length and related-party customers. Consistent with Clausing (2003), the authors claim that the transfer prices set in the case of arm's length customers are substantially larger than the prices set for affiliated firms. Flaaen (2017) extends the research by Clausing (2003) and Bernard et al. (2006) using new data and methodology. The author argues that the gap between the arm's length and related-party export prices increases for low-tax countries in the period after a one-time dividend repatriation tax holiday in the United States. By contrast, the comparable gap between the arm's length and related-party import prices decreases for low-tax countries during this period. Flaaen (2017) concludes that both of these results point to a strategic use of transfer prices for profit shifting by US multinationals. Bartelsman and Beetsma (2003) find similar outcomes using data on intra-sectoral trade between OECD countries. Overesch and Schreiber (2010) also confirm these findings for the sample of German multinationals and Davies et al. (2017) for the sample of French firms. Furthermore, there is robust evidence that suggests intangible assets play an important role in profit shifting via the channel of transfer pricing. This is because a strategic allocation of intellectual property between affiliates of a multinational group induces transactions of intra-firm royalty payments that may deviate from the arm's length price. To extend on this point further, Desai et al. (2006) identify in their analysis that large international firms with extensive intra-firm trade and a high research and development (R&D) intensity are most likely to have affiliates in tax havens.

Although there are good reasons to believe that transfer pricing and licensing of IP represent the predominant routes used by multinationals to shift profits,[84] the empirical evidence on this issue is not straightforward. An evaluation of the general evidence on profit shifting by Heckemeyer and Overesch (2013) shows that around one-third of all shifted profits is shifted via the channel of internal debt financing and two-thirds via related-party trade. By contrast, the results of Dharmapala and Riedel (2013) suggest a larger effect of debt financing, whereas the findings of Grubert (2003) point to equal shares.

[84] The interest rate on intra-group loans can be directly compared to the market interest rate and for this reason profit shifting is limited to it. By contrast, there is more discretion and therefore a larger leeway in setting transfer prices on highly specific transactions (for example, in the case of royalty payments), as pointed out by Overesch and Schreiber (2010).

The effectiveness of anti-avoidance legislation is a further topic which is explored within the profit shifting literature. Wamser (2014), Weichenrieder and Windischbauer (2008), and Overesch and Wamser (2010) analyze the impact of the 2001 reform in Germany, which resulted in thin capitalization regulations being tightened. They argue that a direct consequence of the reform was a reduction in intra-group loans granted to German companies by their foreign affiliates. Weichenrieder and Windischbauer (2008) also study the effect of thin capitalization rules on real investment of multinational enterprises; however, they do not find a visible impact. Buslei and Simmler (2012) and Dressler and Scheuering (2012) investigate the new German interest stripping rule which was introduced in 2008, with their investigation showing that the companies affected by this reform responded by decreasing their debt-to-assets ratios. Buettner et al. (2012) use comprehensive micro-level data from the Microdatabase Direct Investment (MIDI) databank on German outbound investment to study the effect of interest deduction restrictions on the leverage of foreign affiliates of German multinationals. The authors argue that an introduction of thin capitalization rules reduces tax sensitivity of intra-group debt and gives firms an incentive to use external debt.

A recent study by Blouin et al. (2014) investigates the influence of interest deduction restrictions on a company's leverage using micro-level data on US multinationals and their foreign subsidiaries in 54 countries over the period between 1982 and 2004. Contributing to previous studies, the authors draw a comparison between the effect a mere existence of anti-avoidance measures has and the impact of an increase of their stringency and enforcement. They find that a presence of interest deduction restrictions reduces an affiliate's debt-to-assets ratio, with more pronounced results in the case of the limitations on borrowing from a parent company compared to other group members. Furthermore, Blouin et al. (2014) argue that interest deduction restrictions on leverage have a stronger impact in countries that automatically apply anti-avoidance rules, in contrast to countries that have a discretionary enforcement.

Bartelsman and Beetsma (2003) carried out one of the first attempts to measure the influence of transfer pricing regulations on profit shifting. They empirically tested the effect of a broad range of factors on profits reported by multinationals using sectoral data. The authors claim that the international differences in corporate income tax rates along with several other attributes of the tax system including an enforcement of transfer pricing regulations constitute major incentives or discouragements for MNEs to shift profits. Lohse and Riedel (2013) elaborate on the study of Bartelsman and Beetsma (2003) using micro-level panel data on affiliates of MNEs in 26 European states. In the first step of their analysis, the authors confirm general findings in the related literature stating that corporate tax rates have a negative impact on reported pre-tax profits of multinationals. In addition, Lohse and Riedel (2013) find that transfer pricing regulations substantially reduce tax incentives to shift profits. According to the authors, firms located in high-tax jurisdictions where strict transfer pricing regimes are in place are less likely to shift income than companies located in high-tax jurisdictions where transfer pricing rules are not enforced. Beer and Loeprick (2015) confirm these findings arguing that within four years of the introduction of the mandatory documentation requirements, the amount of profits shifted between subsidiaries of MNEs decreases by around 60%. They show that the profit shifting behavior of subsidiaries with high intangibles-to-total-assets ratios is less influenced by documentation requirements than the profit shifting behavior of affiliates with a low fraction of intangible assets.

Klassen and Laplante (2012) investigate the effectiveness of transfer pricing regulations by employing micro-level data on US multinationals and their foreign subsidiaries. Their study significantly contributes to the previous literature through recognizing that profit shifting not only depends on the enforcement of transfer pricing regulations in a certain country but also on the implementation of transfer pricing rules in other jurisdictions. Saunders-Scott (2013) contributes to the previous literature on the relationship between reported profits and transfer pricing rules by explaining all possible channels through which these regulations might influence total tax revenues. The author develops a theoretical model and finds empirical evidence to support the idea that a strict enforcement of transfer pricing laws limits both profit shifting outflows and inflows. According to Saunders-Scott (2013), if a company has more subsidiaries in high-tax jurisdictions, it reports lower profits once strict transfer pricing regulations have been introduced. By contrast, if the affiliates of this firm are located in low-tax countries, it reports higher profits after the enforcement of transfer pricing rules. Furthermore, Saunders-Scott (2013) argues that tighter transfer pricing laws induce greater compliance costs for firms and these additional expenses subsequently reduce companies' profitability, which contributes to an overall negative effect of the enforcement of transfer pricing regulations on reported profits and consequently on the total tax revenues.

We believe Saunders-Scott (2015) is the only study that investigates the impact of interest deduction restrictions of an affiliate's reported profits, rather than on its debt. The author therefore combines identification strategies of two branches of profit shifting literature: studies on a strategic use of related-party trade and papers on intra-group debt financing. Saunders-Scott (2015) uses the Orbis database provided by the Bureau van Dijk to extract firm-level financial information on multinational enterprises from 55 countries in the period between 2006 and 2012. The author shows that the implementation of interest deduction restrictions in an affiliate's country reduces its earnings before interest and tax by -3.8%. Saunders-Scott (2015) attributes this finding to a substitution of debt shifting by transfer pricing manipulation. The author argues that the costs of shifting via transfer pricing manipulation depend on the total volume shifted and if the total volume is limited by interest deduction restrictions, the marginal costs of shifting via transfer pricing manipulation decrease.

Our study contributes to the previous literature on profit shifting channels through a comprehensive analysis of the interdependency between different types of anti-avoidance legislation. Therefore, our analysis is most closely related to Saunders-Scott (2015) and contributes to it by investigating not only how interest deduction restrictions influence shifting via intra-firm trade but also by analyzing how transfer pricing regulations affect shifting via debt. Furthermore, in addition to examining the effectiveness of transfer pricing rules and interest deduction restrictions separately, we also analyze the mutual impact of an interaction of the two types of anti-avoidance legislation on a multinational's shifting behavior. Moreover, we indirectly contribute to the empirical literature that investigates the influence of anti-avoidance rules on real investment of multinational firms. Namely, a substitutive relationship between the two channels of profit shifting would explain why previous studies were not able to establish a clear link between anti-avoidance regulations and the investment behavior of MNEs. For instance, Weichenrieder and Windischbauer (2008) show that interest deduction restrictions do not affect the real investment of large enterprises, whereas Buettner et al. (2017) argue that interest deduction limitations affect firms' real investment to a greater extent than transfer pricing rules.

3.3 Theoretical Considerations

3.3.1 The Model

In line with Saunders-Scott (2015), we consider a multinational corporation that consists of two affiliates that reside in two different countries: a high-tax country with a tax rate τ_H and a low-tax country with a tax rate τ_L. The high-tax affiliate can shift part or all of its true pre-tax profit

π_H to the affiliate in the low-tax country. π_H is defined as the taxable profit that would have been reported in the absence of profit shifting.[85] The true profit can be shifted from the high-tax to the low-tax affiliate by increasing internal debt or manipulating interest rates on intra-group loans. It can also be relocated by increasing intra-group trade or overpaying for intangible assets, tangible goods, and services provided by the low-tax affiliate. S denotes the combined volume of shifted profits via the channel of internal debt and intra-group trade. The respective intra-group payments are deductible from the tax base of the high-tax affiliate and increase the low-tax affiliate's profits π_L.

Profit shifting may induce costs C, which are assumed to be not tax deductible.[86] These costs may be split into the general (or non-channel-specific) costs and the channel-specific costs, depending on whether they arise from the use of a particular profit shifting channel or from profit shifting as such. The general costs may result from an increased audit risk, an increased need for mitigation strategies, as well as potential adjustments of intra-group transactions via one or both channels if profits are below a certain threshold. In addition, shifting high volumes of profits carries the risk of a reputational damage for MNEs. Moreover, a multinational might bear costs from complying with the regulations that tackle intra-group profit shifting and from establishing circumvention strategies. For example, an arm's length principle is a basic anti-avoidance regulation, which requires intra-group transactions, including interest payments and transfer prices, to follow the same conditions as transactions between independent parties.[87]

The channel-specific costs include negative channel-specific side effects from profit shifting. Despite a potentially lower capacity to raise external debt, there are no obvious costs from side effects of profit shifting via intra-group debt.[88] By contrast, profit shifting via transfer pricing manipulation results in conflicts within internal performance measurement and incentive setting systems.[89] This subsequently leads to inefficiency costs that increase with a growing difference between the real transfer price and the tax-optimal transfer price.[90] If companies use two sets

[85] See Fuest et al. (2011).
[86] Some costs may in fact be tax deductible (see Dharmapala and Riedel (2013)). Assuming a deductibility of shifting costs does not fundamentally affect our results.
[87] See Eden (2009) and Zinn et al. (2014) for a cross-country overview.
[88] Costs from secondary effects that arise from external debt financing, in particular bankruptcy costs and costs from information asymmetries, do not play a relevant role in determining internal financing under a precondition that the total third-party debt of a multinational corporation defines a bankruptcy risk. See Chowdhry and Nanda (1994), Gordon (2010), and Overesch and Wamser (2014) for further details.
[89] These costs arises from tax induced intra-group transactions that deviate from the optimal structure of intra-group trade from a management's perspective.
[90] See Hiemann and Reichelstein (2012).

of books for tax-optimal transfer prices and internal transfer prices, these inefficiency costs may be avoided, which results in the shifting costs being limited to additional administrative expenses needed to operate a two-book system.[91] Moreover, some countries have introduced channel-specific anti-avoidance regulations such as transfer pricing rules and interest deduction limitations.

Assuming that *C* represents both the channel-specific and the general costs of profit shifting, the aim of the multinational corporation is to maximize its total after-tax profit Π as shown in equation 3.1.

$$\Pi = (1 - \tau_H)(\pi_H - S) + (1 - \tau_L)(\pi_L + S) - C \tag{3.1}$$

It can be identified from equation 3.1 that the optimal amount of shifting out of the high-tax country S^* arises when the tax advantage from profit shifting equals marginal costs:

$$\frac{\partial C}{\partial S^*} = (\tau_H - \tau_L) \text{ with } \tau_H = 0 \text{ for } S - \pi_H \text{ if } S > \pi_H \tag{3.2}$$

According to equation 3.2, the tax advantage from profit shifting will be zero or negative for each unit of profits shifted in excess of the high-tax affiliate's true profits because the corresponding deductions will not reduce its taxable income in the same year.

Transfer pricing manipulation and excess interest payments are considered to be the two input factors used to produce the output – shifted profits *S*. Since both shifting channels serve exactly the same purpose of reducing profits in the high-tax country and increasing profits in the low-tax country, the value of shifting one unit via certain channel equals the value of shifting one unit via the other channel. Hence, the multinational is indifferent in using these two input factors and will always choose the cheaper shifting channel. This means that the conditional input demand for shifting profits via transfer pricing manipulation S_T^* equals:

$$S_T^*(S) = \begin{cases} S - S_D^*(S - \Delta S) \text{ if } C_T\left(S - S_D^*(S - \Delta S)\right) < C_D\left(S - S_T^*(S - \Delta S)\right) \\ [0 + S_T^*(S - \Delta S), S - S_D^*(S - \Delta S)] \text{ if } C_T\left(S - S_D^*(S - \Delta S)\right) = C_D\left(S - S_T^*(S - \Delta S)\right) \\ 0 + S_T^*(S - \Delta S) \text{ if } C_T\left(S - S_D^*(S - \Delta S)\right) > C_D\left(S - S_T^*(S - \Delta S)\right) \end{cases} \tag{3.3}$$

[91] See Hiemann and Reichelstein (2012), p. 4.

and the conditional input demand for shifting profits via intra-group debt $S_D{}^*$ equals:

$$\mathrm{S}_D^*\ (\mathrm{S}) = \begin{cases} \mathrm{S} - S_T^*(S - \Delta S\ ) \ \text{if}\ C_D\left(\mathrm{S} - S_T^*(S - \Delta S\ )\right) < C_T\left(\mathrm{S} - S_D^*(S - \Delta S\ )\right) \\ [0 + S_D^*(S - \Delta S\ ), S - S_T^*(S - \Delta S\ )]\ \text{if}\ C_D\left(\mathrm{S} - S_T^*(S - \Delta S\ )\right) = C_T\left(\mathrm{S} - S_D^*(S - \Delta S\ )\right) \\ 0 + S_D^*(S - \Delta S\ ) \ \text{if}\ C_D\left(\mathrm{S} - S_T^*(S - \Delta S\ )\right) > C_T\left(\mathrm{S} - S_D^*(S - \Delta S\ )\right) \end{cases} \quad (3.4)$$

$$\text{with}\ \ \mathrm{S}_D^*\ (\mathrm{S}\ -\ \Delta S) = S_T^*(S - \Delta S\ ) = 0\ \text{if}\ \mathrm{S} = 1 \quad (3.5)$$

Consequently, the total cost function of profit shifting is derived from the minimum cost combinations of the two input factors (which equal the two shifting channels) for all potential output levels:

$$\mathrm{C}\ (\mathrm{S}_T^*\ (\mathrm{S}), \mathrm{S}_D^*\ (\mathrm{S})) = \sum_{x-0}^{x-S_T^*(S)} C_T\ (x) + \sum_{y-0}^{y-S_D^*(S)} C_D\ (y) \quad (3.6)$$

In equation 3.6, $C_T(x)$ and $C_D(y)$ denote the costs of shifting unit x via transfer pricing and unit y via debt. Whether a substitution between the two profit shifting channels is optimal depends on how these costs per shifted unit are determined. By following the existing literature, we assume that all profit shifting costs are convex in the amount of shifted profits.[92] This can be formalized as follows:

$$C_i(S_i),\ C_i'(S_i) > 0\ \ \text{and}\ \ C_i''(S_i) > 0\ \ \text{with}\ \ \ i\ [D, T, Total] \quad (3.7)$$

3.3.2 Substitution between Profit Shifting Channels

If the costs for each profit shifting channel depend only on the volume of profits shifted via this channel (i.e. $C_T(S_T)$ and $C_D(S_D)$),[93] the optimal amount of profit shifting from the high-tax country to the low-tax country via each channel is determined by equations 3.8 and 3.9.

$$\frac{\partial C_D(S_D^*)}{\partial S_D^*} = (\tau_\mathrm{H} - \tau_\mathrm{L}\ )\ \text{with}\ \tau_\mathrm{H} = 0\ \ \text{for}\ S - \pi_\mathrm{H}\ \ \text{if}\ S > \pi_\mathrm{H} \quad (3.8)$$

[92] See as examples: Dharmapala and Riedel (2013), p. 7 and Saunders-Scott (2015).
[93] See Saunders-Scott (2015) for different assumptions regarding the cost function.

$$\frac{\partial C_T(S_T^*)}{\partial S_T^*} = (\tau_H - \tau_L\,) \text{ with } \tau_H = 0 \text{ for } S - \pi_H \text{ if } S > \pi_H \qquad (3.9)$$

Whether it is optimal to substitute towards one channel following a cost increase of the other channel depends on the level of total profit shifted in the optimum before the change in costs. If the optimal amount of profit shifting has been below the total true profits *($S^* < \pi_H$)*, an increase in the marginal channel-specific costs will decrease the optimal amount of profits shifted via this channel. However, the amount shifted via the other channel should remain unchanged as neither its costs nor the determination of the tax benefits are influenced by the reduction in the amount shifted via the first channel and in this case a substitution will not occur.

By contrast, if it has been optimal to shift total true profits ($S^* = \pi_H$), an increase in the channel-specific costs may either have no impact or reduce the optimal amount shifted via this channel. In the given example of profit shifting from a high-tax country to a low-tax country, the marginal benefit function is a step function which is constant with the positive values of the tax differential *($\tau_H - \tau_L$)* up to the amount of total true profit and turns negative for all units above the total true profits ($S - \pi_H$). Thus, it is possible that the last unit shifted via one or both profit shifting channels in the optimum bears marginal costs below the tax advantage *($\tau_H - \tau_L$)*. Up to the level of the true profits, the company will always choose the cheaper channel for each unit shifted. For this reason, if the costs of one channel increase while still remaining below the tax rate differential and additionally leaving the price ratio of the two channels for all units of shifted profits unaffected, the shifted amount via both channels should remain unchanged.

If, ceteris paribus, the price ratio reverses for certain units of shifted profits (meaning that the other channel now yields a lower cost), the amount shifted via the channel with increased costs should decline and the amount shifted via the other channel should increase. With respect to equations 3.8 and 3.9, this substitution between the two channels in response to a reversion of the price ratio for certain units of shifted profits results from a change in the value of τ_H (from its real value to zero and vice versa) in both equations.[94]

[94] In addition, if it is optimal to shift total true profits, an increase in the cost of one channel also decreases the amount shifted via this channel if the marginal costs rise above the tax advantage *($\tau_H - \tau_L$)*. A substitution towards the other channel will only then be optimal if the last unit shifted via the other channel yields costs below the tax differential.

However, companies may also substitute between the profit shifting channels if it is optimal to shift less than the total true profits. This is the case when we consider the non-channel-specific shifting costs $C_{Total}(S_{Total})$ that are convex in the total amount to be shifted via both channels (which implies that $C'_{Total}(S_{Total}) > 0$ and $C''_{Total}(S_{Total}) > 0$). As discussed above, these costs may result from increased audit or reputational risks. In this case, the high-tax affiliate determines the optimal amount of shifting using the two channels according to the following conditions:

$$\frac{\partial C_D(S^*)}{\partial S^*} = (\tau_H - \tau_L) \text{ with } \tau_H = 0 \text{ for } S - \pi_H \text{ if } S > \pi_H \tag{3.10}$$

$$\frac{\partial C_T(S^*)}{\partial S^*} = (\tau_H - \tau_L) \text{ with } \tau_H = 0 \text{ for } S - \pi_H \text{ if } S > \pi_H \tag{3.11}$$

Equations 3.10 and 3.11 establish that an increase in the channel-specific costs of a certain channel will increase the marginal costs of profit shifting and consequently reduce the optimal amount shifted via this channel. The reduction in the shifted amount S should then reduce the marginal costs of shifting via the other channel with unchanged channel-specific costs, which in turn may increase the optimal level of profits shifted via this channel.

In summary, if the shifting costs are channel-specific, companies may only substitute between the channels if it is optimal to shift total true profits. However, if there are other non-channel-specific costs, which depend on the total amount shifted via both channels, companies may substitute between the channels even if it is optimal to shift less than total true profits.

3.3.3 Hypotheses Derivation

The considerations above show that a substitution between shifting channels depends on the structure of their cost functions. In this section, we concentrate on the channel-specific anti-avoidance regulations and develop our hypothesis based on the assumptions about the components and structure of the cost functions of the two shifting channels.

With regard to intra-group debt, Burnett (2014) identifies that there is usually a large range of possible arm’s length amounts of debt and corresponding interest rates, which form a comparison group for the intra-group borrowing of multinationals. In the case of intra-group royalty payments, an arm’s length price is often hard to determine due to the highly specific nature of intangible assets. Therefore, it is relatively easy to justify high levels of profits shifted via this channel, even under an application of the arm's length principle. With respect to the transfer of common tangible goods and services, Dawson and Miller (2009) note that companies should find themselves more restricted in their profit shifting behaviour even in the absence of detailed transfer pricing regulations, since tax authorities may compare related-party transactions to the available third-party payments. As a result, for corporations that trade tangible assets or services that are easy to value, severe transfer pricing manipulation may result in double taxation even if no strict transfer pricing regulations exist. Based on these considerations, we derive Hypothesis 1 of our study:

> *In the absence of strict anti-avoidance regulations, non-IP-intensive companies mainly shift profits via intra-group debt, whereas IP-intensive firms shift profits via royalty payments.*

If a high-tax country has interest deduction limitations in place, interest payments on debt above the safe harbor ratio will no longer be deductible and will face double taxation. Consequently, the tax benefit of profit shifting will turn negative for excess interest payments. For companies that shift high levels of their total profits via interest payments, it will be optimal to reduce the amount shifted via intra-group interest payments. These companies may substitute shifting high levels of debt by an increased use of transfer pricing manipulation if the costs of shifting via the other channel do not exceed the tax benefit. Hence, according to Hypothesis 2:

> *If a country introduces interest deduction limitations, companies that have been shifting profits via intra-group debt will reduce their interest payments and increase shifting via the transfer pricing channel.*

If a high-tax country introduces transfer pricing rules, a multinational corporation will face additional fixed costs if any intra-group transactions are present. In addition, strict transfer pricing regulations increase the threat of being audited. Transfer pricing rules following the OECD guidelines generally apply not only to intra-firm trade but also to the interest rates on intra-group loans, although less focus is usually placed on the level of intra-group debt.[95] Most countries handle intra-group borrowing with the help of more specific thin capitalization or

[95] See OECD (2012).

earnings stripping rules. As a result, the additional fixed costs and reduced potential for receiving a tax advantage from profit shifting via transfer pricing manipulation should make shifting via interest payments cheaper once transfer pricing rules are introduced. For this reason, a reduction in shifting via transfer pricing manipulation and an increase in shifting via internal debt can be expected.[96] Hypothesis 3 thus reads:

> *If a country introduces strict transfer pricing regulations, companies that have been shifting profits via intra-firm trade will reduce transfer pricing manipulation of tangible and intangible assets and increase shifting via the debt channel.*

If it is the case where an anti-avoidance regulation is introduced which targets one profit shifting channel while another anti-avoidance rule restricts the other shifting channel, the observable substitution will depend on how firms have previously used the two shifting channels. For example, if interest deduction restrictions exist, they should not allow a substitution towards the debt channel if transfer pricing documentation rules are introduced and if a company already fully exhausts the debt channel up to the permitted threshold. It is worth noting that transfer pricing regulations are typically more flexible than interest deduction limitations. Determining the arm’s length price is often very difficult, particularly in the case of firm-specific IP due to missing comparable transactions. Even if transfer pricing documentation rules do exist, firms should have greater flexibility for substituting towards the transfer pricing channel in the case that interest deduction limitation rules are introduced. However, the leeway for transfer pricing manipulation is likely to be smaller in the case of tangible goods compared to intangible assets. Consequently, Hypothesis 4 states:

> *If transfer pricing regulations exist and interest deduction limitations are introduced, most companies may have some leeway to substitute towards the transfer pricing channel. In addition, the substitution should be more pronounced for IP-intensive firms as compared to non-IP-intensive companies.*

[96] Of course, such a substitution will only take place in firms that have been shifting parts of their profit via transfer pricing manipulation before the introduction of strict transfer pricing regulations.

3.4 Data

3.4.1 Firm-Level Data

We use firm-level data from the Amadeus database provided by the Bureau van Dijk in the empirical part of our paper. This database includes accounting information on group structures of more than 21 million companies in Europe. However, we only consider firms that report unconsolidated accounts, since we require information on the activities of single companies. In addition, we only focus on the affiliates of MNEs and exclude purely domestic firms from our sample. In order to determine multinational enterprises, we use information on direct parent firms and their subsidiaries.[97] Since intra-group profit shifting requires a substantial ownership share, we follow Beer and Loeprick (2015) and only consider affiliates with an ownership share of at least 90%. Furthermore, we exclude headquarter firms from our sample due to the findings of Dischinger and Riedel (2010) and Dischinger et al. (2014) who argue that the location of profits and profitable assets may be biased in favor of the headquarters. However, these firms are included back in the sample as part of one of our robustness checks. Moreover, loss-making firms from the benchmark estimations are excluded because they face different tax planning incentives than profitable enterprises (see Huizinga and Laeven (2008) and Dischinger and Riedel (2011)). Finally, we eliminate firms active in the financial sector and years with implausible values for our main variables of interest.

Our empirical analysis includes two identification strategies: the first identification strategy employs a panel of European companies which belong to a multinational group.[98] This analysis covers the period between 2004 and 2012 and includes firms located in 32 countries. In total, 103,714 firms provide the information required for the analysis of the substitution of debt shifting by intra-firm trade manipulation and 85,949 companies provide necessary data for the analysis of the substitution of transfer pricing shifting by debt manipulation. Table A.1 in the appendix gives an overview of a cross-country distribution of observations in this sample. The second identification strategy is established by conducting a difference-in-difference estimation of a tax reform that was introduced in France in 2007. For this analysis, we use a balanced panel of 1,040 French affiliates of multinational groups in the period between 2004 and 2009.

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[97] Since data on ownership is static in the Amadeus database, we use information on ownership structures in 2012 and assume that it did not change in the previous years.
[98] We define a company as a part of a multinational group if at least one firm in the group resides in a different country.

3.4.2 Data on Tax Rates and Anti-Avoidance Regulations

The data on tax rates was obtained from the *CBT Tax* database[99] provided by the University of Oxford and the *Global Corporate Tax Handbooks*[100] published by the International Bureau of Fiscal Documentation (IBFD). The information on transfer pricing regulations was collected from the transfer pricing guides published by Deloitte,[101] Ernst & Young,[102] KPMG,[103] and PwC.[104] Data on thin capitalization and earnings stripping rules was obtained from *Global Corporate Tax Handbooks*. In the case of both – transfer pricing rules and interest deduction restrictions – we consider not only their presence but also their level of strictness, since rules that bite are more likely to have an impact on profit shifting behavior of MNEs.

Our study follows Beer and Loeprick (2015), with the years since the introduction of mandatory transfer pricing documentation requirements used as an indicator for the strictness of transfer pricing rules. Transfer pricing documentation requirements constitute a crucial element of increasing transparency of the transfer prices determination. It should be noted that time is an important factor of these rules, as it normally takes tax authorities several years or more to gain experience and knowledge of intra-group transfer prices to effectively detect mispricing. The advantages of this measure include its clear definition and interpretation as well as the fact that it brings a lot of variation. However, there are authors who use different variables to measure the strictness of transfer pricing rules and in order to ensure that our findings are robust, we test our baseline results by employing a binary transfer pricing variable comparable to the one used by Lohse and Riedel (2013). This variable also focuses on formal transfer pricing documentation rules; however, it does not take into consideration the effect of time and therefore exhibits significantly less variation in our dataset. The variable is set to one if formal transfer pricing documentation rules exist and equals zero otherwise.[105] In a further robustness check, we take into account the existence of informal transfer pricing documentation rules.[106] We use a measure for the existence of informal transfer pricing rules while simultaneously

[99] See Oxford University Centre for Business Taxation (2016).
[100] See International Bureau of Fiscal Documentation (1995-2012).
[101] See Deloitte (2014).
[102] See Ernst & Young (2005-2012).
[103] See KPMG (2015).
[104] See PricewaterhouseCoopers (2012).
[105] In addition, Saunders-Scott (2015) employs a transfer pricing index based on Mescall and Klassen (2014). However, we cannot construct this measure for a sufficient number of country-year combinations due to the data availability issues.
[106] In some countries, transfer pricing documentation requirements have not been enforced by the national law but are required to exist in practice.

controlling for the years since the introduction of formal transfer pricing regulations. The respective variable is set to zero if neither formal nor informal transfer pricing documentation rules exist and it is equal to one if informal transfer pricing documentation rules are present. Furthermore, starting from the year in which formal transfer pricing documentation rules are introduced, the years following on from their introduction are also counted. Table A.2 in the appendix gives an overview of the formal and informal transfer pricing documentation rules across all countries in our sample.

With regard to interest deduction restrictions, we face the challenge of constructing a measure that includes both thin capitalization rules, which limit interest deductibility based on a firm's debt-to-equity ratio, and earnings stripping regulations, which limit interest deductibility based on a company's earnings before interest, taxes, depreciation, and amortization (EBITDA). For these reasons, in our baseline analysis we rely on a comprehensive variable that enables thin capitalization rules and earnings stripping regulations to be taken into account. This variable classifies interest deduction restrictions into three different categories as follows: all countries that do not have rules restricting the deductibility of interest payments (which go beyond a general application of the arm's length principle) are assigned to category 1. Countries that apply thin capitalization rules with a safe harbor ratio above the average safe harbor ratio in our sample (which is 3) are assigned to category 2. Countries that do not use a general thin capitalization rule but apply some anti-avoidance regulation against excessive intra-group debt shifting are also classified into this category.[107] In addition, countries that have a general thin capitalization rule with a safe harbor ratio of 3 or less but exclude a broad range of transactions from their application are also assigned to category 2.[108] Category 3 comprises all countries that apply a thin capitalization rule with a safe harbor ratio of 3 or below without broad exceptions. The earnings stripping rules applicable in Germany (from 2008), Italy (from 2008), and Spain (from 2012) are assigned to category 3 as well. This reflects the idea that particularly in Italy and Spain the earnings stripping rules have been perceived to be stricter than the thin capitalization rules that were previously applicable. In Germany, assigning earnings stripping rules to category 3 reflects an unchanged level of strictness compared to prior years where a

[107] Table A.4 in the appendix provides information on these special interest deduction limitations.
[108] An example includes France during the years between 2004 and 2006, when only interest payments to parent companies resident in certain non-EU countries where covered by thin capitalization rules.

thin capitalization rule with a debt-to-equity ratio of 3:1 was present. Table A.5 in the appendix summarizes our main indicator for interest deduction limitations by country and year.

In addition, we implement a robustness check by including an alternative proxy for interest deduction restrictions in our benchmark estimation. Here, we attempt to reflect the safe harbor debt-to-equity ratio[109] in countries with thin capitalization rules. According to Buettner et al. (2012), a direct use of this ratio is not feasible, since it approaches infinity when no restrictions are imposed. Therefore, we follow Buettner et al. (2012) who conduct a non-linear transformation of the safe harbor ratio denoted by σ and use it as a proxy for the strictness of thin capitalization rules.[110]

$$Strictness = \frac{1}{1+\sigma} \tag{3.12}$$

In equation 3.12, *Strictness* stands for the measure of the strictness of thin capitalization rules and σ denotes a country's safe harbor ratio. *Strictness* can only be determined for countries that apply a thin capitalization rule; therefore, it is equal to zero if a country does not have this type of regulations. The level of the safe harbor ratio varies between 1 and 8 in our sample, which yields a maximum value of the strictness indicator of 0.5. Table A.3 in the appendix gives an overview of the debt-to-equity ratios applied under thin capitalization rules in the countries under analysis.

3.4.3 Macroeconomic Controls

The data on gross domestic product (GDP), GDP growth, and GDP per-capita was extracted from the World Bank's *Development Indicators*[111] and is measured in constant USD. We also obtained the information on the unemployment rate from the World Bank's *Development Indicators*. It reflects a country's total unemployment rate in percent of its total labor force as estimated by the International Labor Office. Information on corruption is derived from the World Bank's *Control of Corruption Indicator*.[112] Data on inflation is taken from the database

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[109] A safe harbor debt-to-equity ratio indicates up to which level interest deduction is safely granted by the host-country's tax system. See OECD (1987) for more details.
[110] See Buettner et al. (2012), p. 933.
[111] See World Bank (2015).
[112] See World Bank (2016c).

World Economic Outlook[113] provided by the International Monetary Fund and it reflects the percentage change in average consumer prices. Finally, we construct a measure for growth opportunities, which we define as the median annual sales growth per industry in each country. Table A.6 in the appendix provides detailed descriptive statistics on all variables included in the panel estimation. Table A.7 gives an overview of all variables included in the analysis of the French tax reform.

3.5 Identification Strategies

3.5.1 Estimation Based on the Variation of Tax Parameters over Time

3.5.1.1 Substitution of Debt Shifting by Transfer Pricing Manipulation

In order to investigate whether multinationals substitute profit shifting via internal debt by shifting via intra-firm trade, we look at the tax rate sensitivity of EBIT at different strictness levels of interest deduction restrictions and transfer pricing regulations. Earnings before interest and taxes should not be influenced by profit shifting via internal debt because they explicitly exclude interest payments. This allows us to separately analyze the effect of anti-avoidance rules on shifting via the transfer of goods, services, and intangibles. We conduct this analysis in two steps: the first step refers to Lohse and Riedel (2013) and Beer and Loeprick (2015) in investigating the effectiveness of transfer pricing regulations in hindering profit shifting via the channel of intra-firm trade. This allows us to control for the strictness of transfer pricing rules and effectively analyze their interaction with the corporate income tax rate. The second step involves extending previous research by adding a triple interaction term between the tax rate and two types of anti-avoidance regulations in order to test the impact of transfer pricing rules on the tax rate sensitivity of EBIT with and without strict interest deduction restrictions. This is done with the help of equation 3.13.

$$\begin{aligned} Log(EBIT)_{it} = {} & \beta_0 + \beta_1 CIT_{it} + \beta_2 TP_{it} + \beta_3 CIT_{it} * TP_{it} + \beta_4 TC_{it} + \\ & + \beta_5 CIT_{it} * TC_{it} + \beta_6 TC_{it} * TP_{it} + \beta_7 CIT_{it} * TP_{it} * TC_{it} + \\ & + \beta_8 \boldsymbol{X}'_{it} + \mu_i + \delta_{jt} + \varepsilon_{it} \end{aligned} \tag{3.13}$$

[113] See International Monetary Fund (2016).

In equation 3.13, *Log(EBIT)* is the dependent variable that denotes a natural logarithm of earnings before interest and taxes of affiliate i in year t. *CIT* represents a corporate income tax rate augmented by local taxes on profits levied in year t in the country where firm i resides. In accordance with Lohse and Riedel (2013) and Beer and Loeprick (2015), we employ this variable as the main indicator for profit shifting incentive and expect its coefficient to be negative. Furthermore, in line with Lohse and Riedel (2013), Beer and Loeprick (2015), and Saunders-Scott (2015), we expect that strict transfer pricing regulations *TP* effectively reduce the tax rate sensitivity of EBIT ($\beta_3 > 0$). Assuming that some companies have the required leeway to substitute between the two dominant profit shifting channels – debt shifting and transfer pricing manipulation – the tax rate sensitivity of EBIT should increase if interest deduction restrictions are tightened but transfer pricing regulations remain weak.[114] This is shown in equation 3.13 through an interaction term between the tax rate and interest deduction restrictions *TC* and therefore we expect $\beta_5 < 0$. The triple interaction of the tax rate *CIT*, interest deductibility variable *TC*, and transfer pricing indicator *TP* takes into account that if a certain scope exists in substituting profit shifting via debt by profit shifting via transfer pricing manipulation, the effectiveness of one anti-avoidance regulation will be conditional on the enforcement of the other one. The investigation of this effect constitutes one of the major contributions of this study to the previous literature.

Finally, $\boldsymbol{X}'$ represents a vector of relevant firm and country-level controls chosen following the previous literature on the effectiveness of transfer pricing regulations, such as Lohse and Riedel (2013) and Beer and Loeprick (2015). $\boldsymbol{X}'$ includes a company's main input factors – fixed assets and costs of employees – that reflect its true profits (as opposed to shifted revenues). In addition, it contains a host country's characteristics including its GDP, GDP per-capita, a GDP growth rate, and an unemployment rate. μ_i and δ_{jt} are company and industry-year fixed effects respectively, with ε_{it} representing an error term.

3.5.1.2 Substitution of Transfer Pricing Manipulation by Debt Shifting

In order to investigate whether there is a substitution of the transfer pricing channel by debt shifting, we look at the tax rate sensitivity of interest payments at different strictness levels of anti-avoidance rules. Here, we use a similar approach as in equation 3.13 but with the natural

114 This is especially true for companies that have previously shifted via intra-group debt.

logarithm of interest paid as the dependent variable. In equation 3.14, *Log(Interest Paid)* is the dependent variable and it denotes a natural logarithm of interest payments made by firm *i* in year *t*. Previous authors in this field of literature have used an affiliate's total or internal debt as a dependent variable (see as examples: Desai et al. (2004), Overesch and Wamser (2010), Buettner and Wamser (2013), and Wamser (2014)). However, since the information on a company's debt is not available to us, we continue by using interest payments to investigate the role of debt in profit shifting.[115]

$$\begin{aligned} Log(Interest\ Paid)_{it} = \beta_0 + \beta_1 CIT_{it} + \beta_2 TP_{it} + \beta_3 CIT_{it} * TP_{it} + \\ + \beta_4 TC_{it} + \beta_5 CIT_{it} * TC_{it} + \beta_6 TC_{it} * TP_{it} + \\ + \beta_7 CIT_{it} * TP_{it} * TC_{it} + \beta_8 \boldsymbol{X'}_{it} + \mu_i + \delta_{jt} + \varepsilon_{it} \end{aligned} \tag{3.14}$$

In equation 3.14, the main independent variables of interest *CIT*, *TP*, and *TC* are identical to the ones described in equation 3.13. The vector $\boldsymbol{X'}$ includes controls chosen following Desai et al. (2004). For example, in line with the authors we include firm-level controls such as a logarithm of a company's sales, its ratio of EBITDA to total assets, and its ratio of net property, plant, and equipment to total assets into our estimation. Sales are used as a proxy for a firm's size and we expect that larger companies have better access to credit markets and therefore have higher interest payments. This also appears to be the case for profitable firms, which are measured and controlled for by the ratio of EBITDA to total assets. A high level of tangible fixed assets may serve as collateral and should facilitate external borrowing as well. Moreover, $\boldsymbol{X'}$ contains country-level controls such as *Corruption*, *Inflation*, and *Growth Options*. In line with Desai et al. (2004), we expect a negative effect of inflation on leverage and consequently on interest expenses because of a higher risk premium required to obtain a credit. Corruption index is used as a proxy for creditor rights and political risk. *Growth Options* denotes the median annual sales growth per industry and country. In line with equation 3.13, μ_i and δ_{jt} in equation 3.14 are company and industry-year fixed effects respectively and ε_{it} represents an error term.

[115] The major limitation of using *Interest Paid* as a dependent variable is that it does not distinguish between intra-group and external interest payments. Hence, we can draw only imprecise conclusions about the substitution of transfer pricing manipulation by the debt channel. Further research using data on internal interest payments or debt ratios is required to validate our findings.

3.5.2 Quasi-Experimental Analysis of a French Tax Reform

The estimation approach presented in the previous section relies on analyzing firms' reactions to changes in relevant tax parameters over time. A common concern for studies that use this approach is that the detected results are potentially prone to confounding effects that are not fully controlled for in the regression analysis. For example, if countries change transfer pricing rules and interest deduction restrictions either in the same period or within a short time span, it becomes difficult to disentangle the effectiveness of individual regulations. In order to improve the identification strategy of the relationship between shifting strategies, we use the difference-in-difference approach to analyze a quasi-experimental reform setting in France. Here, a comparison between the reported profits of firms that were affected and firms that were unaffected by the thin capitalization rules reform is made. Both the corporate income tax rate and the strictness of transfer pricing regulations remained unchanged in France during the years considered in our analysis. In addition, we are not aware of any other reforms that might have had different effects on the treatment and control groups.

In 2007, a reform act extended the application of French thin capitalization rules to related parties within the European Union (EU). Before that, French thin capitalization rules were restricted only to interest payments made to controlling shareholders.[116] Due to the EU case law,[117] these rules were no longer applicable to interest payments to controlling shareholders that reside in the EU from 2004 onwards. Furthermore, the rules did not apply to interest payments made to controlling shareholders resident in countries that had signed a required treaty with France.[118] The Finance Act of 2006[119] has introduced new interest deduction restrictions for fiscal years beginning on or after January 1, 2007. These rules limited the tax deductibility of interest payments on loans granted by related parties and in addition to interest transactions to parent companies, interest payments to other associated firms were also covered by the new thin capitalization rules.[120] Whereas a debt-to-equity ratio of only 1.5:1 applied

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[116] A controlling shareholder was defined as a shareholder that directly owned more than 50% of a company's share capital or voting rights. Under this thin capitalization rule, a debt-to-equity ratio of 1.5:1 applied.
[117] See European Court of Justice (2002).
[118] This treaty either contained a non-discrimination clause similar to Art. 24(5) of the OECD Model Convention or did not explicitly authorize the application of French thin capitalization rules and has been negotiated or renegotiated after July 23, 1992.
[119] See Ernst & Young (2008).
[120] Associated companies are defined as two companies in which one holds directly or indirectly a minimum of 50% of the other firm's capital or as two companies in which a third enterprise holds directly or indirectly 50% of the capital.

before 2007, the new thin capitalization rules introduced an additional test in which it was decided that interest payments should be deductible only if they do not exceed 25% of a company's EBITDA. The interest that exceeds the higher of the two thresholds is considered non-deductible for tax purposes.[121] We use the following difference-in-difference specification to study the impact of the 2007 reform:

$$Log(EBIT)_{it} = \beta_0 + \beta_1 Treat_i + \beta_2 After_t + \beta_3 Treat_i * After_t + + \beta_4 \boldsymbol{X'}_{it} + \mu_i + \delta_{jt} + \varepsilon_{it} \tag{3.15}$$

In equation 3.15, *Log(EBIT)* is the dependent variable that denotes a natural logarithm of a firm's *i* earnings before interest and taxes in year *t*. *Treat* is a binary variable that is equal to one for all firms that are assigned to the treatment group and is set to zero for all companies assigned to the control group. We classify a firm as a treated one if it was facing unrestricted debt shifting opportunities prior to the reform and became subject to interest deduction restrictions from 2007 onwards. We define three criteria a company has to fulfil in order to be assigned to the treatment group. The first criterion states that its parent company must reside in one of the countries covered by the exemption of thin capitalization rules between 2004 and 2006 (EU member states or certain treaty-exempted countries). As a second criterion, its reported median interest payments in the three years prior to the reform must exceed 150,000 EUR, since this amount of interest remained deductible after the reform irrespective of a company's debt-to-equity ratio.[122] As a third criterion, only companies with higher tax rates than their parent firms are included in the treatment group. This step is made with reference to Graham (2013) who suggests that other enterprises have a disincentive to feature high levels of intra-group debt and are unlikely to be affected by interest deduction restrictions before or after the reform. Consequently, the control group includes companies with parent firms that reside in countries covered by thin capitalization rules before 2007 as well as companies without a tax incentive and firms with low interest payments. The variable *After* equals zero for pre-reform years between 2004 and 2006 and takes on the value of one for the post-reform period between 2007 and 2009.

[121] If the non-deductible interest is 150,000 EUR or less, all interest is considered to be deductible.
[122] We rely on the interest payments reported before the reform to ensure exogenous treatment.

The coefficient of interest in equation 3.15 is β_3. The identifying assumption is that in the absence of a reform the dependent variable would have followed a similar trend in both treatment and control groups. Since treated firms face a higher cost of shifting profits via interest payments, they are expected to rely more on trade mispricing upon policy intervention if they have some discretionary leeway of doing so. Consequently, we expect β_3 to be negative. This would suggest that firms affected by the reform are more likely to reduce their EBIT than the unaffected companies. $\boldsymbol{X}'$ in equation 3.15 comprises firm-level controls such as fixed assets and the costs of employees. In addition, equation 3.15 contains industry-year fixed effects δ_{jt} and company fixed effects μ_i. ε_{it} is an error term.

3.5.3 IP-Intensive Firms vs. Non-IP-Intensive Companies

According to Hypothesis 1, we expect that companies belonging to groups with a high IP intensity mainly shift their profits via transfer pricing manipulation, while other companies engage in profit shifting via intra-group debt if none of the profit shifting channels are restricted by anti-avoidance rules. Apart from this, Beer and Loeprick (2015) show that the profit shifting behavior of subsidiaries with high intangibles-to-total-assets ratios is less influenced by anti-avoidance legislation than the profit shifting behavior of affiliates with a low fraction of intangible assets. In order to test our hypothesis and take into account the fact that firms differ in their potential to substitute between the two profit shifting channels,[123] we estimate the benchmark models presented in sections 3.5.1 and 3.5.2 for IP-intensive and non-IP-intensive companies. We classify IP-intensive firms as those that belong to MNEs with an IP intensity above the median of our sample,[124] with IP intensity defined as the ratio of intangible assets to total fixed assets.[125]

Since certain countries, such as Germany, do not allow the capitalization of self-created intangible assets, we additionally assign all companies active in R&D-intensive industries to the subsample of IP-intensive firms. We define R&D-intensive industries based on the

[123] IP-intensive firms are less restricted in conducting profit shifting, because the arm's length price on the use of intangibles is often hard to determine and can therefore be more easily manipulated than transfer prices for other transactions or intra-group interest payments. See Dischinger and Riedel (2011) for details.
[124] We refer to the IP intensity of a group, because the opportunity to shift profits via royalty payments does not depend on the company's own level of IP intensity but rather on the existence of valuable intangible assets at the level of any of the group's affiliates.
[125] We test alternative definitions of IP intensity in the robustness checks.

Stifterverband report,[126] which shows the aggregate internal R&D investments per industry in 2008. Hence, we classify all industries that invested more than the sample's average of one billion EUR in R&D in 2008 as R&D-intensive. This includes the following sectors:

- Manufacturing of chemicals and chemical products;
- Manufacturing of basic pharmaceutical products and pharmaceutical preparations;
- Manufacturing of computers, electronics, and optical products;
- Manufacturing of electrical equipment;
- Manufacturing of machinery and equipment;
- Manufacturing of motor vehicles, trailers, and semi-trailers;
- Manufacturing of air and spacecraft;
- Information and communication;
- Scientific research and development.

3.6 Results

3.6.1 Estimation Based on the Variation of Tax Parameters over Time

3.6.1.1 Substitution of Debt Shifting by Transfer Pricing Manipulation

This part of the paper presents the results of estimations described in section 3.5.1.1. The main independent variables of interest in column I of Table 3.1 include a corporate income tax rate, an indicator for the strictness of transfer pricing rules *TP*, and their interaction. In column II, we additionally consider the interest deduction restrictions *TC* and a triple interaction between both anti-avoidance rules and a corporate income tax rate. The last two columns show the results after splitting the sample into IP-intensive and non-IP-intensive firms.

Column I of Table 3.1 displays a negative and statistically significant tax sensitivity of reported EBIT. Holding other factors constant, on average a one percentage point increase in the tax rate leads to a -0.35% decrease in a company's reported profits. This negative relationship has already been established in the earlier literature on profit shifting (see the meta-study of Heckemeyer and Overesch (2013) for an overview). The effect size is, however, somewhat smaller (in absolute terms) than the average effect size derived in this meta-study. Furthermore, this column reinvestigates the influence of transfer pricing regulations on a firm's profits.

[126] See Stifterverband für die Deutsche Wissenschaft (2013).

Consistent with Bartelsman and Beetsma (2003), Lohse and Riedel (2013), Saunders-Scott (2013), and Beer and Loeprick (2015), we find that an implementation of transfer pricing documentation rules in high-tax countries leads to an increase in firms' reported earnings before interest and taxes. The coefficient on the interaction term between the corporate income tax rate and the transfer pricing rules is positive and statistically significant with a t-value of 4.3. It indicates that on average the tax rate sensitivity decreases by -0.1 percentage points each year after the introduction of transfer pricing documentation requirements. The effect size is comparable to the one reported by Beer and Loeprick (2015) who use the same measure for the strictness of transfer pricing regulations. As for the other variables, input factors such as fixed assets and the cost of employees seem to play an important role in determining a company's profits, which is also consistent with our predictions and the findings of earlier studies, such as Lohse and Riedel (2013), Beer and Loeprick (2015), and Saunders-Scott (2015). Furthermore, a higher GDP growth rate appears to be positively correlated with reported profits, while a higher unemployment rate is likely to decrease firms' earnings.

The effectiveness of transfer pricing regulations depends on whether profit shifting via transfer pricing can be substituted by profit shifting via interest payments and vice versa. To take into account this substitution and test Hypothesis 3 of our study, we increase the regression in column I by an indicator for interest deduction restrictions targeting the potentially substitutive shifting channel of intra-group debt. Column II of Table 3.1 demonstrates the results of this estimation based on equation 3.13. It includes the corporate income tax rate and strictness indicators for transfer pricing rules and interest deduction restrictions, which are the main independent variables of interest. In addition, pairwise interactions and an interaction term between all three variables of interest are also included. The triple interaction takes into account that the effect of transfer pricing documentation rules on the tax rate sensitivity of EBIT depends on the strictness of interest deduction restrictions.

In the presence of the triple interaction, the two-way interaction between the transfer pricing rules and CIT reflects the case where only formal transfer pricing rules exist, whereas interest deduction limitations do not. The coefficient on two-way interaction is statistically significant and its magnitude is substantially larger than the size of the coefficient in column I, which suggests that in the absence of thin capitalization rules companies in high-tax countries seem

Table 3.1 Regression Results: Log(EBIT) as a Dependent Variable

	Full Sample		IP	Non-IP
	I	II	III	VI
CIT	-0.351***	-0.013	-0.507**	0.563*
	(0.107)	(0.194)	(0.252)	(0.308)
TP	0.020***	0.054***	0.052***	0.057***
	(0.002)	(0.005)	(0.006)	(0.008)
*CIT*TP*	0.103***	0.517***	0.564***	0.442***
	(0.024)	(0.079)	(0.104)	(0.123)
TC		0.027***	0.004	0.052***
		(0.007)	(0.009)	(0.011)
*CIT*TC*		-0.358***	-0.065	-0.702***
		(0.109)	(0.142)	(0.171)
*TP*TC*		-0.025***	-0.024***	-0.027***
		(0.003)	(0.003)	(0.004)
*CIT*TP*TC*		-0.228***	-0.266***	-0.170**
		(0.044)	(0.057)	(0.070)
Log(Fixed Assets)	0.082***	0.082***	0.089***	0.074***
	(0.003)	(0.003)	(0.004)	(0.004)
Log(Costs of Empl.)	0.395***	0.393***	0.399***	0.385***
	(0.006)	(0.006)	(0.008)	(0.009)
Unemployment Rate	-0.012***	-0.011***	-0.011***	-0.012***
	(0.001)	(0.001)	(0.001)	(0.002)
Corruption	0.000	-0.002	-0.010	0.015
	(0.017)	(0.017)	(0.022)	(0.029)
GDP Growth Rate	0.005***	0.006***	0.007***	0.006***
	(0.001)	(0.001)	(0.001)	(0.002)
Log(GDP)	0.432**	-0.109	0.102	-0.341
	(0.189)	(0.207)	(0.273)	(0.320)
Log(GDP/capita)	-0.268	0.349*	0.141	0.574*
	(0.174)	(0.195)	(0.259)	(0.296)
Year-Industry FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of Companies	103,714	103,714	60,732	42,982
No. of Observations	541,323	541,323	325,494	215,829
R^2 (within)	0.087	0.087	0.092	0.082

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Robust standard errors are reported in parentheses. Units of observation are firms. The dependent variable is *Log(EBIT),* which denotes a natural logarithm of a firm's earnings before interest and taxes. *CIT* stands for a corporate income tax rate. *TP* measures the strictness of transfer pricing regulations. *TC* measures the strictness of interest deduction restrictions. *Log(Fixed Assets)* and *Log(Cost of Empl.)* are firm-level controls and represent natural logarithms of a company's fixed assets and the cost of employees respectively. *Unemployment Rate* stands for a country's rate of unemployment. *Corruption* represents a corruption index. *GDP Growth Rate* is a country's rate of GDP growth. *Log(GDP)* denotes a natural logarithm of a country's gross domestic product. *Log(GDP/capita)* stands for a natural logarithm of a country's GDP per-capita. FE stands for fixed effects. IP represents a sample of IP-intensive firms as defined in section 3.5.3 and Non-IP includes a sample of all other companies.

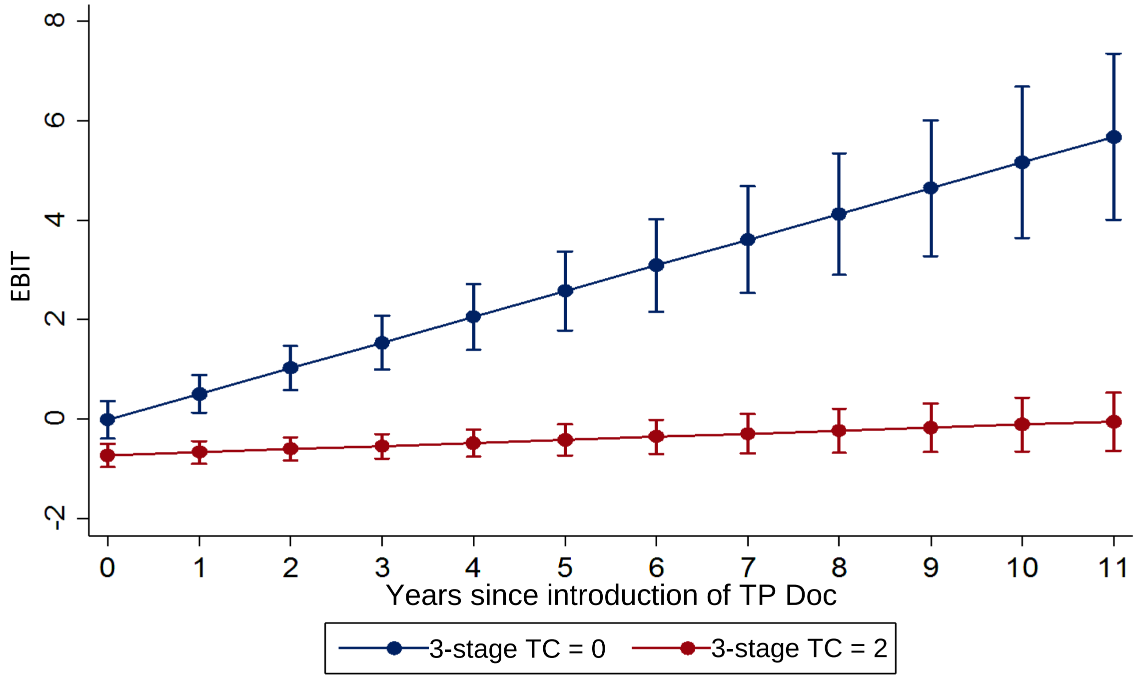
to shift less via the transfer pricing channel if transfer pricing rules exist.[127] The interaction term between the corporate income tax rate and the indicator for interest deduction restrictions in column II reflects the case where only interest deduction restrictions exist but transfer pricing documentation rules do not apply. The coefficient on these restrictions is negative and statistically significant and the combined coefficient suggests that in the absence of strict transfer pricing documentation rules, strict interest deduction restrictions decrease the tax sensitivity of EBIT on average by -0.37 percentage points, with each decrease in the three-stage indicator for interest deduction restrictions. This yields a tax rate sensitivity of EBIT of around -0.73 in countries with strict interest deduction restrictions (*TC* is equal to 2) but no transfer pricing documentation requirements. Since EBIT does not include interest payments, this relationship indicates the existence of a substitutive relationship between the two profit shifting channels and therefore confirms Hypothesis 3 of out study.

According to columns II-IV of Table 3.1, the triple interaction between CIT, transfer pricing rules, and interest deduction restrictions is negative and statistically significant. This suggests that transfer pricing documentation rules are less effective in reducing transfer pricing manipulation if strict interest deduction restrictions are present. To give an example, the average marginal effect yields a tax rate sensitivity of -0.54 with strict interest deduction limitations and 1.53 without them three years after formal transfer pricing documentation rules have been introduced. Figure 3.1 shows the average marginal effects of corporate income tax on EBIT with and without interest deduction restrictions.

According to Figure 3.1, the tax rate elasticity of EBIT is positive after transfer pricing regulations have been introduced if no interest deduction limitations exist. This suggests that transfer pricing regulations eliminate profit shifting via transfer pricing manipulation and the rules become more effective each year after their introduction. Figure 3.1 also shows that the tax rate sensitivity is negative irrespective of the level of transfer pricing strictness if interest deduction limitations are strict and it is statistically significant within six years of transfer pricing rules being introduced.

[127] Whether they substitute this channel by shifting via internal debt (which in this case is not restricted) depends on the effect of the interaction term in regressions with interest payments as a dependent variable. We carry out this analysis in the next section.

Figure 3.1 Average Marginal Effects of CIT on EBIT: Full Sample



In column II of Table 3.1 we do not observe a negative tax sensitivity for the case that neither strict interest deduction restrictions nor transfer pricing regulations exist. A reason for this might be that not all companies shift profits using intra-firm trade in the absence of anti-avoidance regulations. Some firms will rely mainly on shifting via internal debt, particularly if costs from secondary effects of transfer pricing manipulation are higher than costs from shifting via intra-group debt. This is likely to be the case for multinational groups without valuable intangible assets or other intra-group transactions for which transfer prices can be easily manipulated.

According to Hypothesis 1, IP-intensive companies shift mainly via transfer pricing manipulation, while other firms engage in shifting via intra-group debt if none of the profit shifting channels is restricted by anti-avoidance rules. In order to test this hypothesis, we split the baseline sample into IP-intensive and non-IP-intensive companies. In line with Hypothesis 1, columns III and IV of Table 3.1 show that IP-intensive firms shift profits via transfer pricing manipulation in the absence of any anti-avoidance regulations. For this subgroup, we find a negative tax rate sensitivity of EBIT. For companies with a low IP intensity, an increase in the tax rate even has a weak positive effect on EBIT. A reason for this might be that despite the absence of strict channel-specific anti-avoidance rules, countries usually apply the arm’s length principle. As a result of this, firms that largely rely on shifting via intra-group debt have an incentive to increase EBIT because in an arm's length comparison higher levels of EBIT may justify higher levels of debt.[128]

Most non-IP-intensive companies do not seem to engage in transfer pricing manipulation in the absence of strict anti-avoidance legislation for both profit shifting channels. Therefore, the negative coefficient on the interaction between interest deduction restrictions and CIT in column IV of Table 3.1 indicates that companies engage in profit shifting via transfer pricing manipulation if strict interest deduction limitations are in place. This interaction term is not statistically significant for companies with a high IP intensity. This is plausible if Hypothesis 1 remains to be true, so that most of these companies do not extensively shift via the debt channel in the absence of strict transfer pricing rules and are consequently not affected by an introduction or a tightening of interest deduction restrictions.

The interaction of the indicator for the strictness of transfer pricing rules and CIT is positive for both IP-intensive and non-IP-intensive firms (see columns III and IV of Table 3.1), but its coefficient is slightly higher for companies with a high IP intensity. The average marginal effects suggest that an increase in the tax rate does not trigger profit shifting via transfer pricing manipulation for companies in both subsamples if only transfer pricing documentation rules but no interest deduction limitation rules are present (see Figures 3.2 and 3.3). According to columns III and IV of Table 3.1, the coefficient on triple interaction is negative for both subsamples. Looking at the average marginal effects, we find that for IP-intensive firms the negative tax rate sensitivity given strict interest deduction restrictions is statistically significant for all levels up to seven years after the introduction of transfer pricing documentation rules (see Figure 3.2). For non-IP-intensive firms, the negative tax rate sensitivity is only statistically significant in the first four years after transfer pricing documentation rules have been introduced if strict interest deduction restrictions exist (see Figure 3.3). The size of the coefficient and its statistical significance declines with each additional year of the existence of transfer pricing documentation rules.

[128] This argument is only reasonable as long as the increase in EBIT is lower than the increase in the respective interest payments.

Figure 3.2 Average Marginal Effects of CIT on EBIT: IP-Intensive Firms

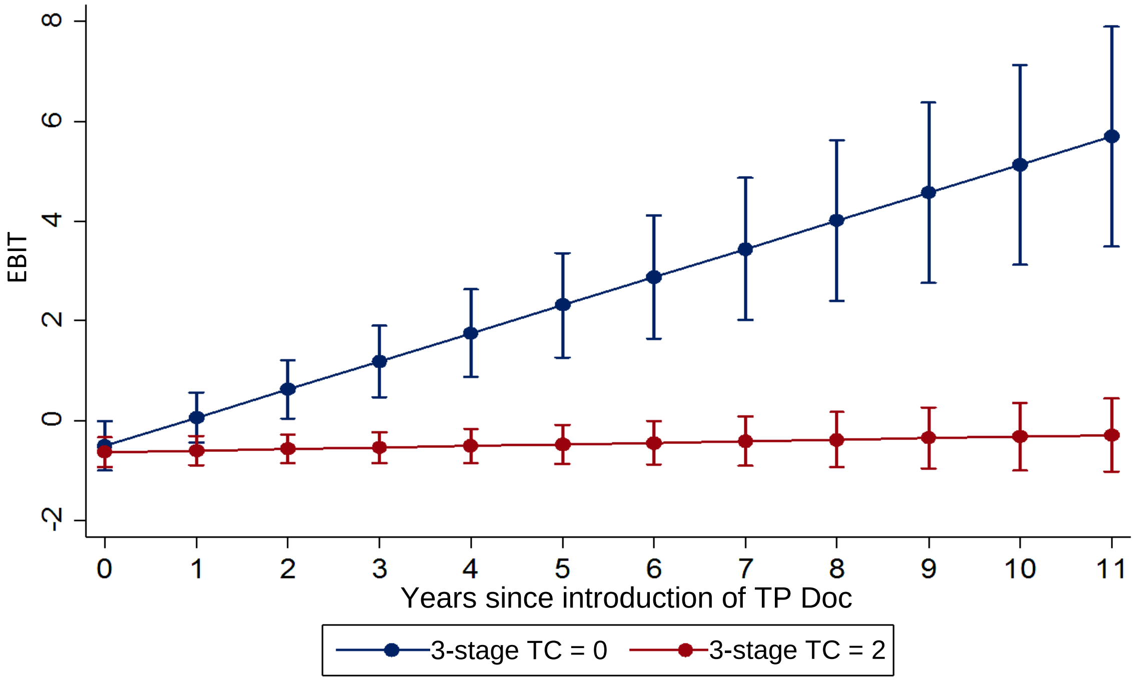
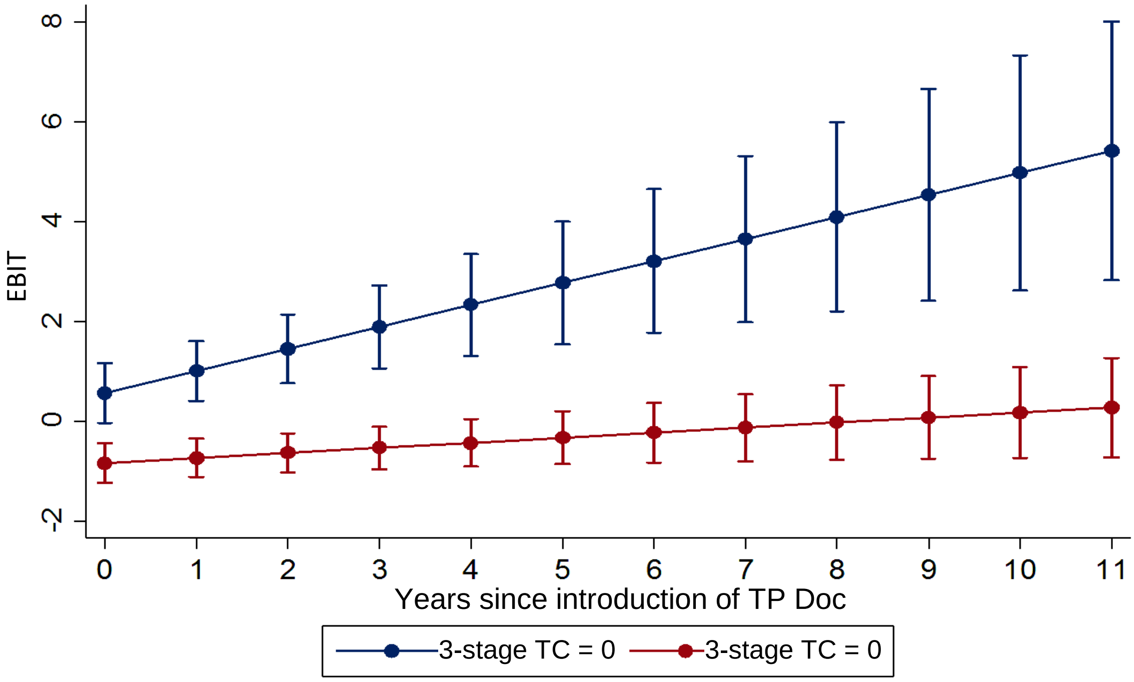


Figure 3.3 Average Marginal Effects of CIT on EBIT: Non-IP-Intensive Firms



These findings suggest that strict transfer pricing rules are less effective in reducing transfer pricing manipulation if interest deduction restrictions are also strict, which indicates that there is a substitutive relationship between the two profit shifting channels. While transfer pricing documentation rules increase the costs of shifting via the transfer pricing channel and induce a substitution towards the debt channel, they still leave considerable leeway for transfer pricing manipulation in the case that the debt channel is restricted. However, this leeway is reduced year by year after transfer pricing documentation requirements have been introduced. This reduction suggests that the increasing experience of the tax authorities enhances their effectiveness in tackling transfer pricing manipulation.

Following the results in columns II-IV of Table 3.1, we conclude that IP-intensive firms shift profits mainly via transfer pricing manipulation in the absence of anti-avoidance regulations. This finding confirms Hypothesis 1 of our study. An introduction of interest deduction limitations induces firms to increase shifting via the transfer pricing channel, which is in line with Hypothesis 2. If shifting via both channels is restricted by anti-avoidance regulations, transfer pricing rules appear to be less effective in reducing shifting via transfer pricing manipulation, especially in the case of IP-intensive firms, which confirms Hypothesis 4.

3.6.1.2 Substitution of Transfer Pricing Manipulation by Debt Shifting

The previous section has shown that restricting the possibility of profit shifting via internal debt leads to an increase in shifting via intra-firm trade. Thus, we conclude that there is a substitution between the two profit shifting channels. In order to validate this finding, we examine in this section whether hindering shifting via transfer pricing manipulation has an impact on shifting via debt. We implement this analysis by empirically estimating the effect of changes in a country's corporate income tax rate and anti-avoidance regulations on corporate interest payments. The details on this identification strategy are given in section 3.5.1.2.

Table 3.2 shows the results of estimating the model shown in equation 3.14. Parallel to Table 3.1, the first column of Table 3.2 presents the results without considering the triple interaction term. Here, we replicate the outcomes achieved by Desai et al. (2004) and other previous authors, such as Weichenrieder and Windischbauer (2008), Overesch and Wamser (2010), and Buettner et al. (2012). According to column I, the interaction term on *CIT* and interest deduction limitations *TC* is negative and statistically significant. This implies that companies pay less

Table 3.2 Regression Results: Log(Interest Paid) as a Dependent Variable

	Full Sample		IP	Non-IP
	I	II	III	IV
CIT	1.859***	1.101**	0.190	3.126***
	(0.485)	(0.496)	(0.647)	(0.824)
TC	0.044***	0.013	0.020	-0.019
	(0.015)	(0.015)	(0.020)	(0.022)
*CIT*TC*	-3.227***	-2.330***	-2.046***	-2.834***
	(0.262)	(0.274)	(0.365)	(0.437)
TP		0.005	0.020	-0.015
		(0.010)	(0.012)	(0.016)
*CIT*TP*		0.610***	0.881***	0.044
		(0.191)	(0.245)	(0.308)
*TP*TC*		0.034***	0.034***	0.035***
		(0.005)	(0.006)	(0.009)
*CIT*TP*TC*		-0.218**	-0.350***	0.089
		(0.106)	(0.136)	(0.170)
Net PPE/Assets	0.336	0.336	0.214	1.423***
	(0.298)	(0.298)	(0.227)	(0.075)
EBITDA/Assets	-0.005	-0.005	-0.010	-0.001
	(0.004)	(0.004)	(0.009)	(0.002)
Log(Sales)	0.618***	0.620***	0.636***	0.604***
	(0.013)	(0.013)	(0.017)	(0.017)
Corruption	0.209***	0.129***	0.117**	0.142**
	(0.036)	(0.038)	(0.048)	(0.064)
Inflation	-0.017***	-0.022***	-0.011**	-0.033***
	(0.003)	(0.003)	(0.005)	(0.005)
Growth Options	-0.012	-0.010	-0.005	-0.167***
	(0.007)	(0.007)	(0.006)	(0.033)
Year-Industry FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of Companies	85,949	85,949	52,761	33,188
No. of Observations	375,573	375,573	238,004	137,569
R^2 (within)	0.059	0.060	0.062	0.064

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Robust standard errors are reported in parentheses. Units of observation are firms. The dependent variable is *Log(Interest Paid)*, which denotes a natural logarithm of a firm's interest payments. *CIT* stands for a corporate income tax rate. *TP* measures the strictness of transfer pricing regulations. *TC* measures the strictness of interest deduction limitations. *Net PPE/Assets*, *EBITDA/Assets*, and *Log(Sales)* are firm-level controls and represent a ratio of a company's net property, plant, and equipment to total assets, its ratio of earnings before interest, taxes, depreciation, and amortization to total assets, and a natural logarithm of its sales respectively. *Corruption* represents a corruption index and indicates the level of governance and political risk in a country. *Inflation* stands for a country's rate of inflation. *Growth Options* denotes the median annual sales growth per industry and country. FE stands for fixed effects. IP represents a sample of IP-intensive firms as defined in section 3.5.3 and Non-IP includes a sample of all other companies.

interest out of high-tax countries with strict anti-avoidance rules, which suggests that strict interest deduction restrictions effectively hinder profit shifting using interest payments. With regard to other control variables, a company's sales appear to have a positive effect on interest paid, which is consistent with the findings of Desai et al. (2004), Overesch and Wamser (2010), Buettner and Wamser (2013), and Wamser (2014). In addition, *Inflation* exhibits a negative effect on interest payments, which is also consistent with earlier literature, including Desai et al. (2004). In line with Desai et al. (2004), *Corruption*, which indicates the level of governance and political risk in a country, is positively correlated with interest outflows.

Column II of Table 3.2 displays the results of estimating equation 3.14 using the full sample, while column III considers only IP-intensive firms and column IV shows the outcomes for companies with a low IP intensity. Consistent with Hypothesis 1 and our findings presented in Table 3.1, IP-intensive firms do not seem to heavily engage in profit shifting via interest payments if no anti-avoidance regulations for either channel exist. However, we find a positive tax rate sensitivity for these companies if strict transfer pricing documentation rules are present but no interest deduction limitations apply. This suggests that the reduction in shifting via transfer pricing manipulation found for this subsample in Table 3.1 is compensated by an increase in shifting via debt.

The coefficient on the two-way interaction between interest deduction limitations and corporate income tax rate in columns II-IV of Table 3.2 is negative and statistically significant. Its large size indicates the effectiveness of strict interest deduction limitations in reducing profit shifting via interest payments if no transfer pricing regulations exist. The coefficient on the triple interaction turns out to be negative and statistically significant in the case of IP-intensive firms. Figures 3.4-3.6 show the average marginal effects of a corporate income tax on *Interest Paid* with and without anti-avoidance legislation. While Figure 3.4 displays the outcomes for the full sample, Figure 3.5 concentrates on the IP-intensive firms and Figure 3.6 on the non-IP-intensive companies. According to Figure 3.4, tax rate elasticity of *Interest Paid* is positive after transfer pricing regulations have been introduced if no interest deduction limitations exist. This finding supports Hypothesis 3 of our study. Moreover, the tax rate sensitivity is negative irrespective of the level of transfer pricing strictness if interest deduction limitations are present, which is in line with Hypothesis 4.

According to column IV of Table 3.2, in the sample of non-IP-intensive firms the tax rate seems to have a positive impact on interest paid if no anti-avoidance regulations exist. This supports Hypothesis 1, according to which these companies shift via intra-group debt rather than transfer pricing manipulation in the unrestricted case. Hence, it is also conclusive that the coefficient on the interaction term between tax rate and interest deduction limitations is higher (in absolute terms) for the sample of non-IP-intensive companies as compared to their IP-intensive counterparts. The interaction between the tax rate and the transfer pricing rules is positive but not statistically significant in the case of non-IP-intensive enterprises. This also matches our assumption that in the non-restricted case companies with a low IP intensity do not make extensive use of shifting via transfer pricing manipulation. For this reason, an introduction of transfer pricing documentation rules does not necessarily have to influence these companies. The coefficient on the triple interaction is negative and statistically significant only for companies with a high IP intensity. Hence, in the case of non-IP-intensive firms, interest deduction limitations seem to be effective in reducing profit shifting via interest payments irrespective of the transfer pricing regulations.

Figure 3.4 Average Marginal Effects of CIT on Interest Paid: Full Sample

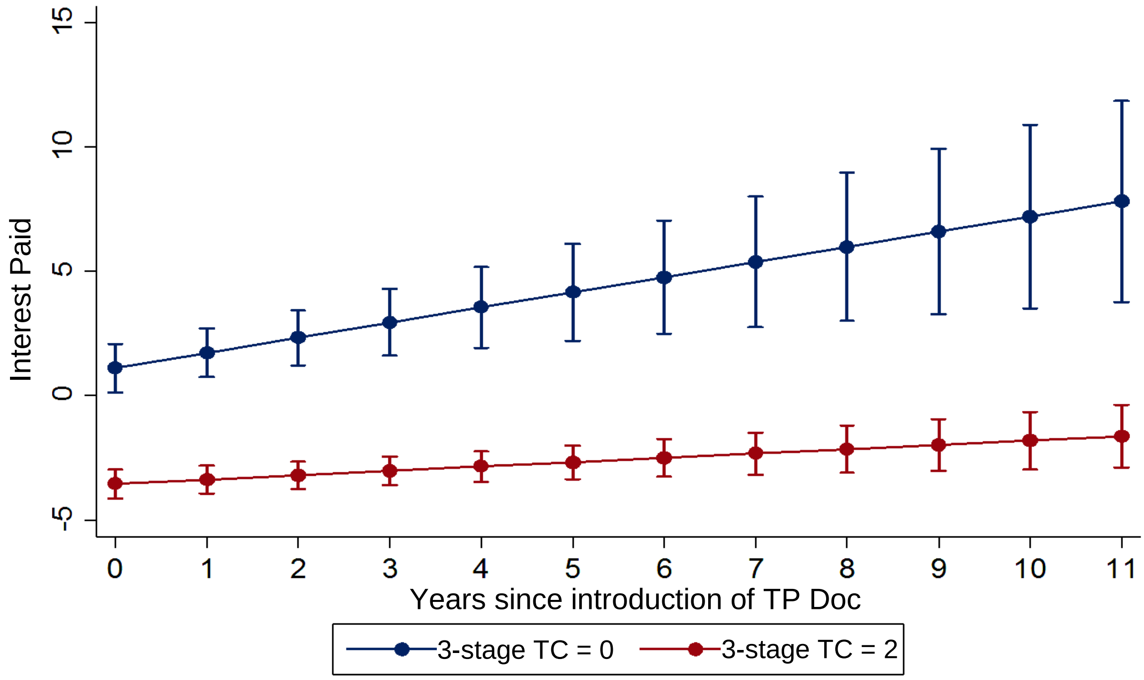


Figure 3.5 shows that if strict interest deduction limitations and strict transfer pricing regulations exist, IP-intensive companies feature a negative tax rate sensitivity of interest paid. This suggests that a simultaneous application of both sets of anti-avoidance rules effectively decreases shifting of IP-intensive firms via the channel of interest payments. As shown in the previous section, an application of both sets of regulations has a less effective outcome in the case of shifting via intra-firm trade. Hence, we conclude that IP-intensive firms have a substantial leeway for profit shifting by means of transfer pricing manipulation even if formal transfer pricing regulations exist, which is in line with Hypothesis 4. By contrast, Figure 3.6 shows that anti-avoidance regulations on both profit shifting channels are less effective in the

case of non-IP-intensive companies. However, these firms respond to interest deduction limitations, which points to a smaller dependency of non-IP-intensive firms on profit shifting via the channel of transfer pricing in the absence of anti-avoidance regulations.

Figure 3.5 Average Marginal Effects of CIT on Interest Paid: IP-Intensive Firms

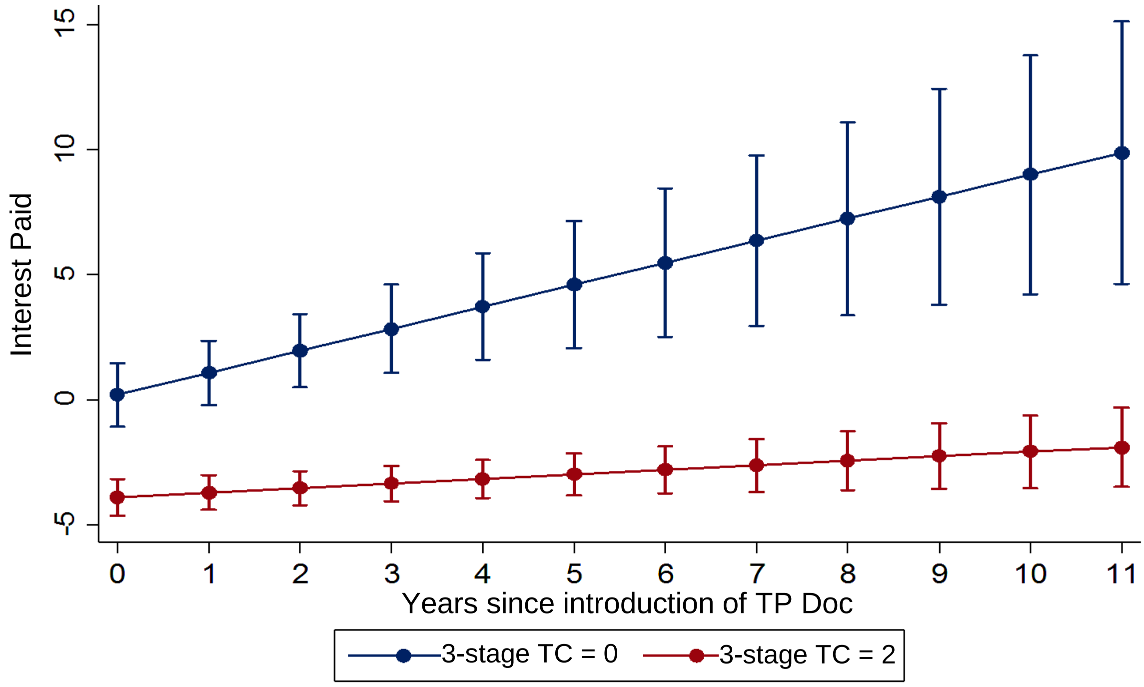
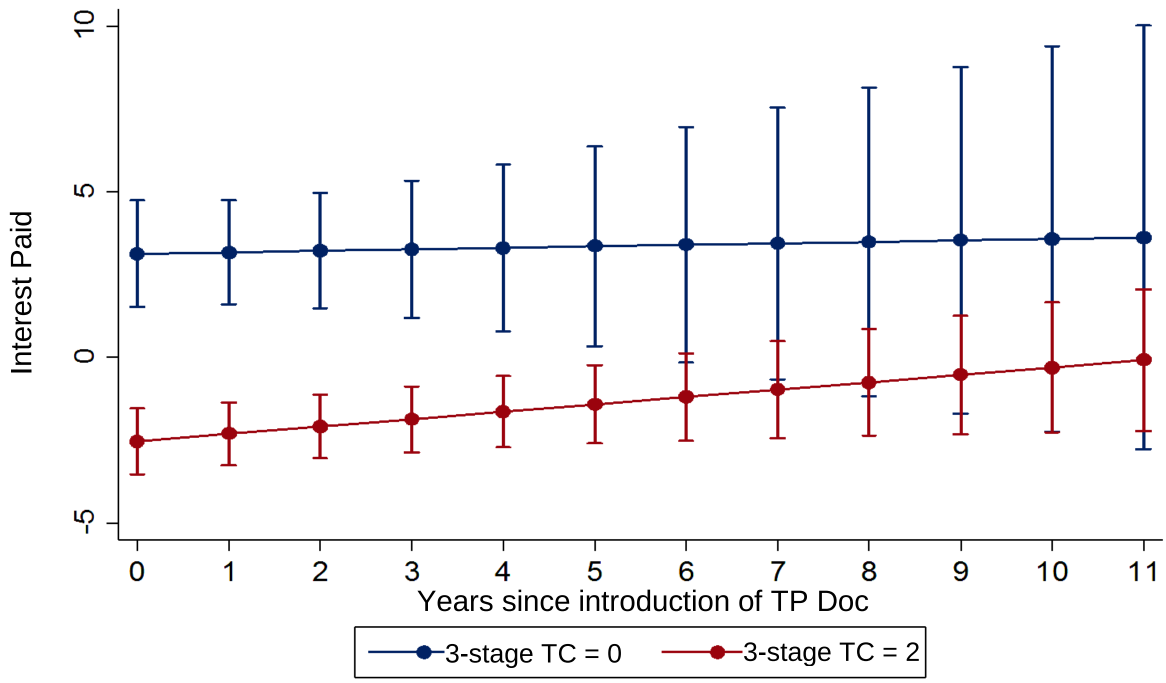


Figure 3.6 Average Marginal Effects of CIT on Interest Paid: Non-IP-Intensive Firms



In summary, following the results in columns II-IV of Table 3.2, we conclude that non-IP-intensive firms shift profits mainly via interest payments in the absence of anti-avoidance legislation, which confirms Hypothesis 1 of our study. An introduction of transfer pricing rules induces firms to increase shifting via the debt channel, which is in line with Hypothesis 3. If shifting via both channels is restricted by anti-avoidance legislation, interest deduction restrictions appear to be more effective than transfer pricing regulations, especially in the case of IP-intensive firms, which confirms Hypothesis 4. On that account, the regression results based on equations 3.13 and 3.14 provide evidence which shows that an introduction or tightening of anti-avoidance regulations tackling one profit shifting channel may trigger a substitution towards the other shifting channel. While total profit shifting might slightly decrease if strict transfer pricing documentation regulations and interest deduction limitations exist, the effectiveness of transfer pricing documentation rules appears to be less noticeable than prior studies suggest if the potential for a substitution is taken into consideration.

3.6.1.3 Robustness Tests

We conduct several robustness checks to reassess our findings. For example, we replace the indicators for anti-avoidance rules with alternative measures. The results for these robustness checks with EBIT as a dependent variable are provided in Table A.8 and the results of the robustness tests with interest paid as a dependent variable are given in Table A.9 in the appendix. Following Buettner et al. (2012), we use a non-linear transformation of the debt-to-equity ratio as an alternative indicator for interest deduction limitations (see columns I and II of Tables B.8 and B.9). If no thin capitalization rules exist, the indicator is equal to zero and in countries that apply an earnings stripping ratio this variable is set to missing.[129] Furthermore, following Lohse and Riedel (2013) we use an alternative measure for the strictness of transfer pricing regulations. This is a binary variable, which equals one if formal transfer pricing documentation rules exist in a country and zero otherwise (see columns III and IV of Tables B.8 and B.9). Moreover, we additionally incorporate informal transfer pricing documentation rules using a variable that is set to one for all countries with an informal transfer pricing documentation requirement. We combine this measure with our main variable of interest to take into account the effect of time. Consequently, this variable increases by one each year after

[129] Section 3.4.2 provides more details on the construction of this variable.

formal transfer pricing documentation rules have been introduced (see columns V and VI of Tables B.8 and B.9).

If we use the level of the debt-to-equity ratio as an indicator for interest deduction limitations, the results of the estimations according to equation 3.13 (with *Log(EBIT)* as a dependent variable) and equation 3.14 (with *Log(Interest Paid)* as a dependent variable) remain comparable to our baseline findings. One major difference is that the interaction between the interest deduction restrictions and the corporate income tax rate in column II of Table A.8 still remains negative for non-IP-intensive firms but it is no longer statistically significant. The negative triple interaction suggests that companies mainly substitute towards the transfer pricing channel if both interest deduction limitations and transfer pricing regulations are present. The results show a higher positive coefficient on the interaction between the tax rate and the transfer pricing rules indicator for non-IP-intensive companies in column II of Table A.8 and column II of Table A.9 as compared to our findings for these firms in Tables 3.1 and 3.2. This suggests that more substitution towards the debt channel occurs only in the presence of transfer pricing regulations.

If we use an alternative transfer pricing variable based on Lohse and Riedel (2013), most of our baseline results are confirmed. The only difference is that the tax rate sensitivity of IP-intensive firms is negative but no longer statistically significant once we use an alternative measure (see column III of Table A.8). Moreover, the interaction between the tax rate and transfer pricing rules (in the regression with *Log(EBIT)* as a dependent variable) is no longer statistically significant for companies with a low IP intensity. However, these results have to be treated with caution, since the binary *TP* variable exhibits considerably less variation in our sample compared to our benchmark indicator for transfer pricing regulations. The transfer pricing variable which incorporates both informal transfer pricing documentation rules and the effect of time on the strictness of transfer pricing regulations (see columns V and VI of Table A.8) shows no substantial difference to the baseline findings.

In addition to using alternative definitions of the anti-avoidance regulations, we also apply alternative definitions of IP intensity. The results for regressions with EBIT as a dependent variable are shown in Table A.10 and the results for estimations with interest paid as a dependent variable are provided in Table A.11 in the appendix. In the first variation (see columns I and II of Tables B.10 and B.11), we split the sample according to a group’s ratio of intangible assets to total assets. Under this definition, companies active in R&D-intensive industries are (contrarily to our main regression results) not automatically assumed to be IP-intensive. In the second alternative (see columns III and IV of Tables B.10 and B.11), we define IP intensity based on the level of intangible assets held by an affiliate instead of the ratio of intangible assets to total assets. In a third alternative (see columns V and VI of Tables B.10 and B.11), we use the ratio of intangible assets to total fixed assets and additionally include all firms active in R&D-intensive industries in the sample of IP-intensive companies. The variations in the definition of IP intensity do not alter our baseline findings.

Finally, we add headquarter companies back to our sample. The results of this robustness test for both EBIT and interest paid as dependent variables are shown in Table A.12 in the appendix. The empirical findings that arise from using this sample closely resemble our benchmark results. However, the magnitudes of the tax sensitivity of EBIT and interest paid in the absence of anti-avoidance regulations are somewhat smaller (in absolute terms) than our baseline findings. This also applies to the tax sensitivity in the case where both anti-avoidance regulations are strict, which confirms the previous findings by Dischinger and Riedel (2010) and Dischinger et al. (2014) who claim that headquarter firms are less prone to shift profits than other group affiliates.

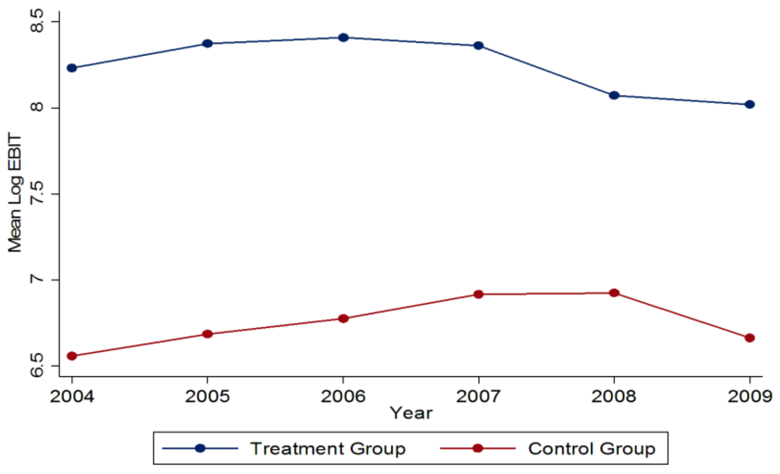
3.6.2 Quasi-Experimental Analysis of a French Tax Reform

3.6.2.1 Baseline Findings

The empirical evidence presented in the previous section suggests that multinational enterprises are able to substitute between profit shifting channels. In order to validate this finding, we additionally examine the outcomes of a reform in France using a difference-in-difference approach. As described in section 3.5.2, we divide the sample into treatment and control groups in this part of the analysis. Figure 3.7 shows that the average EBIT of treatment and control groups followed a parallel trend during the three years prior to the reform introduction in 2007. However, the average reported profits declined more for treated firms than for the untreated ones in the post-reform years. On that account, the parallel trend assumption required for a difference-in-difference setting can be confirmed for both the full sample (Panel A) and the subsample of IP-intensive firms (Panel B).

Figure 3.7 Common Trend of EBIT in Treatment and Control Groups

Panel A. Full Sample



Panel B. IP-Intensive Firms

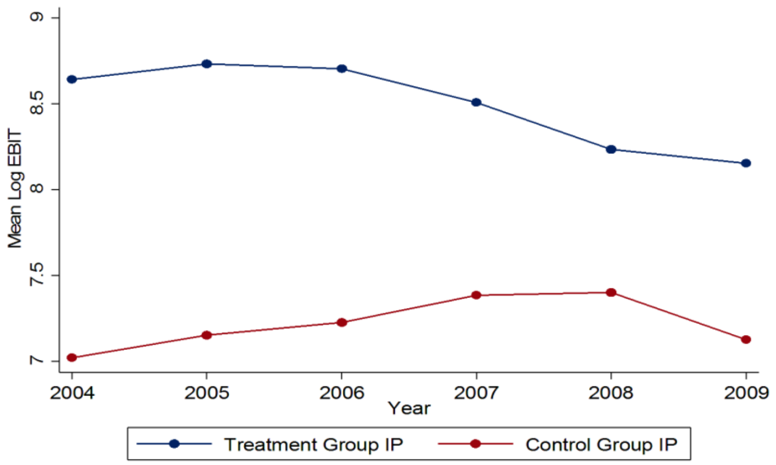


Table 3.3 summarizes the results of the difference-in-difference estimation. Column I presents the regression results with both industry-year and firm fixed effects but not the firm-level time-variant variables. The coefficient on the difference-in-difference estimator is negative and statistically significant at the level of 1%. It remains negative and statistically significant once we add fixed assets and employee compensation to the benchmark specification (see column II). This finding confirms Hypothesis 2 along with our previous results, suggesting that firms react to an introduction or tightening of interest deduction restrictions by using transfer pricing manipulation more aggressively.

In order to test the idea that treated firms differ in their potential to manipulate transfer prices, we conduct the benchmark analysis separately for IP-intensive and non-IP-intensive companies. The results shown in columns III and IV of Table 3.3 indicate a negative and statistically significant coefficient on the difference-in-difference estimator for IP-intensive companies and an insignificant coefficient for non-IP-intensive firms. The magnitude of the coefficient for IP-intensive companies is more negative than the coefficient for the full sample. This finding supports Hypothesis 4, according to which companies with a high IP intensity have more leeway in substituting debt shifting by transfer pricing manipulation. In order to validate these results, we conduct a triple difference-in-difference estimation instead of splitting the sample into two parts. This is carried out by including an indicator variable for intangibles' intensity *IP* into the benchmark model. The coefficient on the triple difference estimator appears to be negative and statistically significant. Furthermore, with an F-value of 6.4 the joint coefficient is also highly significant. These results further support Hypothesis 4.

Table 3.3 Regression Results of the Difference-In-Difference Estimation: Log(EBIT) as a Dependent Variable

	Full Sample		IP	Non-IP	Full
	I	II	III	IV	V
After	1.525	-0.868**	-0.273***	-1.216**	-0.891**
	(0.966)	(0.410)	(0.053)	(0.523)	(0.405)
*Treat*After*	-0.367***	-0.314**	-0.573***	-0.097	-0.066
	(0.131)	(0.126)	(0.157)	(0.164)	(0.166)
*After*IP*					0.056
					(0.046)
*Treat*After*IP*					-0.497**
					(0.227)
Controls	No	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
No. of Companies	938	938	506	432	938
No. of Observations	5,628	5,628	3,036	2,592	5,628
R^2 (within)	0.072	0.124	0.165	0.104	0.125

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Robust standard errors are reported in parentheses. Units of observation are firms. The dependent variable is *Log(EBIT)*, which denotes a natural logarithm of a firm's earnings before interest and taxes. *After* is equal to zero for pre-reform years between 2004 and 2006 and takes on the value of one for the post-reform period between 2007 and 2009. *Treat* is a binary variable that is equal to one for all firms that are assigned to the treatment group and is equal to zero for all companies assigned to the control group. *Controls* includes *Log(Fixed Assets)* and *Log(Costs of Empl.)*, which represent natural logarithms of a company's fixed assets and the cost of employees respectively. FE stands for fixed effects. IP represents a sample of IP-intensive firms as defined in section 3.5.3 and Non-IP includes a sample of all other companies.

3.6.2.2 Robustness Tests

As a robustness test, we check whether our benchmark results remain the same once we define the treatment group differently. The corresponding estimation outcomes are shown in Table 3.4 and we begin by assigning only companies that have a tax incentive and a parent firm in an EU member state or a country with a required treaty to the treatment group. The additional requirement of interest payments above 150,000 EUR is ignored. Here, treated firms are indicated by the variable $Teat_2$. As a second alternative, we refer to the mean instead of the median interest payments in the three years prior to the reform to determine whether companies fulfil the requirement of interest payments above the exempt amount (see $Teat_3$).

Table 3.4 Robustness Tests Using Alternative Definitions of Treatment and Control Groups as Well as a Placebo Test: Log(EBIT) as a Dependent Variable

	Full Sample			
	I	II	III	IV
After	-0.866**	-0.868**	0.060	
	(0.409)	(0.410)	(0.132)	
*$Treat_2$*After*	-0.104*			
	(0.057)			
*$Treat_3$*After*		-0.308**		
		(0.120)		
*$Treat_4$*After*			-0.315**	
			(0.135)	
After(Placebo)				-0.184
				(0.574)
*Treat*After(Placebo)*				-0.082
				(0.133)
Controls	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of Companies	1,040	938	204	938
No. of Observations	6,240	5,628	1,224	3,752
R^2 (within)	0.115	0.124	0.115	0.158

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Robust standard errors are reported in parentheses. Units of observation are firms. The dependent variable is *Log(EBIT)*, which denotes a natural logarithm of a firm's earnings before interest and taxes. *After* is equal to zero for pre-reform years between 2004 and 2006 and takes on the value of one for the post-reform period between 2007 and 2009. *After(Placebo)* is equal to zero for 2004 and 2005 and takes on the value of one for 2006 and 2007. *Treat* is a binary variable that is equal to one for all firms that are assigned to the treatment group and is set to zero for all companies assigned to the control group. *Controls* includes *Log(Fixed Assets)* and *Log(Costs of Empl.)*, which represent natural logarithms of a company's fixed assets and the cost of employees respectively. FE stands for fixed effects.

Finally, rather than referring to the tax incentive as a precondition of being assigned to the treatment group, we classify all companies with a parent in the EU or a treaty-exempted country with interest above 150,000 EUR as the treatment group (see *Teat₄*) instead. According to columns I-III of Table 3.4, the alternative definitions of the treatment group yield results that are similar to the baseline findings. Moreover, we conduct a placebo test, in which we assume that the reform was enforced in 2006 instead of 2007. According to column IV of Table 3.4, the results of a placebo test turn out to be statistically insignificant.

In line with the analysis presented in section 3.6.1.3, we test the findings of this part of the paper using two alternative definitions of IP intensity. According to Table 3.5, the results remain almost unchanged once IP-intensive firms are defined differently. The coefficient on the difference-in-difference estimator is negative and statistically significant in the case of IP-intensive firms, which demonstrates the robustness of our baseline findings.

Table 3.5 Robustness Tests Using Different Definitions for IP Intensity: Log(EBIT) as a Dependent Variable

	IP: intangible assets/total assets of a group > median of all groups		IP: intangible assets of a group > median of all groups	
	IP	Non-IP	IP	Non-IP
	I	II	III	IV
After	0.838***	0.108***	0.831***	0.110**
	(0.253)	(0.040)	(0.247)	(0.046)
*Treat*After*	-0.563***	-0.126	-0.529***	-0.039
	(0.170)	(0.181)	(0.177)	(0.145)
Controls	Yes	Yes	Yes	Yes
Year-Industry FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
No. of Companies	427	385	434	378
No. of Observations	2,562	2,310	2,604	2,268
R^2 (within)	0.192	0.118	0.197	0.122

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Robust standard errors are reported in parentheses. Units of observation are firms. The dependent variable is *Log(EBIT)*, which denotes a natural logarithm of a firm's earnings before interest and taxes. *After* is equal to zero for pre-reform years between 2004 and 2006 and takes on the value of one for the post-reform period between 2007 and 2009. *Treat* is a binary variable that is equal to one for all firms that are assigned to the treatment group and is set to zero for all companies assigned to the control group. *Controls* includes *Log(Fixed Assets)* and *Log(Costs of Empl.)*, which represent natural logarithms of a company's fixed assets and the cost of employees respectively. FE stands for fixed effects. IP represents a sample of IP-intensive firms and Non-IP includes a sample of all other companies.

3.7 Conclusion

This paper theoretically and empirically analyzes the substitution between two profit shifting channels such as the strategic use of intra-firm trade and internal debt. The main contribution of this study is the combination of two strands of empirical literature: the first strand analyzes the influence of transfer pricing rules on an affiliate's reported profits (see as examples: Bartelsman and Beetsma (2003), Lohse and Riedel (2013), Saunders-Scott (2013), Beer and Loeprick (2015)). The second strand of literature investigates the impact of interest deduction restrictions on a company's internal leverage (see as examples: Weichenrieder and Windischbauer (2008), Overesch and Wamser (2010), Buettner et al. (2012), Blouin et al. (2014)). Expanding on the research conducted by Saunders-Scott (2015), we examine whether or not there is a substitution between these two channels of profit shifting.

The empirical analysis of our study is based on two identification strategies. We begin by conducting a panel data analysis using firm-level data on European companies over the period between 2004 and 2012. Afterwards we employ data on French firms to estimate the outcomes of the 2007 reform in France, which strengthened thin capitalization rules for one group of firms while leaving them unchanged for another.

A few conclusions can be drawn from our study: first, in line with previous literature we find that an enforcement of strict transfer pricing regulations in a high-tax country leads to an increase in earnings reported by its resident companies. At the same time, an introduction of strict interest deduction limitations in a high-tax country reduces firms' interest payments. These results confirm the effectiveness of these two types of anti-avoidance regulations when they are considered apart from of one another. Secondly, we find that if the debt shifting is restricted by interest deduction limitations, more profit shifting occurs via the transfer pricing channel as long as transfer pricing regulations are not strict. In addition, a tightening of transfer pricing rules intensifies the use of interest payments for profit shifting. Therefore, we conclude that there is a substitution between profit shifting via debt and profit shifting via intra-firm trade. Thirdly, by taking into account that firms might be able to choose between transfer pricing shifting and debt shifting and that anti-avoidance rules might interact, we explicitly consider a triple interaction of the corporate income tax rate, transfer pricing rules, and interest deduction restrictions. According to our findings, firms continue to use intra-firm trade for profit shifting even if both transfer pricing rules and interest deduction restrictions exist. Finally, we find different results for IP-intensive firms and non-IP-intensive firms. In line with Beer and Loeprick (2015), we conclude that IP-intensive companies can engage more easily in profit shifting, because the arm's length price on the use of intangibles is often hard to determine and can therefore be more easily manipulated than transfer prices on other transactions or intra-group interest payments.

As for policy recommendations that arise from this study, our results show that disregarding the conditional effect might provide biased conclusions about the effectiveness of transfer pricing regulations and interest deduction restrictions. Thus, policy makers should consider the substitution between different profit shifting channels when introducing new reforms. Moreover, policy makers should take into account that IP-intensive firms have more opportunities for profit shifting and engage more aggressively in tax planning than other companies.

Chapter 4

The Impact of Taxes on Bilateral Royalty Flows

4.1 Introduction

In recent years, the issue of base erosion and profit shifting (BEPS) has increasingly gained importance in the tax policy agenda of the Organization for Economic Co-Operation and Development (OECD),[130] the G20,[131] and the European Commission.[132] These organizations have formally recognized the harmfulness of BEPS and developed an Action Plan[133] to combat it. One of the key objectives of this plan is to restrict the strategic use of intangible assets for profit shifting. For example, Action 8 of the OECD Action Plan on BEPS (2013) suggests that an important task of the international community is "[…] ensuring that profits associated with the transfer and use of intangibles are appropriately allocated in accordance with […] value creation."[134]

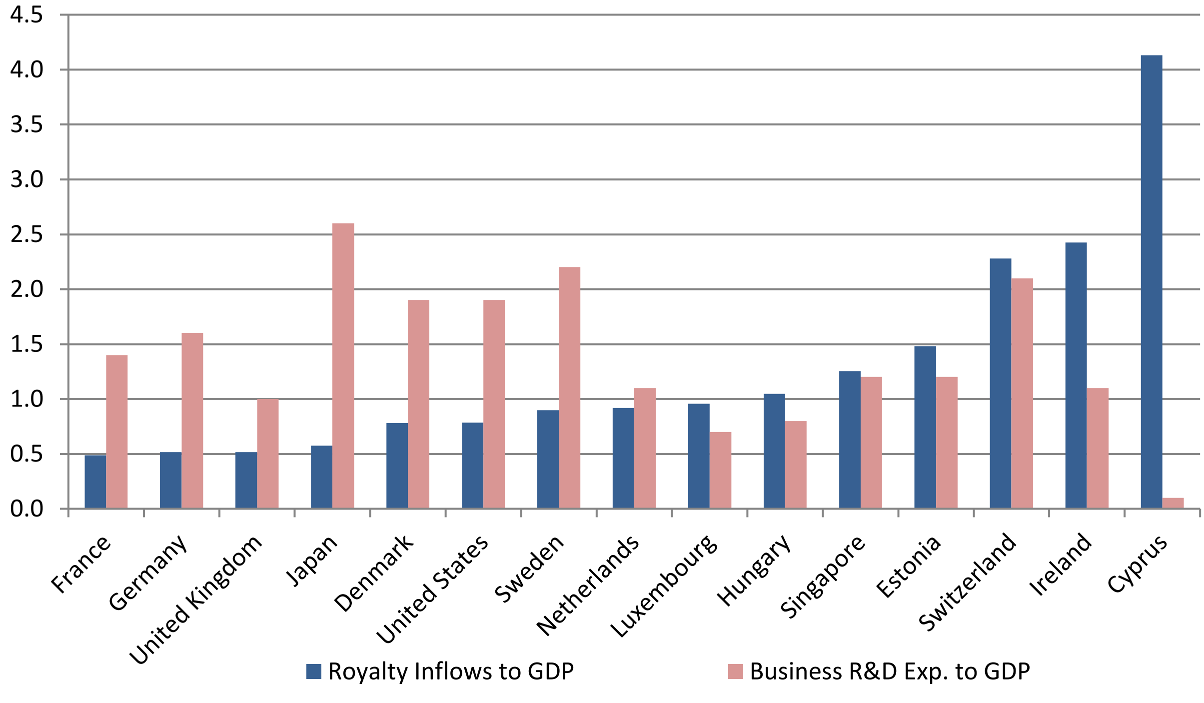
There are several ways in which multinational enterprises (MNEs) may strategically use intangible assets. First, firms that use foreign intellectual property (IP) have to pay royalties to the IP owners. Kopits (1976) notes that royalties set between non-related parties are determined by the significance of the technology, availability of alternatives, research expenses, and other factors. By contrast, royalties transferred between related parties might deviate from the true price in order to shift profits from high-tax affiliates to low-tax group members and eventually to minimize an overall corporate income tax (CIT) burden of a multinational group. Secondly, a multinational might decide to locate its IP-creating unit at a low-tax subsidiary, as Dischinger and Riedel (2011) suggest. Moreover, the authors argue that even if the initial asset is created in a high-tax country, a relocation of the intangible's ownership to a low-tax affiliate at a later

[130] See OECD (2013a).
[131] See OECD (2015a).
[132] See COM (2016a).
[133] See OECD (2013a) and OECD (2015a).
[134] See OECD (2013a), p. 20.

date may still be attractive from a multinational's point of view. Manipulating intra-group royalty payments and strategically locating or relocating intangible assets within a corporate group would increase the royalty transfer from high-tax to low-tax affiliates. That is why the main aim of this paper is to establish whether corporate taxation affects bilateral royalty flows and to confirm or reject the argument that multinational enterprises use intangible assets for profit shifting.

Figure 4.1 presents some insights into the data on international royalty flows. It shows fifteen countries with the largest share of royalty inflows in relation to gross domestic product (GDP) in 2012. In addition, this figure details R&D intensity of these countries measured as a ratio of business expenditure on research and development (R&D) in relation to GDP.[135]

Figure 4.1 The Ratio of Royalty Inflows in Relation to GDP (Top 15 Recipients), 2012, %



Notes: GDP stands for gross domestic product and R&D stands for research and development. Sources: OECD, database *Trade in Services – EBOPS*[136] and Eurostat, database *Total Intramural R&D Expenditure (GERD) by Sectors of Performance [rd_e_gerdtot] – Business Enterprise Sector.*[137]

According to Figure 4.1, some of the top recipients of royalty payments are low-tax countries such as Ireland, the Netherlands, and Switzerland. It should be noted that several of these

[135] See OECD (2016b).
[136] See OECD (2002, 2010).
[137] See Eurostat (2016).

countries have a high R&D intensity as well. For example, in Switzerland the share of business R&D expenditure in relation to GDP was 2.1% in 2012, which is of the same magnitude as in the United States (1.9%) and Japan (2.6%). However, with regard to other low-tax countries that are less R&D-intensive, taxation might be one of the factors that determines their royalty inflows. This research question constitutes the focus of our study.

We investigate the link between taxation and royalties using the OECD statistics on bilateral royalty flows. Our sample includes 3,422 country-pairs that we observe in the period between 1995 and 2012. As for the identification strategy, we apply the Poisson pseudo-maximum likelihood estimator in a fixed-effects framework in our baseline model. According to our main findings, the elasticity[138] of royalty intensity with respect to taxation is -2.3. This implies that increasing the taxation of royalties by 1% leads to a -2.3% drop in bilateral royalty payments in relation to sales. The following example demonstrates the economic significance of these results. An average ratio of royalties to sales in our dataset equals 0.01%, or 30 million USD. Assuming that royalty taxation does not influence sales, a one percent decrease in the taxation of bilateral royalty flows would increase an average bilateral royalty flow by 690 thousand USD, a sizable amount.

The contribution of this study to the previous literature is threefold: first, our analysis closely relates to the empirical research on the effect of taxation on bilateral royalty payments (see as examples: Kopits (1976), Hines (1995), Grubert (1998), Collins and Shackelford (1998), Mutti and Grubert (2009)). We contribute to this literature by applying a different identification strategy, which allows us to control for unobserved country or country-pair specific effects that may be heavily correlated with tax levels. In addition, earlier studies used to focus on the US multinationals and their foreign subsidiaries, whereas our analysis includes a broader range of countries. Hines (1995) finds that the tax elasticity of the intensity of royalty payments is between 0 and -1.0. Our preferred identification strategy, in turn, results in a -2.3 elasticity of royalty intensity with respect to taxation and this finding is robust against using the estimation approach chosen by Hines (1995).[139] We also extend the research questions of earlier studies by identifying, for example, that both tax rates and tax differentials between countries affect bilateral royalty flows.

[138] Elasticity is defined as a percentage change in the dependent variable in response to a percentage change in the independent variable.
[139] Section 4.4.1 provides a more detailed comparison of our results to the previous literature.

Secondly, we contribute to the empirical literature on taxation and the location of intangible assets (see as examples: Huizinga et al. (2008), Dischinger and Riedel (2011), Karkinsky and Riedel (2012), Griffith et al. (2014), Alstadsæter et al. (2015), Böhm et al. (2015), Bradley et al. (2015), Dinkel and Schanz (2015)). These authors argue that the low-tax affiliates of multinational enterprises tend to hold a larger number of intangible assets than their counterparts in high-tax countries. Ernst et al. (2014) show that multinationals are not just likely to locate their intangibles in tax havens, they also seemingly tend to place their most valuable assets there. We expand on these studies by estimating the effect of taxation on royalties, which are fees paid for the use of intangibles. The estimates that we find using data on royalty payments reflect both effects – the tax elasticity of the location of intangible assets and the tax elasticity of their quality.[140]

Finally, we contribute to the ongoing work on the OECD Action Plan on BEPS by analyzing several of its reform suggestions and quantifying their potential outcomes. For instance, this paper provides an empirical investigation which shows how enforcing the Nexus Approach,[141] together with an implementation of controlled foreign company rules and an introduction of strict transfer pricing regulations, could affect bilateral royalty flows.[142] We find that anti-avoidance measures suggested within the scope of the OECD Action Plan on BEPS are likely to limit the use of intangibles as a means of profit shifting and will therefore reduce bilateral royalty flows.

The paper is structured as follows: section 4.2 describes the conceptual framework behind our empirical analysis. Section 4.3 presents the model of estimation and explains the construction of the main variables. Section 4.4 provides a summary of the key findings followed by a few robustness checks and extensions. Finally, section 4.5 draws an overall conclusion and identifies what changes could be made when carrying out any future empirical analyses within this field.

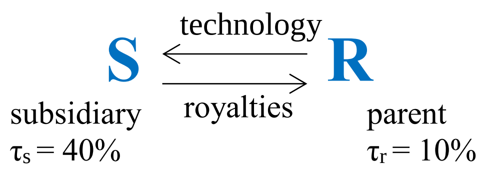
[140] Any elasticity with respect to patent counts is consistent with even larger elasticities regarding license payments (as a single patent may suffice to induce a very large sum of license payments).
[141] See OECD (2015a) for more information.
[142] The Nexus Approach, controlled foreign company rules, and transfer pricing regulations are addressed respectively in Actions 5, 3, and 7 of the OECD Action Plan on BEPS. See OECD (2013a).

4.2 Conceptual Framework

4.2.1 Motives behind Profit Shifting

To explore the motives behind profit shifting, in Figure 4.2 we provide an illustration of a royalty flow between two companies. A multinational company shown in this figure consists of a parent firm and its wholly owned foreign subsidiary. The parent provides its affiliate with new technology and receives royalties in return, which results in royalty payments being transferred from a source country *S* to the recipient country *R*. Without a loss of generality, we further assume that the statutory corporate income tax rate is 40% in *S* and 10% in *R*.

Figure 4.2 An Illustration of a Royalty Flow between Two Companies



Kopits (1976) argues that if firms located in *S* and *R* are not related, a royalty payment is determined by the significance of the technology, availability of alternatives, market demand structure, R&D expenditure, and other institutional and legal factors. By contrast, royalties transferred between related parties (as shown in Figure 4.2) might be independent of market forces or technological conditions and may instead depend on the tax burden incurred in each country of operation. For instance, if the multinational represented in Figure 4.2 were interested in shifting profits from a subsidiary to the parent, it would increase royalty payments above the arm's length price. Since the true price for the use of intangible assets is often hard to determine due to the lack of comparable arm's length transactions, the tax authorities may be unable to argue against royalty fees that deviate from the arm's length value. As a result, part of the subsidiary's profits is shifted to the low-tax country, which ultimately minimizes a multinational's overall tax liability.

Furthermore, instead of manipulating the amount of royalty payments, a multinational could relocate its intangible assets to the low-tax group member.[143] The multinational represented in Figure 4.2 would then relocate all intellectual property to the parent in order to increase its

[143] See Dischinger and Riedel (2011), p. 691-693.

royalty payments to the low-tax country. Endres and Spengel (2015) provide an overview of a few tactics that an MNE could use for a strategic location or relocation of intangible assets between group members. To give an example, under a contract R&D project a high-tax affiliate conducts research, while the low-tax affiliate agrees to bear the financial risks. The latter becomes the owner of a resulting intangible and consequently receives royalties from other group members that use this intellectual property. Alternatively, an affiliate in a high-tax country might sell an intangible asset to a group member located in a low-tax jurisdiction. Nevertheless, this strategy might trigger not only a high selling price but an exit tax as well. Finally, a multinational could decide to carry out its research and development in a low-tax country. However, as one of the major inputs of R&D is human capital, this decision might generate high expenses in the case where domestic researchers are relocated or local researchers have to receive training.

4.2.2 Theoretical Considerations

4.2.2.1 Baseline Model

We apply a theoretical framework based on Dharmapala and Riedel (2013), Hines (1995), Grubert (2003), and Huizinga et al. (2008) to analyze the effect of taxation on international royalty flows. In line with these authors, we develop a model of a profit-maximizing multinational enterprise that transfers intra-group royalties. Furthermore, we consider the tax consequences that companies face when they exchange royalties under different methods of double taxation avoidance such as a tax credit, an exemption, and a deduction method.

In line with Dharmapala and Riedel (2013), we assume that the affiliate shown in Figure 4.2 earns pre-tax profits π_s and its parent earns π_r. In addition, the subsidiary's country charges a corporate tax τ_s and the parent's country levies τ_r. We also assume that the subsidiary generates sales using local inputs of capital, labor, and intermediate products as well as intellectual property provided by the parent firm and its own technology. Referring to Hines (1995), we define S as a subsidiary's sales in the local market, R as the technology provided by the parent firm, R^* as the technology that the affiliate generates on its own, and we set φ to represent other input factors of the local market. An affiliate's profits can then be defined as $\pi_s = (S(R, R^*, \varphi) - R^* - r)$, where r stands for a royalty payment transferred from the subsidiary to the parent.[144]

[144] See Hines (1995), p. 232.

At the same time, we assume that profits of the parent company consist of exogenously earned profits π_r and royalty income r.

As discussed above, multinationals may set royalties below or above the arm's length value for profit shifting reasons. However, deviations of royalty payments from the arm's length price could bring about different types of costs. For example, Dharmapala and Riedel (2013) argue that profit shifting might increase a multinational's expenses on legal and accounting services if a situation occurs where the level of royalty payments has to be justified to the local tax authorities or needs to be defended in court. Furthermore, according to Grubert (2003), a multinational engaged in profit shifting not only faces the risk of tax penalties but also bears the cost of economic inefficiencies created by profit shifting. There might also be concealment costs or costs associated with negative publicity if advocacy groups, such as the Tax Justice Network,[145] disseminate the effective tax rate of a multinational, as Dharmapala and Riedel (2013) note. Consistent with the works of Hines (1995), Grubert (2003), Huizinga et al. (2008), and Dharmapala and Riedel (2013), we assume that the need for a strong justification of the size of royalty payments increases with a growing difference between the true value of transferred technology R and royalties paid by a subsidiary to its parent firm r. In addition, we follow Hines and Rice (1994) and Huizinga and Laeven (2008) and assume that shifting costs are decreasing with growing R. This reflects the idea that a firm's accounts have to be distorted relatively little to accommodate profit shifting if the true value of transferred technology is relatively large. As a result, we express the total shifting costs of a multinational shown in Figure 4.2 as $a(R-r)^2/R$, where α is a constant factor.

Some of the costs associated with profit shifting are tax deductible and others are not. In the baseline scenario, we follow Dharmapala and Riedel (2013) along with Grubert (2003) and Huizinga et al. (2008) and assume that shifting costs are not tax deductible.[146] Hence, the multinational enterprise presented in Figure 4.2 maximizes its after-tax profit Π which is expressed as follows:

[145] More information can be found at: http://www.taxjustice.net/

[146] According to Dharmapala and Riedel (2013), if the shifting costs were assumed to be deductible, it would not be entirely obvious in which country they would be incurred and a multinational would have an incentive to shift these deductions from one country to another. However, as a robustness check we follow Hines (1995) and assume that the shifting costs are deductible at the level of a shifting subsidiary. We present the corresponding theoretical analysis along with the empirical outcomes in appendix B1. As it is evident from Table B.1, the results are not fundamentally affected if the shifting costs are assumed to be tax deductible; however, the interpretation of the findings becomes more complex.

$$\Pi = (1 - \tau_s)(S(R, R^*, \varphi) - R^*) + (1 - \tau_r)\pi_r + + (\tau_s - \tau_r)r - \alpha \frac{(R - r)^2}{R} \tag{4.1}$$

The first term of equation 4.1 represents the subsidiary's after-tax profits, while the second term shows the parent's after-tax profits. The third term describes the after-tax royalty payments transferred from a source country *S* to a recipient country *R*. Finally, the last term indicates costs that arise from profit shifting. τ_s denotes the statutory corporate income tax rate in a source country and τ_r is the statutory CIT rate in the recipient country. The first order condition of Π describing an optimal choice of transferred royalties then reads as

$$\frac{\partial \Pi}{\partial r} = (\tau_s - \tau_r) + \frac{2\alpha (R - r)}{R} = 0 \tag{4.2}$$

which yields

$$r = R\left(1 - \frac{(\tau_r - \tau_s)}{2\alpha}\right) \tag{4.3}$$

According to equation 4.3, optimal royalties transferred from a subsidiary to the parent increase with an increasing corporate income tax rate in a subsidiary's country τ_s and decrease with an increasing corporate income tax rate in the parent's country τ_r. In addition, transferred royalties should increase with the growing true value of transferred technology.

4.2.2.2 Elaboration of the Baseline Case

Calculations presented in equations 4.1-4.3 apply to the majority but not to all royalty transactions. This is due to different double taxation relief (DTR) systems that exist across countries. These regulations determine a country entitled to levying taxes on bilateral royalty flows, which helps to avoid double taxation. Table 4.1 summarizes taxation of royalty payments under different systems of double taxation relief. According to Table 4.1, an exemption implies that the tax on royalty payments from a source country *S* to a recipient country *R* is equal to a withholding tax w_s. If an ordinary tax credit applies, the taxation of royalty flows consists of either a withholding tax w_s or a corporate income tax in the recipient country τ_r. The amount of a tax burden in this case depends on whether the withholding or corporate income tax rate is higher. If the recipient country allows taxes that are paid on royalties abroad to be deducted, the tax rate consists of a withholding tax as well as τ_r on the income after inference of a withholding tax.

Table 4.1 Taxation of Bilateral Royalty Payments

Exemption		w_s
Ordinary Tax Credit	if $w_s \geq \tau_r$	w_s
	if $w_s < \tau_r$	τ_r
Deduction		$w_s + (1 - w_s)\,\tau_r$

Notes: Taxation is stated from the perspective of the recipient country, i.e. it calculates the tax burden, which effectively applies to royalties paid by a firm in the source country to a firm in the recipient country. The exemption method leads to the smallest tax burden, whereas the deduction results in the largest tax burden for companies. In a given instance for a country such as Germany, the source country levies an additional tax on royalty payments, which is taken into account in our calculations.[147]

Referring to Table 4.1, if two countries use an exemption method to avoid double taxation of bilateral royalty payments, we adjust equation 4.1 as follows:

$$\Pi = (1 - \tau_s)(S(R, R^*, \varphi) - R^*) + (1 - \tau_r)\pi_r + (\tau_s - w_s)r - \alpha\frac{(R - r)^2}{R} \qquad (4.4)$$

The first term of equation 4.4 represents taxation of the subsidiary's profits, the second term shows taxation of the parent firm's profits, the third term represents the taxation of a royalty transaction, and the last term shows the costs associated with profit shifting. Taking the first order condition of *Π* with respect to *r* and rearranging yields

$$r = R\left(1 - \frac{(w_s - \tau_s)}{2\alpha}\right) \qquad (4.5)$$

As indicated by equation 4.5, an optimal amount of royalties transferred from a source country to a recipient country decreases with a growing withholding tax w_s and increases with a growing corporate income tax in a source country τ_s. Hence, the effects of taxes on royalty flows are

[147] The German Trade Tax Act (*Gewerbesteuergesetz*, section 8 No. 1(f)) requires that 6.25% of royalties are added to the tax base of the trade tax on income. Trade tax rates differ across German municipalities and in order to quantify the value of this tax, we follow the OECD calculation of the effective corporate income tax rates and take the trade tax rate in the capital city of Berlin as a representative rate (i.e. 14.35% in 2012, which is also close to the average of all federal states). The German local tax rate on royalty outflows is then calculated as follows: 6.25%*14.35% = 0.89688%.

analogous to the ones presented in equation 4.3, with the only difference being in the types of taxes that enter the equation.

Some countries offer a tax credit on taxes paid abroad and where this happens to be the case, the taxation of a royalty transaction depends on whether a withholding tax rate in a source country or a corporate income tax rate in the recipient country is higher. If a withholding tax rate w_s exceeds the CIT rate τ_r, effectively[148] only the withholding tax is levied on royalties and as a result the scenario presented in equations 4.4-4.5 applies. By contrast, if w_s is smaller than τ_r, the CIT of the recipient country is effectively levied on a royalty payment, so that the scenario described in equations 4.1-4.3 takes place.

If a deduction method applies in a recipient country, the parent firm is allowed to deduct a withholding tax paid at source from its corporate income tax base. A multinational will then maximize its profits as in equation 4.6.

$$\begin{aligned} \Pi = (1-\tau_s)(S(R,R^*,\varphi) - R^*) + (1-\tau_r)\pi_r + \\ + \big((1-\tau_r)(1-w_s) - (1-\tau_s)\big)r - \alpha\frac{(R-r)^2}{R} \end{aligned} \quad (4.6)$$

In equation 4.6, the first term represents the taxation of an affiliate's profits, while the second term shows taxation of the parent. The third term reflects taxation of a subsidiary's income shifted as a royalty payment. According to the third term, the parent deducts a withholding tax paid abroad from its taxable income. The final term of equation 4.6 represents costs associated with profit shifting. An optimal choice of royalties in this case equals

$$r = R\left(1 - \frac{((1-\tau_s) + (1-w_s)(1-\tau_r))}{2\alpha}\right) \quad (4.7)$$

According to equation 4.7, statutory corporate income tax rates in the source and recipient countries along with a withholding tax rate on royalty outflows influence the royalty fees transferred from the subsidiary to its parent.

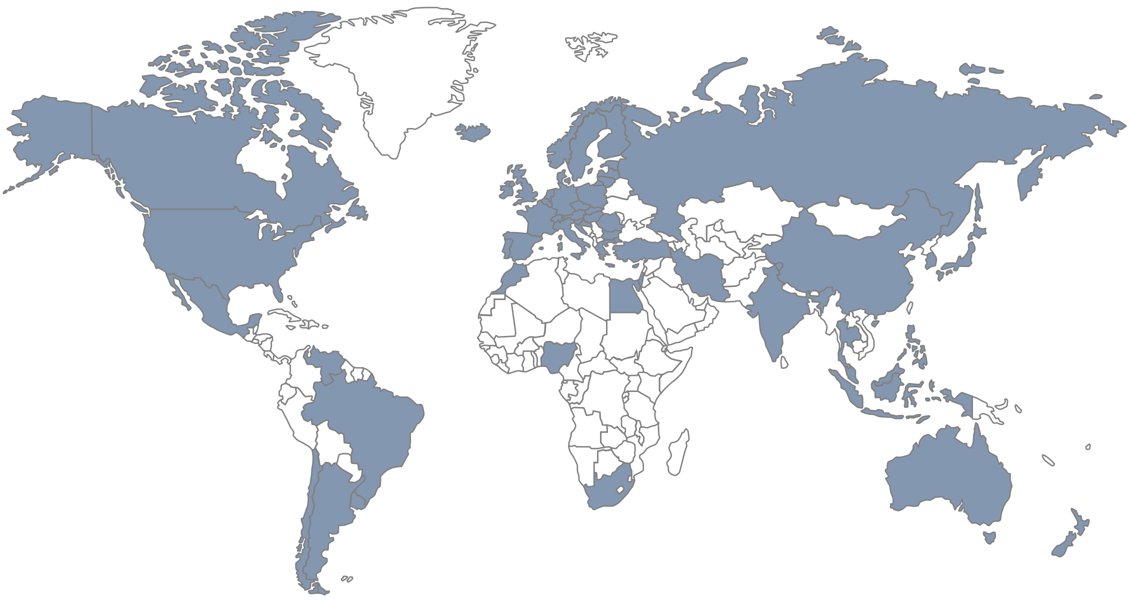
[148] With the word "effectively", we mean the following: both a withholding tax and a corporate income tax are paid on a royalty transaction; however, a company in a recipient country receives a tax credit on withholding taxes paid abroad. Since a withholding tax rate exceeds the corporate income tax rate, the tax credit does not suffice to make up for withholding taxes paid abroad. As a result, the amount of taxes paid on a royalty transaction equals the withholding tax rate.

4.3 Empirical Strategy and Specification

4.3.1 Sample

We test predictions formulated in section 4.2 by empirically analyzing data on bilateral royalty flows. Our sample includes fifty-nine countries and covers the time span between 1995 and 2012. Since the empirical analysis is carried out on the country-pair level, 3,422 country-pairs enter our dataset. Figure 4.3 displays a map of countries covered in our study, with a list of these countries enclosed in Table B.2 in the appendix. As shown, all thirty-four OECD members and additionally twenty-five non-OECD states[149] are included in our analysis.

Figure 4.3 Coverage Map



4.3.2 Baseline Specification

In order to determine whether taxation affects bilateral royalty flows, we estimate the following benchmark model:

$$Royalty\ Intensity_{srt} = \beta_0 + \beta_1 \tau_{st} + \beta_2 T_{srt} + \beta_3 \boldsymbol{X'}_{rt} + \\ + \beta_4 Log(Trade\ btw. S\ and\ R)_{srt} + \mu_{sr} + \vartheta_t + \varepsilon_{srt} \quad (4.8)$$

[149] The non-OECD countries that are included in our study are Argentina, Brazil, Bulgaria, China, Croatia, Cyprus, Egypt, Hong Kong, India, Indonesia, Iran, Latvia, Lithuania, Malaysia, Malta, Morocco, Nigeria, Philippines, Romania, Russian Federation, Singapore, South Africa, Thailand, Uruguay, and Venezuela.

According to equation 4.3 in the previous section, taxation influences royalty payments. In line with this argumentation, we refer to Hines (1995) and Mutti and Grubert (2009) and use *Royalty Intensity*$_{sr}$ as a dependent variable in our baseline empirical specification. *Royalty Intensity*$_{sr}$ represents the share of royalty flows from a source country *S* to a recipient country *R* in relation to the output of corporate sector in country *S*.[150] τ_s denotes statutory corporate income tax rate in *S*. T_{sr} stands for a tax rate on royalty flows from *S* to *R*. In order to construct this variable, we analyze double taxation avoidance methods (as shown in Table 4.1) between each country-pair and formulate T_{sr} either following equation 4.3, 4.5, or 4.7, depending on which double taxation relief applies.

$\boldsymbol{X'}_{rt}$ is a vector of the recipient country's characteristics such as *Log(R&D Exp.)*, *Log(Population)*, *Log(GDP/capita)*, and *Property Rights*. *Log(Trade btw. S and R)*$_{sr}$ depicts a logarithm of the total exports and imports of goods between countries *S* and *R*. μ_{sr} and ϑ_t denote country-pair and time fixed effects respectively, with ε_{sr} representing an error term. Table B.3 in the appendix gives definitions of all variables and contains information on the data sources. The next section provides a detailed explanation of the construction of the main variables of interest.

4.3.3 Main Variables of Interest

4.3.3.1 Royalty Intensity

Referring to previous studies on royalty payments (see Hines (1995) and Mutti and Grubert (2009)) along with our theoretical considerations presented in section 4.2, we define the dependent variable of the baseline specification as a ratio of total bilateral royalty flows[151] in relation to the total output of corporate sector in country *S*. Both the numerator and the denominator of *Royalty Intensity* are measured in millions of USD.[152] As many countries do not exchange royalties at all, this variable is concentrated at zero.

[150] For our benchmark regressions with the Poisson pseudo-maximum likelihood estimator, this implies that the total value added of the corporate sector is used as an exposure variable.

[151] If there are discrepancies in the definitions of royalty flows across countries, this could be seen as a measurement error in the dependent variable, which may cause an attenuation bias. However, the available technical description of the OECD database does not give a reason to expect substantial differences in the definitions of royalty flows across countries.

[152] *Royalty Intensity* is constructed using nominal-terms data; however, calculating this variable with real-terms data does not influence the outcomes of the empirical analysis.

4.3.3.2 Tax Variables

4.3.3.2.1 Tax Rates

Following equation 4.3, τ_s enters the baseline specification and this variable represents the statutory corporate income tax rate in *S*. Furthermore, we combine the findings from equations 4.3, 4.5, and 4.7 to construct T_{sr} which reflects the taxation of bilateral royalty flows, depending on a system of double taxation avoidance applied between two countries. As shown in Table 4.1, the methods used to avoid double taxation of royalty payments include an exemption, an ordinary tax credit, and a deduction. Table 4.2, in turn, provides statistics on how often each method occurs in our dataset, and according to this table, in around 87% of cases a company that has paid a withholding tax on royalties at source receives a tax credit in the recipient country. In around 8% of cases, a firm that has paid a withholding tax on royalties at source is exempt from further taxation of these royalties in the recipient country. All other country-pairs allow a company that receives after-withholding tax royalties to deduct the withholding tax paid at source from its tax base.

Table 4.2 Systems of Double Taxation Relief in Our Sample

	Freq.	Percent	Cum.
Exemption	5,278	8.57	8.57
Ordinary Tax Credit	53,541	86.92	95.49
Deduction	2,777	4.51	100.00
Total	61,596	100.00	

T_{sr} comprises royalty taxation either in accordance with equation 4.3, 4.5, or 4.7, depending on which DTR system applies. A following example demonstrates the calculation of this variable when we take royalties transferred from Germany to Poland in 2012 into consideration. According to the tax treaty between these two countries, an ordinary tax credit applies to the withholding tax paid on royalties at source. However, the withholding tax rate on royalties flowing from Germany to Poland is 0% due to the European Union (EU) Interest and Royalties Directive (2003).[153] Since w_s is smaller than τ_r (0% < 19%), royalties transferred from Germany to Poland are taxed according to equation 4.3, which implies that they are taxed at the Polish

[153] See European Commission (2003b).

statutory corporate income tax rate τ_r. In addition, royalties flowing from Germany from 2008 onwards have not been fully deductible from the tax base of a local trade tax on income. This implies that royalties are partially taxed with a trade tax when they are leaving the country.[154] As a result of this, the effective tax rate on royalty payments T_{sr} equals 19.897%, which is the sum of the Polish CIT rate and the German local tax rate on royalty outflows.

Table 4.3 contains details on T_{sr} and its components, with the values of this variable ranging from 0% to 60% and its average amounting to around 30%. The higher rates of T_{sr} occur in the 1990s, especially between countries that avoid double taxation with the help of a deduction method, which proves to be less favorable from a company's point of view than an ordinary tax credit or an exemption. Furthermore, Table 4.3 demonstrates that a withholding tax w_s, which enters the calculation of T_{sr}, corresponds to one of the three following withholding tax rates. The first one is a unilateral withholding tax rate that is set by each country and applies to royalty outflows if there are no bilateral tax treaties. The second one is a bilateral withholding tax rate, which is set according to a tax treaty between two countries and is usually lower than a unilateral withholding tax rate. Finally, the third one is an EU-level withholding tax rate according to the EU Interest and Royalties Directive (2003).[155] It applies between the countries of the European Union and overrules the unilateral and bilateral withholding tax rates if they exist.

Table 4.3 Descriptive Statistics on T_{sr} and Its Components

	Obs.	Mean	Std. Dev.	Min	Max
T_{sr}:	61,596	0.30	0.08	0.00	0.60
• τ_r	61,596	0.29	0.07	0.10	0.50
• w_s	61,596	0.10	0.09	0.00	0.40
Unilateral WHT in *S*	61,596	0.19	0.09	0.00	0.40
Bilateral WHT between *S* and *R*	61,596	0.06	0.06	0.00	0.40
EU-Level WHT in *S*[1]	61,596	0.003	0.02	0.00	0.10
• Local Tax on Royalties in *S*[2]	61,596	0.00	0.00	0.00	0.01

Notes: [1]EU Interest and Royalties Directive (2003) provides for a transitional regime applicable to new members of the European Union, such as Bulgaria, Greece, Latvia, Poland, and Portugal, where the withholding tax is set at 5% instead of 0%. [2]See footnote 147 for an example; the exclusion of this tax from T_{sr} does not alter our empirical findings. All variables in the table are measured in percent from 0 to 1. WHT stands for withholding tax on royalties. Countries *S* and *R* represent the royalties' source and recipient countries respectively.

[154] See footnote 147.

[155] See European Commission (2003b). It is therefore assumed that the conditions under which the EU Interest and Royalties Directive (2003) applies are fulfilled in our dataset.

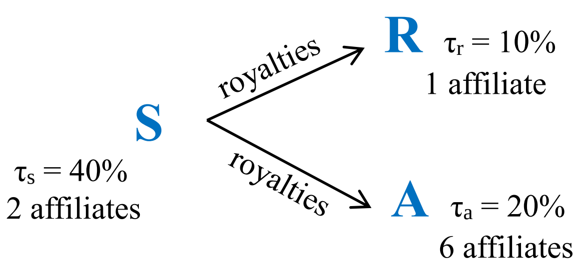
4.3.3.2.2 Tax Differences

Another independent variable of interest is *Tax Difference*. We calculate it following the framework developed by Huizinga et al. (2008), Karkinsky and Riedel (2012), and Ernst et al. (2014). This variable indicates a profit shifting incentive for multinationals. In other words, *Tax Difference* reflects a relative level of taxation in the given recipient country compared to the taxation in other countries. This variable is measured using five various methods, with $(\tau_r - \tau_s)$ representing the first one. It is an unweighted difference between the tax rates on royalty income in recipient country *R* and source country *S*. A lower level of taxation in the recipient country *R* as compared to the source country should attract more royalty inflows into *R*. However, it should be the case that even more royalties flow into the recipient country *R* if its tax rate on royalty income is not only lower in comparison to a source country *S* but also in comparison to the tax rates in all of the potential royalty recipients. Therefore, we calculate $(\tau_r - \tau_j)$ as an alternative measure of *Tax Difference*. As shown in equation 4.9, $(\tau_r - \tau_j)$ is an unweighted average of tax differences between τ_r, which is the statutory tax rate on royalty income in *R*, and τ_j, that represents an average of statutory tax rates on royalty income in the remaining fifty-eight countries *J*.

$$(\tau_r - \tau_j)_r = \sum_{j \neq r}^{n} \frac{1}{N}(t_r - t_j), \quad r \neq j \tag{4.9}$$

We demonstrate the calculation of $(\tau_r - \tau_s)$ and $(\tau_r - \tau_j)$ with the example shown in Figure 4.4, where it is assumed that country *S* only pays royalties to two countries *R* and *A*.

Figure 4.4 An Illustration of International Royalty Flows



If the tax on royalty income is 10% in *R* while it is 40% in *S* and 20% in *A*, then $(\tau_r - \tau_s)$ amounts to -30% (resulting from 10% – 40%) and $(\tau_r - \tau_j)$ is equal to -20% (resulting from 1/2(10% – 40%) + 1/2(10% – 20%)). Negative values of these variables indicate that the taxation of royalty income in *R* is relatively low, which gives multinationals an incentive to increase their royalty payments to *R*.

The first two measures of tax differences are easy to calculate and interpret, although they may be imprecise because they do not include weights on tax differences. Therefore, we calculate *$(\tau_r - \tau_j)$(affil.weight)*, which is a weighted average of tax differences between a statutory tax rate on royalty income in *R* and the statutory tax rates in other countries *J*. In order to construct the weight, initially we analyze the ownership structures of multinational firms.[156] Afterwards, we calculate the number of multinationals' foreign affiliates in each country, which enables us to determine the strength of each country-pair's connection through multinational groups.[157] The tax differences of country-pairs that are more closely connected are given a larger weighting, since shifting by means of royalty payments is easier if a firm has multiple affiliates in the source and target countries. The calculation of *$(\tau_r - \tau_j)$(affil.weight)* can be demonstrated using the example given in Figure 4.4. If it is assumed that there is a multinational company that consists of one affiliate in *R*, two affiliates in *S*, and six affiliates in *A*, *$(\tau_r - \tau_j)$(affil.weight)* will then amount to -15% (resulting from 2/8(10% – 40%) + 6/8(10% – 20%)).

$(\tau_r - \tau_j)$(affil.weight) may still measure the tax difference imprecisely, because the number of affiliates might not exactly indicate the easiness of profit shifting in or out of the country. A more precise weight would use the companies' total assets, rather than the number of foreign affiliates and this is precisely what the fourth measure of *Tax Difference* does. *$(\tau_r - \tau_j)$(assets weight)* is a weighted average of tax differences between a statutory tax rate on royalty income in *R* and the statutory tax rates in other countries *J*. The weight in this case is a ratio, the numerator of which includes the total assets of *R*'s foreign affiliates in each country *J* and the denominator of which comprises the total assets of *R*'s affiliates. The last measure of tax differences is *$(\tau_r - \tau_j)$(FDI weight)*, which is identical to *$(\tau_r - \tau_j)$(assets weight)* apart from the different weight here that corresponds to an amount of *R*'s foreign direct investment (FDI) in each country *J* relative to its total FDI. As a result, the last two measures of *Tax Difference* give more weight to the tax differences between *R* and the countries in which it carries out real economic activity.

[156] Following Ernst et al. (2014), we consider a parent firm to own a subsidiary if its ownership share exceeds 50%.

[157] Due to data availability restrictions, the information about ownership structures of multinational firms is available only for the year 2012. Therefore, in the regressions in which this data is used we assume that the ownership structures of multinationals remained constant between 1995 and 2012.

4.3.3.3 Other Control Variables

In addition to the main independent variables of interest, a few other control variables enter our baseline specification. For example, in line with Dischinger and Riedel (2011), Karkinsky and Riedel (2012), and Griffith et al. (2014), we control for the level of innovation in a recipient country. *Log(R&D Exp.)* is used as a proxy for this factor and measures country *R*'s expenditure on R&D. Referring to studies on the impact of taxation on patent location choices (see as examples: Dischinger and Riedel (2011), Ernst and Spengel (2011), Karkinsky and Riedel (2012), Ernst et al. (2014), Griffith et al. (2014), Bradley et al. (2015)), we control for the market size in a recipient country, its wealth, and a level of governance. We accomplish this by including into the estimation *Log(Population)*, *Log(GDP/capita)*, and *Property Rights* respectively. Furthermore, in line with Collins and Shackelford (1998), we add *Log(Trade btw.S and R)* to our baseline model, which denotes the sum of total exports and imports between two countries[158] and functions as a proxy for the strength of their economic partnership. Table 4.4 summarizes descriptive statistics on variables that enter regression estimations, while Table B.3 in the appendix gives an overview of data sources. As it is evident from Table 4.4, the dependent variable and the main independent variables of interest τ_s and T_{sr} along with other control variables are strictly positive. The following section addresses this issue in more detail.

4.3.4 Estimation Strategy

The dependent variable *Royalty Intensity* is concentrated at zero. Apart from this, all variables in the benchmark estimation model only acquire positive values. Previous studies that worked with data on royalty flows have also encountered these issues, which is why authors such as Hines (1995), Collins and Shackelford (1998), Grubert (1998), and Mutti and Grubert (2009) applied a Tobit estimator in their baseline specifications. The Tobit model reflects a situation where some observations are concentrated at a certain value, such as zero. For this reason, this model appears to be a more suitable option for the estimation of royalty flows compared to the ordinary least squares (OLS) estimator, for example. However, Tobit regressions are known to be inconsistent when controlling for fixed effects and are also reliant on homogenous normally

[158] Since the dependent variable *Royalty Flows* is a part of trade in services, we only consider the exports and imports of goods for the construction of *Log(Trade btw.S and R)*.

Table 4.4 Descriptive Statistics

	Obs.	Mean	Std. Dev.	Min	Max
Royalty Flows	61,596	30.05	378.25	0.00	15562.45
Output	61,596	809,603.6	1,896,839	6165.88	1.48e+07
Royalty Intensity	61,596	0.0001	0.001	0.00	0.08
τ_s	61,596	0.29	0.07	0.10	0.50
T_{sr}	61,596	0.30	0.08	0.00	0.60
ws	61,596	0.10	0.09	0.00	0.40
$(\tau_r - \tau_s)$	61,596	0.00	0.12	-0.50	0.50
$(\tau_r - \tau_j)$	61,596	0.00	0.07	-0.19	0.17
$(\tau_r - \tau_j)$*(affil.weight)*	61,596	-0.03	0.07	-0.21	0.14
$(\tau_r - \tau_j)$*(assets weight)*	61,596	-0.03	0.08	-0.42	0.28
$(\tau_r - \tau_j)$*(FDI weight)*	61,596	-0.04	0.12	-0.38	0.27
Log(R&D Exp.)	61,596	7.58	2.13	2.49	12.89
Log(GDP/capita)	61,596	9.37	1.22	6.20	11.36
Log(Population)	61,596	16.68	1.77	12.50	21.02
Property Rights	61,596	65.80	24.26	0.00	95.00
Log(Trade btw.S and R)	61,596	12.74	2.63	0.00	20.24
IP_BoxAcq	61,596	0.03	0.17	0.00	1.00
IP_Box	61,596	0.07	0.25	0.00	1.00
B_Index	13,950[1]	0.91	0.19	0.00	1.18
CFC Rules btw. S and R	61,596	0.12	0.32	0.00	1.00
TP Rules	61,596	2.14	1.57	0.00	5.00

Notes: [1]Data on B-Index is available only for thirty-one countries over the period between 2001 and 2012. Countries *S* and *R* represent a source country and a recipient country respectively. FDI means foreign direct investment. R&D stands for research and development. GDP stands for gross domestic product. CFC means controlled foreign company. TP stands for transfer pricing.

distributed errors, as Greene (2007) notes.[159] The Poisson pseudo-maximum likelihood (PPML) estimator, which is used in our benchmark regressions, is apparently well suited for dependent variables with a large share of zero values and has become a very frequent choice with this type of data (see as examples: Silva and Tenreyro (2006) and Silva and Tenreyro (2011)). According to Wooldridge (2002), Silva and Tenreyro (2006), and Westerlund and Wilhelmsson (2011), the PPML model is suitable in a situation where many observations are concentrated at a certain

[159] See Greene (2007), p. 875-882. In addition, Greene (2004) summarizes the problematics of using a Tobit estimator in the fixed effects framework. The author notes that the maximum likelihood estimator of the fixed effects Tobit model shows essentially no bias in the slope estimators; however, the small sample bias appears to show up in the estimator of the disturbance variance. According to Greene (2004), this bias is transmitted to estimates of marginal effects and is especially evident if the number of observations is small.

value. At the same time, this model enables a fixed-effects framework to be implemented without it being subject to an attenuation bias, which would typically apply in a linear regression. Silva and Tenreyro (2006) also stress the adequacy of the PPML estimator in a setting that is similar to ours. They argue that PPML helps to deal with the heteroscedasticity problem, which is characteristic of bilateral data.

Another issue that arises from using country-pairs as units of observation is a potential correlation between standard errors across country-pairs. If we assume the opposite, standard errors generated in the PPML model might be too small and as a consequence the statistical significance of coefficients may appear too high. To address this problem, we refer to Cameron and Miller (2011) and Egger and Tarlea (2015) and correct for the cluster errors in all estimations. We implement this approach by using the Cameron et al. (2011) and Kleinbaum et al. (2013) method of multi-way clustering in a Poisson pseudo-maximum likelihood model. Multi-way clustering in our estimations implies that the standard errors are clustered at and may be correlated within the following base groups: source country *S*, recipient country *R*, and the year. In addition, these standard errors are clustered at every combination of the three base groups.

4.4 Results

4.4.1 Baseline Results

Table 4.5 presents the outcomes of estimating the equation described in section 4.3.2. *Royalty Intensity* is the dependent variable[160] and fixed effects on the country-pair and time levels are included in all estimations.[161] Moreover, we correct all regressions for clustered standard errors, as discussed in section 4.3.4. In order to compare the goodness of fit across regression models, we report statistics on pseudo R^2 for each specification. This measure represents a likelihood ratio index, also known as the McFadden's R^2.[162]

Column I of Table 4.5 shows the results of an estimation with τ_s and T_{sr} as the only independent variables, whereas column II adds further controls. According to our baseline specification shown in column II, on average a one percentage point increase in the tax rate on bilateral

[160] The ratio of royalties to output is analyzed by employing output as an exposure variable.
[161] Please note that country-pair fixed effects are perfectly collinear with (and therefore include) country-specific effects.
[162] See McFadden (1974) and McFadden (1979) for more information.

royalty payments T_{sr} leads to a -7.7% decrease in the ratio of bilateral royalty flows to output, holding other factors constant.[163] The elasticity[164] of royalties with respect to the tax rate on bilateral royalty payments is -2.3, which is calculated using estimates shown in Table 4.5 and mean values reported in Table 4.4. This implies that a tax rate increase of 1% leads to a -2.3% drop in the intensity of bilateral royalty payments.[165] By contrast, the coefficient on τ_s turns out to be statistically insignificant, which is in line with earlier studies that do not find clear evidence on the impact of a source country's taxation on royalty flows.[166] Column III displays the results with a one-year lag of the two tax variables. This modification produces similar findings as the baseline estimation. Column IV presents an estimation where instead of T_{sr} its three scenarios are included, namely taxes described in equations 4.3, 4.5, and 4.7. According to this column, a statutory corporate tax rate in the recipient country τ_r has a greater economic significance for the determination of *Royalty Intensity* than a withholding tax on royalty payments.

Panel B demonstrates the results of estimations with tax differences as the main independent variables of interest. For instance, columns V and VI show regression outcomes where two unweighted measures for tax differences $(\tau_r - \tau_s)$ and $(\tau_r - \tau_j)$ serve as the main independent variables of interest. Despite the fact that both of them are statistically significant, $(\tau_r - \tau_j)$ has a much larger economic significance than $(\tau_r - \tau_s)$. This finding suggests that a recipient country *R* may receive royalty payments for two possible reasons. The first reason is that the tax rate of a recipient country *R* may be lower than the one in a source country *S*, while the second reason is that its tax rate would be lower than the tax rates in all other countries.

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[163] This implies that the tax semi-elasticity of royalty flows is -7.7. Semi-elasticity is defined as a percentage change in the dependent variable in response to a percentage-point change in the independent variable.

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

[165] We interpret this result as the average treatment effect (ATE) of the treated observations, as defined by Angrist and Pischke (2009). Since we include country-pair fixed effects into the model, the PPML estimator does not consider country-pairs that do not exchange any royalties during our period of observation. Therefore, only country-pairs that have exchanged royalties at least once during 1995-2012 generate the effects reported in Tables 4.5-4.7.

[166] While Hines (1995) does not find a statistically significant impact of a source country's taxation on royalty intensity, Grubert (1998) and Mutti and Grubert (2009) find a negative effect. Kopits (1976) and Collins and Shackelford (1998) do not explicitly include a source country's taxation into their estimations but rather concentrate on the impact of withholding taxes and a recipient country's taxation on royalty payments.

Table 4.5 Regression Results: Royalty Flows and Taxation

Panel A	Baseline		Tax Rate Modifications	
	I	II	III	IV
τ_s	-0.155	-0.086		-0.042
	(0.379)	(0.544)		(0.516)
T_{sr}	-5.990***	-7.743***		
	(1.730)	(1.823)		
$\tau_{s\ t-1}$			-0.183	
			(0.594)	
$T_{sr\ t-1}$			-7.440***	
			(1.674)	
τ_r				-7.842***
				(1.772)
w_s				-4.708**
				(2.277)
$(1 - w_s)(1 - t_r)$				-7.576***
				(1.749)
Log(R&D Exp.)		0.901***	0.903***	0.903***
		(0.128)	(0.125)	(0.128)
Log(GDP/capita)		-1.990**	-1.973**	-1.999**
		(0.812)	(0.791)	(0.826)
Log(Population)		2.820**	2.930**	2.852**
		(1.427)	(1.433)	(1.424)
Property Rights		0.034***	0.035***	0.034***
		(0.011)	(0.011)	(0.011)
Log(Trade btw. S and R)		0.207	0.199	0.215
		(0.173)	(0.176)	(0.167)
Time Fixed Effects	Yes	Yes	Yes	Yes
Country-Pair Fixed Eff.	Yes	Yes	Yes	Yes
Three-Way Cluster	✓	✓	✓	✓
Pseudo R^2	0.873	0.940	0.940	0.941
Observations	61,596	61,596	61,596	61,596

Panel B	Unweighted Tax Differences		Weighted Tax Differences		
	V	VI	VII	VIII	IX
$\tau_{r} - \tau_{s}$	-1.357***				
	(0.430)				
$\tau_{r} - \tau_{j}$		-8.111***			
		(1.809)			
$(\tau_r - \tau_j)$(affil.weight)			-7.290***		
			(1.959)		
$(\tau_r - \tau_j)$(assets weight)				-5.531***	
				(1.592)	
$(\tau_r - \tau_j)$(FDI weight)					-4.396***
					(0.946)
Log(R&D Exp.)	0.875***	0.906***	0.900***	0.899***	0.925***
	(0.135)	(0.124)	(0.141)	(0.139)	(0.138)
Log(GDP/capita)	-1.059	-2.024**	-1.889**	-1.929**	-2.018**
	(0.850)	(0.829)	(0.858)	(0.849)	(0.867)
Log(Population)	1.289	3.013**	4.367***	3.594***	3.046*
	(2.053)	(1.461)	(1.472)	(1.366)	(1.587)
Property Rights	0.036***	0.034***	0.030***	0.029**	0.035***
	(0.013)	(0.011)	(0.011)	(0.012)	(0.011)
Log(Trade btw. S and R)	0.316**	0.218	0.256	0.244	0.239
	(0.160)	(0.159)	(0.175)	(0.164)	(0.169)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Country-Pair Fixed Eff.	Yes	Yes	Yes	Yes	Yes
Two-Way Cluster	✓	✓	✓	✓	✓
Pseudo R^2	0.938	0.941	0.940	0.940	0.942
Observations	61,596	61,596	61,596	61,596	61,596

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Three-Way Cluster implies that standard errors are clustered at (and may be correlated within) base groups (country *S*, country *R*, and year) as well as every combination of the three. Pseudo R^2 represents the likelihood ratio index, also known as McFadden's R^2. Poisson pseudo-maximum likelihood model is applied in all estimations. Observational units are country-pairs. The dependent variable is the ratio of *Royalty Flows* (total royalty flows from country *S* to *R*) in relation to *Output in S* (total value added of firms in country *S*); the ratio of royalties to output is analyzed by employing output as an exposure variable. T_{sr} denotes a tax rate on royalty flows from *S* to *R*. w_s is a withholding tax rate on royalty payments in a source country. τ_r and τ_s represent statutory corporate income tax rates in *S* and *R* respectively. τ_j is an average statutory tax rate in royalties-receiving countries *J*. *Log (R&D Exp.)* is a logarithm of total R&D expenditure in *R*. *Log (GDP/capita)* measures GDP per-capita in *R*. *Log (Population)* denotes a logarithm of country *R*'s total population. *Property Rights* represents a level of intellectual property rights protection in *R*. *Log(Trade btw.S and R)* depicts a logarithm of total trade in goods between *S* and *R*.

Columns VII-IX of Table 4.5 display the results of the estimations in which weighted tax differences serve as the main independent variables of interest. We weigh *$(\tau_r - \tau_j)$(affil.weight)* according to the number of *R*'s foreign affiliates, *$(\tau_r - \tau_j)$(assets weight)* according to the total assets of *R*'s foreign affiliates,[167] and *$(\tau_r - \tau_j)$(FDI weight)* according to *R*'s FDI in each country *J*. As indicated by columns VII-IX, on average a one percentage point increase in the tax differential between a recipient country and other countries leads to a decrease of -4.4% to -7.3% in a share of royalty flows to output.

As for other control variables shown in Table 4.5, the results seem to be in line with the previous literature. For example, consistent with Dischinger and Riedel (2011), Karkinsky and Riedel (2012), Griffith et al. (2014), and other authors who analyze patent location choices, we identify a positive and economically and statistically significant association between a country's level of innovation (represented by *Log(R&D Exp.)*) and its share of royalty flows in relation to output. Moreover, a larger market size of the recipient country and its higher level of property rights protection also appear to contribute positively to royalty exchange. By contrast, growing trade between a country-pair, which indicates an increasing economic co-operation, turns out to be statistically insignificant. In addition, royalties seem to be negatively correlated with country *R*'s GDP per-capita.

Our findings should be interpreted with caution due to several limitations that may have a bearing on the regression estimates. To begin with, previous studies on IP location choices use firm-level data, whereas we conduct our analysis using data aggregated on a country-pair level. Dharmapala (2014) identifies that earlier studies on profit shifting using aggregate data – such as Hines and Rice (1994) – appear to overestimate the semi-elasticity of profit shifting finding absolute values above 2, because they cannot use panel estimation methods in their cross-sectional datasets. Later studies that used panel techniques in firm-level datasets found substantially smaller semi-elasticities with absolute values of around 0.8, as reported by Heckemeyer and Overesch (2013). It is possible to avoid a bias of such an order in our empirical analysis as it also employs panel techniques relying exclusively on within-variation over

[167] Since the information on total firm assets is available only for the time period between 2003 and 2012, we use the data on total assets in 2003 for the period between 1995 and 2002 and therefore assume that firms' total assets have remained constant between 1995 and 2003. Using the sample of 2003-2012 for this estimation does not alter the results.

time.[168] It is important to note that it is not possible to rule out the likelihood of a bias remaining if unobserved firm-specific effects are correlated with tax rate changes.[169] Under the assumption that controlling for country and country-pair specific effects does not correct any of the bias found in previous studies with aggregate data, the empirical estimates in this paper can be interpreted with the following discount: repeating this study with firm-level data, one would expect the semi-elasticity to be around one third of the estimate from the aggregate level. If firms react homogenously to taxes, estimates based on aggregate data or based on firm-level data can be interpreted in the same way. However, if firms react heterogeneously to taxes, then the estimates based on aggregate data represent a weighted average of the underlying firm-level tax elasticities (see Zellner (1962)). If royalty flows are proportional to firm size, then the decisions of large firms dominate in the aggregate and the estimates reflect mainly the tax elasticity of large firms and not an unweighted average elasticity across small and large firms which is frequently presented in a firm-level analysis. For this reason, heterogeneity across firms may suffice to give an explanation for the difference between the two approaches. From a tax policy perspective, the implicit consideration of heterogeneity in aggregate estimates is a positive feature. However, it would of course be preferable to have the micro-level data available, which would enable us to explicitly model and test for heterogeneity in tax elasticities.[170] A second limitation is the inability to distinguish between different types of royalty payments, such as royalty fees for the use of patents, trademarks, copyrights, and other assets.[171] If different kinds of intangibles have different tax elasticities, then our results might be not representative of all types of intangible assets. A third limitation concerns the external validity of our results. As our findings represent an average effect of the fifty-nine countries that are included in the study, it could be the case that royalty flows between countries that are excluded from our analysis are more or less elastic to changes in tax rates.

[168] Table 1 in Dharmapala (2014) reports that Huizinga and Laeven (2008), which rely on a cross-sectional firm-level data, find much stronger semi-elasticities than later studies with panel firm-level data. This may reflect that the bias from exploiting cross-sectional variation is more serious than the bias due to the level of aggregation. The meta-regressions by Heckemeyer and Overesch (2013), Table 2, imply that the semi-elasticity increases by 2 percentage points in absolute value for studies using aggregate data, although this may also reflect these studies' lack of controlling for country fixed effects.

[169] This is mitigated by controlling for country-pair fixed effects, which include country-averages of firm-specific effects.

[170] In the empirical analysis of this study, royalty flows and tax rates are modelled as a log-linear relationship, which reflects the assumption that royalty flows scale with firm size.

[171] Data on subcomponents of royalty flows is only available for approximately 500 observations in total and (with the exception of Canada and the United States) only from 2010 onwards.

4.4.2 Robustness Checks

Table 4.6 contains the results of a few robustness checks. For example, we use an alternative dependent variable *Royalty Flows*, which shows the amount of royalty payments transferred from a source country *S* to a recipient country *R*. Columns I-II of Table 4.6 present the outcomes of this robustness check, and in accordance with the results, an influence of taxation on the amount of bilateral royalty payments is similar to the effect of taxes on the share of royalties to sales (see columns I-II of Table 4.5). Column III of Table 4.6 shows the outcomes of including *After2003* into the baseline estimation, which is a binary variable that is equal to one if a royalty exchange occurs after 2003 and to zero otherwise. Hence, it divides the observed time span into two parts. In this specification, T_{sr} indicates the impact of taxation on the intensity of royalty flows in the first half of the period of observation and the interaction term T_{sr}**After2003* shows the additional effect of T_{sr} in the second half of the time span. According to the results, the impact of taxation on royalty flows is more pronounced in the second half of the period of observation.

Columns IV-VI of Table 4.6 demonstrate the outcomes of our baseline specification after it has been modified with respect to fixed effects and clustering. Column IV shows the results after time fixed effects have been removed and column V displays the outcomes after an additional exclusion of country-pair fixed effects. While the former modification almost does not influence the baseline findings, the latter seems to diminish the economic and statistical significance of the impact of taxation on royalty flows. Other than this, the coefficient on population appears to be negative once country-pair fixed effects have been removed. Column VI presents regression outcomes after the exclusion of a three-way cluster from the baseline model. This alteration results in the same regression coefficients as in the baseline specification (see column II of Table 4.5). However, it decreases the values of standard errors, which suggests that an assumption of independency of standard errors across country-pairs leads to an overestimation of the statistical significance of the results. This confirms the choice of clustering in our benchmark model.

Columns VII-VIII of Table 4.6 display the results of using an alternative model of estimation. In column VII, we follow Hines (1995), Collins and Shackelford (1998), Grubert (1998), and Mutti and Grubert (2009) and apply a Tobit estimator instead of a Poisson pseudo-maximum likelihood model. Tobit allows us to take zero values of the dependent variable into account as

Table 4.6 Robustness Checks

	Royalty Flows		Year-Split	Fixed Effects Modifications		No Cluster	Tobit	OLS
	I	II	III	IV	V	VI	VII	VIII
τ_s	-0.393	-0.201	-0.072	-0.220	-0.426	-0.086	0.003	-0.015
	(0.534)	(0.700)	(0.379)	(0.610)	(0.574)	(0.326)	(0.022)	(0.025)
T_{sr}	-6.068***	-7.457***	-4.981***	-8.112***	-4.001**	-7.743***	-0.123***	-0.052**
	(1.586)	(1.850)	(1.933)	(1.781)	(2.029)	(1.311)	(0.035)	(0.025)
After2003			0.750					
			(0.507)					
T_{sr}*After2003*			-3.177***					
			(1.203)					
Log(R&D Exp.)		0.899***	0.921***	1.234***	1.347***	0.901***	2.477***	1.354***
		(0.129)	(0.115)	(0.189)	(0.121)	(0.091)	(0.100)	(0.122)
Log(GDP/capita)		-2.160***	-2.532***	-2.190**	0.007	-1.990***	-1.660	-2.947*
		(0.736)	(0.857)	(0.886)	(0.526)	(0.558)	(1.814)	(1.653)
Log(Population)		2.429*	2.370	4.994***	-0.555***	2.820***	-0.144***	-0.097**
		(1.445)	(1.450)	(1.252)	(0.185)	(1.063)	(0.036)	(0.042)
Property Rights		0.033***	0.030***	0.034**	0.023**	0.034***	0.073***	0.048***
		(0.012)	(0.009)	(0.016)	(0.011)	(0.006)	(0.024)	(0.015)
Log(Trade btw.S and R)		0.459***	0.185	0.397***	0.290*	0.207**	0.354*	0.033
		(0.172)	(0.138)	(0.126)	(0.159)	(0.104)	(0.201)	(0.163)
Time Fixed Effects	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Country-Pair Fixed Eff.	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Three-Way Cluster	✓	✓	✓	✓	✓		✓	✓
Pseudo R^2	0.869	0.940	0.942	0.936	0.790	0.940	0.138	
R^2								0.305
Observations	61,596	61,596	61,596	61,596	61,596	61,596	61,596	61,596

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Three-Way Cluster implies that standard errors are clustered at (and may be correlated within) base groups (source country *S*, recipient country *R*, and year) as well as every combination of the three. In columns I-IVI, Pseudo R^2 represents the likelihood ratio index, also known as McFadden's R^2. Poisson pseudo-maximum likelihood model is applied in estimations I-VI. Tobit estimator is used in column VII and OLS estimator is applied in column VIII. Observational units are country-pairs. The dependent variable in columns I-II is *Royalty Flows*, which denotes total royalty flows from country *S* to *R*. The dependent variable in columns III-VIII is the ratio of *Royalty Flows* in relation to *Output in S* (total value added of firms in country *S*). In the Poisson regressions shown in columns III-VI, the ratio of royalties to output is analyzed by employing output as an exposure variable. In the Tobit and OLS regressions shown in columns VII-VIII, the ratio of royalties to sales is the left hand side variable. T_{sr} is a tax rate on royalty flows from *S* to *R*. τ_s represents statutory corporate income tax rate in country *S*. *After2003* is a binary variable; it equals one if the royalty transfer occurs after 2003 and zero otherwise. *Log (R&D Exp.)* is a logarithm of total R&D expenditure in *R*. *Log (GDP/capita)* measures GDP per-capita in *R*. *Log (Population)* denotes a logarithm of country *R*'s total population. *Property Rights* represents a level of intellectual property rights protection in *R*. *Log(Trade btw.S and R)* depicts a logarithm of total trade in goods between *S* and *R*.

the censored observations below the smallest value of royalty intensity observed in the sample. Column VIII presents the results when an OLS estimator is applied and the use of alternative estimators such as this one produces results that are similar to our baseline findings. The Tobit estimation leads to a tax semi-elasticity of royalty flows of -12.3, whereas in the case of the OLS estimation it appears to equal -5.2. Other control variables seem to have a similar influence on the dependent variable as in the case of the PPML estimation. However, the coefficient on *Log(Population)* becomes negative in the Tobit and OLS models, which could be due to the inconsistency of these estimators in a fixed-effects framework when the dependent variable is concentrated at zero.

4.4.3 Extended Analysis

In addition to the baseline results, we also analyze how several types of tax policies implemented on a national level or suggested within the scope of the OECD Action Plan on BEPS (2013) would affect the intensity of bilateral royalty flows. We categorize these policies into rewarding (see panel A of Table 4.7) and punitive ones (see panel B of Table 4.7).

4.4.3.1 Rewarding Policies

Rewarding policies, such as IP Box regimes, aim to foster R&D investment. In line with the OECD Nexus Approach, starting from 2015 all current and new IP Boxes should facilitate the taxation of profits from the transfer or use of intangible assets in the place of their creation.[172] However, not all countries have followed this requirement in the past. Some of them have introduced IP Boxes that allow preferential tax treatment to be applied to both self-developed and acquired intangible assets. These types of IP Boxes are inconsistent with the Nexus Approach, because they enable firms to develop intangible assets in high-tax countries and relocate them to the jurisdictions with IP Boxes in order to benefit from a reduced taxation of royalties. Therefore, while IP Box regimes that only recognize self-developed intellectual

[172] See OECD (2015a). Countries with IP Boxes have already begun to implement the Nexus Approach. To give an example, according to Bradley et al. (2015), the UK agreed in 2014 to include a modified Nexus Approach into its IP Box. The Italian patent box regime which was enacted in 2014 likewise imposes nexus conditions.

property foster a firm's R&D activity, those that also permit acquired intangibles might be used for profit shifting. Table B.4 in the appendix gives a worldwide overview of IP Box regimes.[173]

Column I of Table 4.7 shows the outcomes of incorporating IP Boxes into our baseline model. *IP_BoxAcq in S* and *IP_BoxAcq in R* are binary variables, which are equal to one if acquired intangibles are eligible for an IP Box and to zero otherwise. *IP_Box in S* and *IP_Box in R* are also binary variables and are equal to one if self-developed intangibles are eligible for preferential tax treatment and to zero otherwise. In our sample, these two variables mainly differ across countries such as Belgium, China,[174] the Netherlands, and Spain, since it is in these countries where intellectual property that qualifies for a lower IP Box tax rate only includes self-developed and not acquired intangible assets during the time period under analysis. In accordance with the findings shown in column I of Table 4.7, introducing an IP Box that is applicable to the acquired intangibles is likely to attract additional royalty inflows into a recipient country. However, this is not the case if an IP Box exclusively applies to self-developed IP.

Input-oriented R&D incentives constitute another type of rewarding policies and could serve as an alternative to IP Boxes. They include tax credits and tax allowances[175] and focus on fostering the R&D process, whereas IP Boxes mostly support the output of R&D. Input-oriented R&D incentives are measured in the empirical literature by a so-called B-Index, which was developed by Warda (2001) and is defined as follows:

$$B\_Index = \frac{1 - (A\,\tau)}{(1 - \tau)} \tag{4.10}$$

In equation 4.10, τ denotes statutory corporate income tax rate, whereas A represents a combined net present value of allowances and tax credits applied to R&D expenses. If an R&D investment is fully expensed in the given fiscal year, both A and the B_Index are equal to one. However, if a super-deduction is available that allows the double of actual R&D expenses to be deducted, A will be greater than one, which results in the B_Index being smaller than one.

[173] We collected information on IP Box regimes over the period between 1995 and 2012 from Evers et al. (2015a) and extended it through our own research.
[174] In China, intangibles developed abroad are not eligible for an IP Box, whereas intangibles developed at other Chinese companies are allowed to enter the IP Box.
[175] See Spengel and Wiegard (2011) for a detailed worldwide overview of the existing input-oriented incentives for R&D.

Therefore, the B-Index reflects the costs of research and development and its lower values correspond to a more attractive tax system for R&D investment. Table B.5 in the appendix provides an overview of B-Indices across countries.[176] As for the impact of the B-Index on royalty intensity, column II of Table 4.7[177] shows that this variable has a positive impact on royalty outflows in a source country. Since the B-Index can be seen as a cost of conducting research and development, this result implies that worsening conditions for research and development stimulate R&D outflows out of a country. However, this outcome is only statistically significant at a level of 10%. By contrast, a recipient country's B-Index does not appear to play a role in the determination of royalty intensity.

Numerous countries have introduced IP Boxes, tax credits, and tax allowances to foster corporate investment in research and development. In order to evaluate the impact of taxation on royalty intensity in R&D-intensive countries, we include an interaction term between *Log(R&D Exp.)* and the main tax variable in our baseline specification. T_{sr}**Log(R&D Exp)* turns out to be positive and statistically significant in column III of Table 4.7, which implies that a higher level of R&D spending mitigates the negative effect of taxation on royalty intensity.

4.4.3.2 Punitive Policies

In addition to the rewarding policies, we also analyze the punitive policies that the G20 and the OECD supported in recent discussions on BEPS. These policies can be viewed as punitive from a firm's point of view, as they aim to hinder profit shifting by means of royalty payments. They include, for example, an introduction and an enforcement of controlled foreign company (CFC) rules and transfer pricing (TP) regulations. Actions 3 and 7 of the OECD Action Plan on BEPS (2013) state the importance of these anti-avoidance measures for hindering a strategic use of intangible assets.

[176] We collected information on B-Index for thirty-one countries over the period between 2001 and 2012 from Ernst and Spengel (2011), Thomson (2013), and Chen and Dauchy (2015) and completed it through our own research.

[177] The number of observations in column II of Table 4.7 is smaller than in other estimations because the data on B-Index is only available for thirty-one countries over the period between 2001 and 2012.

Table 4.7 Extended Analysis

Panel A	Rewarding Policies		
	IP Box	B-Index	R&D
	I	II	III
τ_s	-0.571	0.304	-0.073
	(0.931)	(0.525)	(0.324)
T_{sr}	-7.323***	-7.909***	-10.220***
	(1.599)	(1.469)	(1.719)
IP_BoxAcq in S	0.462		
	(0.384)		
IP_BoxAcq in R	0.664**		
	(0.283)		
IP_Box in S	-0.286		
	(0.376)		
IP_Box in R	-0.079		
	(0.261)		
B_Index in S		0.753*	
		(0.392)	
B_Index in R		-0.075	
		(0.728)	
Log(R&D Exp.)	0.890***	1.249***	0.946***
	(0.130)	(0.092)	(0.084)
T_{sr}*Log(R&D Exp.)*			1.685***
			(0.614)
Log(GDP/capita)	-1.913**	-2.165**	-1.915***
	(0.795)	(0.970)	(0.554)
Log(Population)	2.011	0.706	1.578
	(1.427)	(2.507)	(1.134)
Property Rights	0.032***	0.030***	0.029***
	(0.011)	(0.010)	(0.005)
Log(Trade btw.S and R)	0.230	0.355**	0.187*
	(0.146)	(0.155)	(0.104)
Time Fixed Effects	Yes	Yes	Yes
Country-Pair Fixed Eff.	Yes	Yes	Yes
Three-Way Cluster	✓	✓	✓
Pseudo R^2	0.942	0.941	0.894
Observations	61,596	13,950	61,596

Panel B	Punitive Policies			
	CFC Rules		TP Rules	
	IV	V	VI	VII
τ_s	-0.021	0.027	0.035	0.084
	(0.362)	(0.338)	(0.305)	(0.340)
T_{sr}	-8.314***	-8.854***	-6.949***	-8.542***
	(1.618)	(1.606)	(1.631)	(1.801)
CFC Rules btw. S and R	-0.349**	-0.735		
	(0.139)	(0.547)		
T_{sr}*CFC Rules btw. S and R*		3.090*		
		(1.856)		
TP Rules in S			0.086	0.074
			(0.055)	(0.049)
TP Rules in R			0.154**	0.188***
			(0.069)	(0.072)
*TP Rules in S*TP Rules in R*			-0.043**	-0.120**
			(0.018)	(0.049)
T_{sr}*TP Rules in S*TP Rules in R*				0.221*
				(0.121)
Log(R&D Exp.)	0.898***	0.911***	0.923***	0.929***
	(0.108)	(0.110)	(0.138)	(0.125)
Log(GDP/capita)	-1.862**	-2.008**	-2.152***	-1.911**
	(0.841)	(0.877)	(0.805)	(0.796)
Log(Population)	2.997**	2.944**	2.423	2.605
	(1.502)	(1.489)	(1.613)	(1.754)
Property Rights	0.033***	0.034***	0.034***	0.035***
	(0.009)	(0.009)	(0.012)	(0.011)
Log(Trade btw.S and R)	0.188	0.201	0.228	0.249
	(0.145)	(0.140)	(0.152)	(0.152)
Time Fixed Effects	Yes	Yes	Yes	Yes
Country-Pair Fixed Eff.	Yes	Yes	Yes	Yes
Three -Way Cluster	✓	✓	✓	✓
Pseudo R^2	0.941	0.941	0.941	0.942
Observations	61,596	61,596	61,596	61,596

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Three-Way Cluster implies that standard errors are clustered at (and may be correlated within) base groups (country *S*, country *R*, and year) as well as every combination of the three. Pseudo R^2 represents the likelihood ratio index, also known as McFadden's R^2. Poisson pseudo-maximum likelihood model is applied in all estimations. Observational units are country-pairs. The dependent variable is the ratio of *Royalty Flows* (total royalty flows from country *S* to *R*) to *Output in S* (total value added of firms in country S); the ratio of royalties to output is analyzed by employing output as an exposure variable. T_{sr} is a tax rate on royalty flows from *S* to *R*. τ_s represents statutory corporate income tax rate in country *S*. *IP_BoxAcq in S* and *in R* are dummy variables that indicate a presence of an IP Box regime applicable to acquired IP in countries *S* and *R* respectively. *IP_Box* in *S* and in *R* are dummy variables that indicate a presence of an IP Box regime applicable to self-developed IP in countries *S* and *R* respectively. *B_Index in S* and *in R* represent B-Indices in a source and a recipient country respectively; B-Index reflects the cost of R&D (the higher the B-Index, the less attractive a tax system is for an R&D investment). *CFC Rules btw. S and R* is a binary variable that is equal to one if CFC rules apply between *S* and *R* and to zero otherwise. *TP Rules in S* and *in R* are indices ranging from 0 to 5 and represent the strictness of transfer pricing rules in *S* and *R* respectively. *Log (R&D Exp.)* is a logarithm of total expenditure on R&D in *R*. *Log (GDP/capita)* measures GDP per-capita in *R*. *Log (Population)* denotes a logarithm of country *R*'s total population. *Property Rights* represents a level of intellectual property rights protection in *R*. *Log(Trade btw.S and R)* depicts a logarithm of total trade in goods between *S* and *R*.

Table B.6 in the appendix provides a list of countries that have CFC rules in place.[178] These regulations typically apply to foreign affiliates of multinational firms. To give an example, if the tax rate of a country in which a foreign subsidiary of a German parent is located falls below 25%, then German statutory corporate income tax rate applies to the passive income generated by this subsidiary. However, since the European Court of Justice (ECJ) *Cadbury Schweppes*[179] case of 2006, CFC rules are not applicable within the European Economic Area.[180] In columns IV-V of Table 4.7 a binary variable *CFC Rules btw. S and R* is added to the baseline model and it is equal to one if CFC regulations apply to the given country-pair in the given year and to zero otherwise.[181] According to our findings, the implementation of CFC regulations negatively affects the intensity of bilateral royalty flows. Column V adds an interaction term T_{sr}**CFC Rules btw. S and R* to the benchmark specification. The coefficient on the interaction is positive, which implies that the implementation of CFC rules diminishes the negative impact of taxation on the intensity of royalty flows.

Furthermore, we analyze the impact of transfer pricing regulations on royalty intensity. Since royalties are transfer prices paid for the use of intangible assets, TP regulations apply to bilateral royalty flows. Several studies, such as Beer and Loeprick (2015) and Saunders-Scott (2015), investigate the impact of TP rules on profits and location decisions. However, to the best of our knowledge, we implement the first attempt to determine a relationship between these types of regulations and royalty payments. We take into account transfer pricing rules by incorporating the TP index suggested by Zinn et al. (2014)[182] into our baseline specification. Table B.7 in the appendix provides a worldwide overview of this measure, which varies from 0 to 5 and reflects not only a mere existence but also the strictness of transfer pricing regulations. As shown in columns VI-VII of Table 4.7, implementing strict TP rules in both a source country and a

[178] Data on CFC rules was collected from Karkinsky and Riedel (2012) and the International Bureau of Fiscal Documentation for the period between 1995 and 2012.

[179] See *Cadbury Schweppes plc and Cadbury Schweppes Overseas Ltd v. Commissioners of Inland Revenue*, C-196/04 (2006).

[180] Denmark is an exception in this case. After the ECJ *Cadbury Schweppes* case in 2006, Denmark did not relax the CFC rules for EU member states as other states did but instead enhanced them to include domestic companies. See Schmidt (2014) for more information.

[181] In order to determine whether CFC rules apply to a royalty transaction, firm-level data is needed. Since our study is based on a country-level analysis, we have to proceed by assuming that CFC rules apply to all bilateral royalty transactions if the rules exist between a country-pair.

[182] We have calculated the Zinn et al. (2014) index for some additional countries and years to achieve a full coverage of our sample. The research was done with the help of Ernst & Young Transfer Pricing Global Reference Guide 2005-2012, KPMG Global Transfer Pricing Review 2005, 2007, 2009, 2011-2012, and PricewaterhouseCoopers International Transfer Pricing 2008-2012.

recipient country decreases the royalty exchange between them. The coefficient on the interaction term T_{sr}*TP Rules in S*TP Rules in R* appears to be positive, which implies that, similarly to the CFC regulations, an introduction of strict transfer pricing rules in both countries mitigates the negative impact of taxation on royalty intensity.

In summary, both rewarding and punitive policies appear to have an impact on bilateral royalty flows. While introducing strict anti-avoidance regulations decreases bilateral royalty payments, a lack of input-oriented R&D tax incentives seems to encourage royalty outflows and some types of output-oriented fiscal incentives (such as IP Boxes that are available for acquired intellectual property) appear to attract royalty inflows.

4.5 Conclusion

The main theoretical prediction of this study is that corporate taxation affects bilateral royalty flows. We test it by carrying out an empirical analysis that employs panel data on 3,422 country-pairs for the time span between 1995 and 2012. We apply the Poisson pseudo-maximum likelihood estimator in a fixed-effects framework in the baseline model, where the royalty intensity serves as the dependent variable and the tax rate on royalty payments constitutes the main independent variable of interest. According to our main results, the tax elasticity of royalty intensity is -2.3. This implies that increasing the statutory corporate income tax rate by 1% leads on average to a -2.3% drop in the intensity of bilateral royalty payments, holding other factors constant. In order to determine the economic significance of our findings, the following example is taken into consideration: the average ratio of bilateral royalty flows to output in our dataset equals 0.01%, or 30 million USD. If it is presumed that royalty taxation has no effect on sales, a one percent decrease in the taxation of royalties would increase an average bilateral royalty flow by 690 thousand USD, which can be regarded as a considerable amount.

The contribution of our study to the previous literature is composed of three parts. We begin by contributing towards the previous research on the impact of taxation on stocks of intangibles, in which we investigate the influence of taxation on royalty intensity. Our second contribution is towards the earlier studies on bilateral royalty flows, whereby we estimate the impact of tax differentials on royalties. As indicated by our findings, on average a one percentage point increase in the tax differential between a recipient country and alternative recipient locations leads to a decrease between -1.3% and -8.1% in the intensity of royalty inflows into this country.

Finally, we contribute to the previous literature by analyzing how an implementation of the OECD Action Plan on BEPS (2013) could affect royalty exchange. This plan includes several rewarding and punitive policies that aim to encourage research and development and enable taxation in accordance with value creation. For example, these policies embrace an enforcement of the Nexus Approach as well as an implementation of strict anti-avoidance legislation. Enforcing the Nexus Approach implies an elimination of IP Boxes that are applicable to acquired intangibles and only allows self-developed assets to benefit from reduced taxation. According to our findings, this step is likely to trigger a decrease in royalty inflows into the countries that currently have IP Boxes applicable to acquired IP. In addition, an implementation of strict controlled foreign company regulations and an enforcement of transfer pricing rules could reduce the intensity of international royalty flows as well. Therefore, our findings lead to the conclusion that an implementation of the OECD Action Plan on BEPS is likely to limit the use of intangibles as a means of profit shifting and will therefore reduce bilateral royalty exchange.

As discussed in section 4.4.1, this study employs data aggregated on a country-pair level. For this reason, one direction for future research is the use of firm-level information to estimate tax sensitivity of royalty payments on a company level. Furthermore, it could also be informative to distinguish between different types of royalty payments, such as royalty fees for the use of patents, trademarks, copyrights, and other assets. If different kinds of intangibles have different tax elasticities, our results may not be representative of the various types of intellectual property. Finally, our findings are based on the average effect of the fifty-nine countries that are included in our study. It is possible that the royalty flows between countries that we do not analyze are more or less elastic to changes in tax rates. Therefore, further analysis that includes a greater coverage of countries, particularly of countries that are either developing or emerging, could potentially enhance the findings of our study.

Chapter 5

Corporate Taxation and the Location of Intangible Assets: Patents vs. Trademarks

5.1 Introduction

Nowadays the ownership of intangible assets[183] is transferable within a corporate group. Though one affiliate within the group may develop an intangible asset, another affiliate could become this asset's owner through a sale of an intangible, a cost sharing agreement, or a contract research project. Moreover, a corporate group might strategically relocate its research and development facilities to a certain affiliate. In this case, a new company within a group would not only register but also develop an intangible asset.

There are several reasons why a corporate group might be willing to strategically choose the locations where its intangibles are developed and where they are held afterwards. Aside from various operational and financial motives, taxation could serve as an explanation for the strategic location or relocation of intangible assets. For instance, if an affiliate in a low-tax jurisdiction owns an intangible asset, other group members that use this asset will have to pay royalty fees to the asset's owner. As a result of this, the royalties are taxed at a low rate and the tax bases of affiliates in high-tax countries decrease. This leads to profits being shifted from high-tax group members to the low-tax members, which ultimately reduces the overall tax burden of a corporate group.

[183] According to the OECD (2013b), an intangible asset 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." Examples include patents, trademarks, copyrights, know-how, franchises, and many others. Source: OECD (2013b), p. 14.

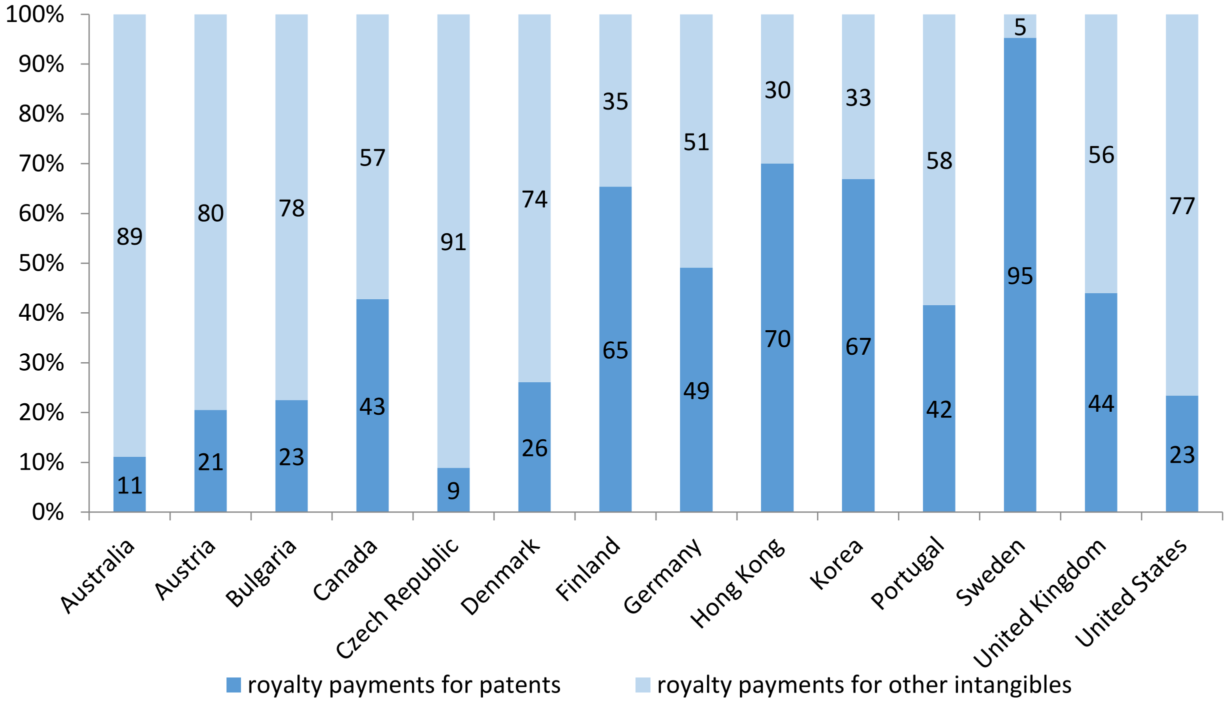
There is plenty of anecdotal evidence which suggests that large multinational companies such as *Starbucks Corp.*[184], *Apple Inc.*,[185] or *Microsoft Corporation*,[186] use intangible assets to minimize their consolidated tax burdens. To give an example, the world's largest spirits producer *Diageo 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.[187] Dischinger and Riedel (2011) note that the central brand management of *Royal Dutch Shell plc* is located in Switzerland, from where it charges royalties to operating subsidiaries that use the company's valuable trademarks. Moreover, many business consultancies help multinational enterprises to strategically allocate their intangible assets. For example, the British consultancy *Brand Finance plc* states in its report that "[…] companies increasingly need to look at brand values […] to most effectively gain value from their intangible assets while minimizing tax payments."[188] Numerous academic studies have also provided empirical evidence on the strategic use of intangible assets by multinational enterprises (see as examples: Ernst and Spengel (2011), Karkinsky and Riedel (2012), Ernst et al. (2014), Griffith et al. (2014), Alstadsæter et al. (2015), Böhm et al. (2015), Bradley et al. (2015), Dinkel and Schanz (2015)). The findings of these authors support the argument that firms use intangible assets for tax planning.

Previous empirical literature on the strategic use of intangible assets is largely focused on patents. Researchers usually assume that findings on patents represent all other types of intangibles, including trademarks, brand names, copyrights, computer software, trade secrets, formulas, know-how, franchises, customer lists, and many others. The focus of earlier studies on patents might constitute a research gap for the following two reasons. First, there are many kinds of intangibles and firms may use them either alongside or instead of patents for profit shifting, as the *Diageo plc* example shows. Secondly, patents only represent a fraction of total intangible assets in most countries, which suggests that there is a high possibility that companies are able to shift profits through other types of intangibles. Figure 5.1 demonstrates that in 2013 only 49% of royalty outflows from Germany were royalty payments for the use of patents. The

[184] See Economist (2012) and Campbell and Helleloid (2016).
[185] See Forbes (2013).
[186] See Business Insider (2013).
[187] See The Guardian (2009a).
[188] See Brand Finance (2008), p. 4.

rest included royalties for the use of trademarks, brand names, copyrights, know-how, franchises, and other intangible assets.

Figure 5.1 Patent Royalties as a Share of Total Royalty Outflows, 2013



Notes: This figure is based on the data on royalty exchange with the rest of the world. In the cases of the UK and the US, only royalty exchange with the EU28 is taken into consideration due to data availability issues. Sources: OECD, database *Trade in Services – EBOPS 2002*; Eurostat, database *International Trade in Services [bop_its6_det]*.

The aim of this paper is to analyze whether corporate taxation influences the location of different types of intangible assets within a corporate group, and if so, to what extent. Answering this research question could contribute to estimating the true magnitude of profit shifting through the channel of intangible assets. The focus of this study is on an empirical comparison of the strategic use of two kinds of intangibles – patents and trademarks.

There are several reasons for the differences in tax elasticities of patent and trademark location choices. As we explain in the next section, patents often belong to patent families which consist of multiple related patents. Such agglomeration of patents implies that they are more likely to be registered in the same country where the first patent within the patent family is held. By contrast, trademarks are more often registered independently or belong to smaller families. Furthermore, the research and development (R&D) process related to the development of a patent usually relies more on the human and physical endowment of a country than designing a trademark. Apart from this, in the case of a patent relocation, a company might be subject to an exit tax on capital gains. The dependency of patents on a country's endowment and the exit taxation lower their transferability and therefore makes them less responsive to taxation compared to trademarks. It is also worth noting that the majority of expenses related to the development of a patent occur before it is actually granted. This idea is important when considering taxation, since a firm may be tempted to locate a patent in a high-tax country in order to deduct large research and development expenditure from its tax base. By contrast, the main marketing expenses on a trademark arise after its registration, in which case a firm seeks to optimize its marketing costs and income from a trademark during the same period of time and might therefore prefer a low-tax location. In addition, the development of a patent requires detailed documentation of who has invented the patent and who has covered the costs. Again, there are usually no such requirements for trademarks, which gives companies a greater leeway for tax planning through a cost sharing agreement or a contract R&D project. Finally, it takes longer and costs more to develop and register a patent than a trademark. A patent protection is granted only for a limited number of years, whereas a trademark grant can be extended for an unlimited period of time. Thus, if a company considers using its intangible assets for profit shifting, trademarks provide a faster, cheaper, and longer lasting solution than patents. According to these arguments, trademarks seem to be a more flexible and more mobile means of profit shifting than patents. Therefore, we expect trademarks to be more responsive to changes in corporate taxation than patents.

We would ideally approach this research question by using information on patent and trademark ownership within corporate groups. However, since most firms do not publicly report such data, we follow the example of previous studies in this field and employ data on patent and trademark applications. As Ernst and Spengel (2011) note, the applicant of an intangible asset is its legal owner, since only an asset's legal owner is entitled to apply for its registration at an international office.[189] Therefore, we use the Orbis database provided by the Bureau van Dijk to gather data on trademark and patent applications filed at the European Patent Office (EPO), the European Union Intellectual Property Office (EuIPO), and the United States Patent and Trademark Office (USPTO) over the period between 1996 and 2012.

[189] Ernst and Spengel (2011) refer to the European Patent Office. Therefore, in the case of the European intangibles, we consider the applicant to be the legal owner. In data from the US Patent and Trademark Office, we observe both the legal owner and the applicant of intangible assets.

Our empirical approach closely follows Griffith et al. (2014). In line with the authors, our sample includes intangibles' applications filed by companies located in fifteen countries: Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.[190] Our sample comprises 624,801 trademark and 1,696,332 patent applications filed by 162,640 firms. Referring to Griffith et al. (2014), we apply a mixed logit model in a fixed-effects framework, which enables us to control for observed and unobserved heterogeneity in intellectual property location[191] choices. This identification strategy also allows us to calculate the own and cross-country tax elasticities of patent and trademark locations. Our main empirical finding is that the tax elasticity[192] of a patent location choice is between -0.1 and -1.4, while the tax elasticity of a trademark ranges between -1.4 and -2.3. This implies that increasing a country's tax rate on royalty income by one percent will on average result in a -0.1% to -1.4% decrease in patent applications and a -1.4% to -2.3% drop in trademark applications, holding other factors constant.

Our contribution to the previous literature is twofold. First, we extend the analysis of the strategic use of intangible assets to trademarks. Earlier studies either focus exclusively on patents (see as examples: Ernst and Spengel (2011), Karkinsky and Riedel (2012), Ernst et al. (2014), Griffith et al. (2014), Alstadsæter et al. (2015), Böhm et al. (2015), Bradley et al. (2015), Dinkel and Schanz (2015)) or do not distinguish between different types of intangibles and instead treat them as a whole (see as examples: Huizinga et al. (2008) and Dischinger and Riedel (2011)). In the first part of the analysis, this study confirms the results of the previous literature by establishing a negative correlation between taxation and the choice of location for patents. We then go one step further by comparing the tax elasticity of trademark location choices with the tax elasticity of patent location choices. This allows us to draw conclusions about the relative importance of these two types of intangibles for tax planning. Secondly, by focusing on trademarks we contribute to Mendonca et al. (2004), Greenhalgh and Longland (2005), Graham and Somaya (2006), von Graevenitz (2007), Greenhalgh and Rogers (2012), and Crass

[190] Further following Griffith et al. (2014), we include only companies with parent firms in one of the following fourteen states: Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. Appendix C2 shows the results after additionally including firms with parent companies that are located in the United States.
[191] In this study, the location of an intangible asset equals the country of ownership. The terms location, country, jurisdiction, and state are used interchangeably.
[192] Elasticity is defined as a percentage change in the dependent variable in response to a percentage change in the independent variable.

and Peters (2014), who carry out empirical analyses of different aspects of trademark ownership. These authors express concerns about the relative neglect of the non-patent intellectual property (IP) research. While they examine the empirical association between trademarks and a firm's value, profitability, or innovation, we analyze the impact of corporate taxation on trademark location choices.

Our study closely relates to Griffith et al. (2014), since we apply the same identification strategy and use similar data. Therefore, we replicate the main findings of Griffith et al. (2014) in appendix C1 and explain the two differences between our data samples. To begin with, Griffith et al. (2014) use statistics on patent applications which have been filed at the EPO, whereas applications from the USPTO are also included in our data sample. A further difference is the period of observation. Griffith et al. (2014) employ data on patent applications filed between 1985 and 2005, whereas we use a sample of the years between 1996 and 2012. Despite these differences, the replication outcomes and the main results of our study are very similar to Griffith et al. (2014). Namely, Griffith et al. (2014) argue that the tax semi-elasticity[193] of patent location choice varies between -0.5 and -3.9. Our baseline results point to an average tax semi-elasticity for a patent location choice that is equal to -2.8. This implies that increasing the tax rate on royalty income by one percentage point leads to a decrease in the country's patent applications on average by -2.8%, holding other factors constant. Expanding on the work carried out by Griffith et al. (2014), we conduct an analogous analysis for trademarks and subsequently compare the obtained tax elasticities of trademark and patent location choices. We find that the average tax semi-elasticity of a trademark location choice is equal to -6.5, which means that on average a one percentage point increase in a statutory tax rate on royalty income leads to a decrease in the country's trademark applications by -6.5%. Moreover, our empirical analysis shows that the difference in the tax sensitivity of patents and trademarks might be explained by an agglomeration effect. Patents appear to be located more often than trademarks in countries where their owners already hold intangible property and are therefore less responsive to changes in corporate taxation.

The results of our study can also be compared with the literature on the impact of taxation on the quantity or quality of patent applications filed by a firm (see as examples: Ernst and Spengel (2011), Karkinsky and Riedel (2012), Ernst et al. (2014)). These authors conduct empirical

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

analyses at the firm level, usually taking the number of a company's patents as the dependent variable and a country's statutory corporate income tax (CIT) rate as the main independent variable of interest. Despite the fact that our methodology differs, our results are still comparable to this strand of literature. For example, Karkinsky and Riedel (2012) find that the tax semi-elasticity of patents is equal to around -3.5. The average tax semi-elasticity of patent location choices in our study is -2.8. Thus, the tax semi-elasticity found in our analysis is slightly smaller in absolute terms than the one reported by Karkinsky and Riedel (2012) and the difference might be explained by the use of a different time period or a different estimation approach.[194]

Furthermore, our results are in line with the literature on the impact of taxation on the share of intangible assets held by an affiliate. For instance, Huizinga et al. (2008) and Dischinger and Riedel (2011) do not distinguish between different types of intangible assets, such as patents, trademarks, copyrights, know-how, but rather treat them all as a whole. Their findings are similar to the literature on patent location choices. Huizinga et al. (2008) and Dischinger and Riedel (2011) claim that the group affiliates that are located in low-tax jurisdictions have a higher intangibles-to-total-assets ratios than their counterparts in high-tax countries. Our results support this finding and we come to the conclusion that an increase in a country's tax rate on royalty income negatively influences the patent and trademark ownership of group affiliates located in the given country. Moreover, our findings suggest that the tax rate differential between the country of an affiliate and the country of its parent firm affects the number of patents and trademarks held by the affiliate as well.

The paper is structured as follows: section 5.2 presents the development of our two hypotheses. Section 5.3 describes the baseline model of our empirical analysis and explains the identification strategy. In section 5.4, we describe the data sources and the construction of key variables. Some descriptive statistics will also be given in this part of the paper. Section 5.5 gives a summary of the main findings and presents a few robustness checks and extensions to the baseline estimation. The last section summarizes our main findings and concludes drawing policy implications.

[194] As a robustness check, we use the methodology of Karkinsky and Riedel (2012) and find results that are similar to the outcomes reported by these authors and other studies who carried out analysis at a firm level (see Table 5.7).

5.2 Hypothesis Development

According to Griffith et al. (2014), intangible assets are more mobile than other kinds of physical or human capital. This implies that they can be transferred relatively easily from one affiliate to another within a corporate group. In addition, intangibles are often unique, which hinders the determination of their true price in the case of selling or licensing. Thus, Dischinger and Riedel (2011) conclude that a firm can strategically use intellectual property for tax planning by either relocating an intangible asset itself or distorting the royalty price charged to other group affiliates that use this asset as an input factor. Indeed, Ernst and Spengel (2011), Karkinsky and Riedel (2012), Ernst et al. (2014), Griffith et al. (2014), Alstadsæter et al. (2015), Böhm et al. (2015), Bradley et al. (2015), and Dinkel and Schanz (2015) find that corporate taxation influences patent location choices. They argue in line with Huizinga et al. (2008) and Dischinger and Riedel (2011) that more intangible assets are located in the low-tax affiliates of multinational groups than in the high-tax ones. At the same time, Hines (1995), Collins and Shackelford (1998), and Dudar et al. (2015) find evidence that highlights the negative impact that taxation has on the direction and volume of international royalty flows. These authors argue that more payments for the use of intangible assets are flowing into low-tax countries than into high-tax jurisdictions and attribute this development to the tax planning by multinational enterprises.

In this study, we concentrate on the first method of using intangible assets for tax planning, namely their strategic allocation within a corporate group. As described by Endres and Spengel (2015), companies may employ various schemes to strategically locate and relocate their intellectual property. For example, there may be an incentive for firms that operate in several countries to relocate their real research and development units to low-tax jurisdictions. In addition, they may decide to carry out cost sharing agreements, contract R&D projects, or to sell the existing IP from one affiliate to another in order to minimize the eventual taxation of royalties and license fees. Following this argumentation and the findings of earlier studies, Hypothesis 1 of this study states:

> *The location of patents and trademarks is sensitive to the taxation of 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 Co-Operation and Development (OECD), a patent is the right granted by a government to an inventor for the exclusive usage of a certain invention during an agreed period. In contrast, a trademark usually refers to the right to exclusive use of a word, a symbol, or other logo that distinguishes a firm's products or services from those offered by the others.[195] The main objective of a patent is to protect a company's technological investments, whereas a trademark aims to protect a firm's marketing assets.

According to Parchomovsky and Wagner (2005), patents usually belong to a family of a number of different but related inventions. Hence, if the first patent has been registered in a particular country, any following patents that belong to the same family will be typically registered in the same location. By contrast, trademarks are more often registered independently or belong to smaller families and are therefore less likely to trigger subsequent trademark applications in the same country. The agglomeration of patents in the same location implies that firms are more limited in choosing a location for a patent as compared to deciding on a trademark's country of ownership, which predicts a more negative tax elasticity of trademarks than patents. We find empirical evidence that supports this argument in section 5.5.3.

In addition, the development of a patent usually 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 being able to embody a sufficiently large inventive step. The development of such an invention often requires substantial R&D expenditure. Apart from this, in certain industries the R&D facilities and human capital required for the development of a patent are country-specific. Germany can be taken as an example to support this argument, as it has a long history and the necessary large stock of research personnel and tangible assets needed for innovative activity in the automotive industry. By contrast, creating a trademark simply involves selecting a word or designing a symbol of a non-generic nature that is not identical or similar to existing trademarks. Marketing expenses related to this procedure are usually of a smaller scale and do not depend on a country's endowment. Finally, in the case of a patent relocation, a company might be subject to an exit tax on capital gains, even under a contract R&D project. Since designing a trademark involves fewer

[195] See OECD (1993), p. 83.

expenses, relies less on the availability of particular research resources in a country, and its relocation might be implemented without exit taxation, its location might be more elastic to taxation than a patent location decision.

From a tax point of view, there is another important difference between patents and trademarks. The majority of expenses connected with the development of a patent are undertaken *before* the patent is actually registered. According to Sandner and Block (2011), this is different in the case of trademarks, where a large share of marketing expenses occurs only *after* the trademark is granted. Therefore, a firm faces R&D expenditure during the first period of the research process but receives income from the resulting patent during the second phase. Moreover, there is also a possibility that an R&D project fails and as an outcome triggers R&D expenses but does not yield any income. This could result in a company viewing the development of a patent in a high-tax country as a more attractive option. By doing so, the related R&D expenses are deducted from the tax base and diminish a firm's tax liability in the high-tax country. These considerations make patens less sensitive to taxation than trademarks.

Another key difference between patents and trademarks is the documentation requirements during their development. Many countries have laws similar to the German Employee Invention Act that requires the precise identification of a patent's inventor.[196] In the case of trademarks, there are usually no such regulations. Hence, if affiliates of a corporate group undertake a cost sharing agreement or a contract R&D project to develop a patent, they have to clearly document which party invented it and which party covered the costs. By contrast, designing a trademark does not usually involve such strict documentation requirements and as a result companies are given a larger leeway for the strategic allocation of trademark rights.

Finally, obtaining a patent is more costly in terms of fees and time spent than registering a trademark. Applying for the European protection of a trademark at the European Union Intellectual Property Office costs 900 EUR, whereas filing a patent application at the European Patent Office incurs a fee of 1,405 EUR. Not only does it cost more, but also it usually takes longer to grant a patent. While the granting process for a trademark takes on average two to three years at the EuIPO, an equivalent procedure for a patent at the EPO requires on average four to five years. Furthermore, patents are only granted for a limited period, which is typically

[196] See Federal Ministry of Justice and Consumer Protection (2009).

up to twenty years.[197] At the same time, the protection of a trademark can be extended over an unlimited period of time.[198] This implies that if a corporate group decides to strategically locate or relocate its intangible assets, trademarks provide a cheaper and faster as well as a longer lasting solution compared to patents. Once again, this suggests that trademarks have a more negative tax elasticity than patents.

There are several reasons for the differences in the tax elasticities of patent and trademark location choices. Some of these explanations are based on differences in the very nature of patents and trademarks and the others arise from differences in the administrative procedures required for developing and registering these two types of intangible assets. Based on the above argumentation, Hypothesis 2 of this study states:

> *The location choice for trademark ownership is more elastic to taxation than the location choice for patent ownership.*

5.3 Identification Strategy

Our identification strategy is based on Griffith et al. (2014) and we replicate their analysis in Table C.1 (see appendix C1), which enables us to compare their findings with the results obtained in our study. In line with the authors, we assume that the latent variable payoff, which firm *f* obtains from choosing location *j* for the ownership of its intangible asset *p*, is described as follows:

$$\pi_{pifj} = \alpha_i \, Tax_{pj} + \beta \boldsymbol{X}_j + \vartheta_{rj} + \varepsilon_{pifj} \qquad (5.1)$$

In equation 5.1, π_{pifj} represents the payoff generated by the intangible asset *p* belonging to the idea *i* owned by firm *f* in country *j*. The idea *i* represents a patent or trademark family and implies that the intangibles within one family are correlated. The term Tax_{pj} denotes a statutory income tax rate which applies to the payoff generated by the intangible asset p in country *j*.[199] Tax_{pj} is substituted by the corporate income tax rate of the parent company in the case that the

[197] See World Intellectual Property Organization (2016).
[198] See European Union Intellectual Property Office (2017).
[199] Tax_{pj} is intangible-specific (as denoted by the subscript *p*) because some IP Boxes apply only to patents and the others include trademarks as well. This implies that in some countries income generated by a trademark is taxed at a regular corporate income tax rate and income generated by a patent is taxed at the reduced IP Box tax rate. See Evers et al. (2015a), p. 508 for details.

controlled foreign company rules apply.[200] The vector $\boldsymbol{X}_j$ and the error term ε_{pifj} represent all other observable and unobservable factors that might have an impact on the payoff π_{pifj}. For instance, $\boldsymbol{X}_j$ includes the quality of country *j*'s intellectual property rights protection, its market size, and R&D expenditure. The benchmark estimation also contains ϑ_{rj}, which denotes country fixed effects as well as fixed effects at the industry-firm size level *r*. Firm *f* will choose location j for the ownership of its intangible asset if

$$\pi_{pifj} > \pi_{pifh}, \quad \forall\ h \in (1, \ldots, H),\ h \neq j \tag{5.2}$$

the probability of which is given by

$$\mathrm{P}\left(\pi_{pifj} > \pi_{pifh}\right) = \frac{\exp\left(\alpha_i\, Tax_{pj} + \beta\, \boldsymbol{X}_j + \vartheta_{rj}\right)}{\sum_{h=1}^{H} \exp\left(\alpha_i\, Tax_{ph} + \beta\, \boldsymbol{X}_h + \vartheta_{rh}\right)} \tag{5.3}$$

In equation 5.2, H indicates the number of potential location choices h. In equation 5.3, parameters α_i and β can be estimated by means of a mixed logit model. Furthermore, in our baseline specification we refer to Griffith et al. (2014) and randomize the coefficient on Tax_{pj} by defining α_i as follows:

$$\alpha_i = \alpha_i{}' + \varphi_r\, \mu_i, \tag{5.4}$$

where parameter $\alpha_i{}'$ indicates the mean marginal effect of tax on the payoff and φ_r shows the standard deviation of the tax effect on the payoff. μ_i is a random term in the tax parameter α_i. Equation 5.4 implies that we relax the independence of irrelevant alternatives (IIA) assumption. In other words, by randomizing the coefficient on Tax_{pj} we allow for the correlation between payoffs of different location choices. According to Nevo (2001) and Train (2009), this step results in a more realistic model design because it enables a greater degree of flexibility in the substitution patterns between different locations. In line with Hypothesis 1 of this study, we expect a negative value of α_i, as it would imply that affiliates of a corporate group that are located in high-tax countries are less likely to own intangible assets than the affiliates in low-tax countries. In accordance with Hypothesis 2, α_i should hold a more

[200] We assume that controlled foreign company rules apply to a given affiliate if the country of the parent firm applies the rules with respect to the country of the affiliate.

negative value in the case of trademarks compared to patents. This would imply that trademark location choices are more elastic with respect to taxation than patent location choices.

5.4 Data

5.4.1 Data on Patents and Trademarks

In order to test the hypotheses described in section 5.2, we carry out an empirical analysis in which patent and trademark ownership choices constitute the dependent variable. It is worth noting, however, that most companies do not disclose information on the ownership of intangible assets within their groups. Therefore, we refer to previous literature[201] and use data on patent and trademark applications as a proxy for patent and trademark ownership choices. As Ernst and Spengel (2011) note, an intangible's 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 was obtained from the Bureau van Dijk and includes patent and trademark applications filed at the European Patent Office, the European Union Intellectual Property Office, and the United States Patent and Trademark Office. In comparison, most previous studies on patent applications only use the EPO statistics. Our sample includes patent and trademark applications made by 162,640 firms located in one of the following fifteen countries: Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States.[202] In total, these enterprises applied for 1,696,332 patents and 624,801 trademarks in the period between 1996 and 2012 (see Table 5.1).

In order to control for the industrial heterogeneity among firms, we divide all patents and trademarks of our sample into three industry classes.[203] In line with Griffith et al. (2014), the three sectors used in the baseline estimations are chemical, engineering, and electrical. The chemical industry includes patents and trademarks connected to pharmaceutics, agriculture, the

[201] See as examples: Ernst and Spengel (2011), Karkinsky and Riedel (2012), Ernst et al. (2014), Griffith et al. (2014), Alstadsæter et al. (2015), Bradley et al. (2015).

[202] Following Griffith et al. (2014), we include only companies with parent firms in one of the following fourteen states: Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. Appendix C2 shows the results after additionally including firms with parent companies that are located in the United States.

[203] For industry identification, we employ the intangible-level data. In the cases where this data is missing, we use the industry classification of a firm.

extraction and processing of raw materials, chemicals, metals, and natural resources. The engineering category primarily comprises intangibles related to the engineering and manufacturing sectors. Finally, the electrical industry includes patents and trademarks in the areas of technology and telecommunications, electronics, computers, research, and similar fields.

Table 5.1 shows the exact number of patents (Panel A) and trademarks (Panel B) in each industry class. According to this table, companies located in Germany own the greatest number of patents while firms that reside in the United States hold the largest portion of trademarks in our dataset. As for industry classification, around 37% of all patents in our sample stem from the engineering sector and around 36% of all trademarks originate in the electrical industry. Furthermore, in order to take into account differences across firms of different sizes, we refer to Griffith et al. (2014) and split each industry into two size groups. Large companies are those with the number of IP applications above the 80th percentile of their industrial sector, whereas the remaining firms are classified as either medium or small and are assigned to the non-large category.

Table 5.1 Summary Statistics on the Number of Patents and Trademarks by Country

Panel A. Patents

	No. of Applications	% of Total, by Industry:		
		Chemical	Engineering	Electrical
Belgium	20,116	49.25	22.05	28.70
Denmark	21,460	44.76	26.03	29.22
Finland	46,729	26.90	21.13	51.98
France	146,420	29.39	36.05	34.56
Germany	844,890	28.73	39.73	31.54
Ireland	5,460	14.98	34.93	50.09
Italy	95,610	40.31	42.74	16.95
Luxembourg	2,549	29.27	34.68	36.05
Netherlands	84,471	22.36	25.87	51.77
Norway	12,661	43.57	29.65	26.78
Spain	29,665	34.12	37.72	28.16
Sweden	71,156	25.42	26.66	47.91
Switzerland	76,819	18.86	54.54	26.60
UK	91,903	27.17	30.74	42.09
US	146,423	30.85	33.88	35.27
Total	1,696,332	29.19	36.99	33.81

Panel B. Trademarks

	No. of Applications	% of Total, by Industry: Chemical	Engineering	Electrical
Belgium	8,938	45.50	30.28	24.22
Denmark	10,833	40.28	36.20	23.52
Finland	5,956	33.63	38.13	28.24
France	41,856	42.35	27.92	29.73
Germany	134,341	35.08	33.65	31.27
Ireland	5,747	39.93	29.34	30.73
Italy	54,074	37.52	42.27	20.21
Luxembourg	4,122	23.68	30.49	45.83
Netherlands	26,784	31.61	33.21	35.19
Norway	2,409	35.16	33.17	31.67
Spain	39,420	35.77	37.05	27.18
Sweden	16,944	32.58	36.78	30.64
Switzerland	28,240	41.48	28.79	29.73
UK	57,819	26.52	26.53	46.95
US	187,318	22.92	30.61	46.47
Total	624,801	31.65	32.48	35.87

It is sometimes the case that intangibles that are generated by the same company in the same industry are closely related to each other in terms of their underlying idea and innovation process. We apply the approach used by Griffith et al. (2014) and allow for the correlation between such assets. As a result, intangibles that emerge from the same firm within the same sector within a period of one quarter and share a network of common inventors are grouped into one idea. According to our data, approximately 80% of ideas include just one intangible.

5.4.2 Tax Data

Tax Rate is the main independent variable of interest, which was constructed by gathering information from a series of the International Bureau of Fiscal Documentation (IBFD) *Global Corporate Tax Handbook*[204] as well as the *IBFD Research Platform*.[205] We use the statutory corporate income tax rates in the main specification, since these rates apply to the income generated by intangible assets and are therefore relevant for tax planning strategies of corporate groups. If a country offers an IP Box, the reduced tax rate is used.[206]

[204] See International Bureau of Fiscal Documentation (1995-2012).
[205] Available at: http://www.ibfd.org/
[206] Information on IP Boxes was taken from Evers et al. (2015a) and extended through our own research.

Furthermore, in accordance with Griffith et al. (2014) the tax rates in our benchmark estimations incorporate controlled foreign company (CFC) rules.[207] These rules endeavor to hinder profit shifting by corporate groups that place their intangible assets in low-tax countries to minimize their consolidated tax liabilities. According to CFC regulations, passive income of a subsidiary in a tax haven is to be taxed at the rate of its parent company. Passive income is defined differently in each country that implements the rules, although it typically refers to royalty payments and other income that is not associated with real economic activity. Table 5.2 provides an overview of the CFC rules that exist in the countries relevant for our analysis.

According to Table 5.2, the strictness of the controlled foreign company regulations varies from country to country. In addition to the standard regulations, some countries have introduced a so-called "Black List" which usually contains tax havens. By contrast, Sweden has developed a "White List" which includes countries that are not considered to support profit shifting activities.

Table 5.2 Countries with CFC Rules in Place

Country	Introduction	Conditions under which CFC Rules are Binding
Belgium	-	-
Denmark	1995	Always binding
Finland	1995	Effective tax rate is < 60% of Finnish tax or 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 on the "Black List"
Luxembourg	-	-
Netherlands	-	-
Norway	1992	Effective tax rate is < 66% of Norwegian tax or on the "Black List"[1]
Spain	1995	Effective tax rate is < 75% of Spanish tax
Sweden	1990	Effective tax rate is < 55% of Swedish tax, except a country is on the "White List"
Switzerland	-	-
UK	1984	Effective tax rate is < 75% of British tax

Notes: [1]The rules do not apply if a tax treaty exists. Since the European Court of Justice Cadbury Schweppes case of 2006, CFC rules do not apply within the European Economic Area except for special cases. Sources: Karkinsky and Riedel (2012) and our own research.

[207] Data on CFC rules was obtained from Karkinsky and Riedel (2012) and extended through our own research.

It should be noted that since the European Court of Justice (ECJ) Cadbury Schweppes[208] case of 2006, the CFC rules are not applicable within the European Economic Area (EEA).[209] Controlled foreign company rules apply to approximately 10% of intangible assets in our sample. Incorporating these regulations in our analysis is of great importance, since profits generated from patents and trademarks are typically classified as passive income and therefore have to be taxed according to controlled foreign company rules if they apply. Aside from this, taking into account the parent company's taxation in the calculation of tax rates provides another source of variation in the main independent variable of interest, as Griffith et al. (2014) note.

5.4.3 Other Control Variables

In addition to tax rates, our benchmark model includes several other independent variables. For example, in line with Griffith et al. (2014) we take into consideration the quality of patents and trademarks. A patent or trademark idea is considered to be of high quality if the majority of its applications have been filed at the European, US, and Japanese registration offices. In addition, we control for *Real Activity* in the case of patents.[210] This is a binary variable that is equal to one if at least one inventor of a patent resides in the given country and to zero otherwise (see Table 5.3).

In line with Griffith et al. (2014), our baseline model includes information on a country's intellectual property rights protection, which is measured with an index developed by the Heritage Foundation.[211] This index ranges from zero to 100 and we define a country as having a high level of intellectual property rights protection if it scores above the median of countries in our sample. In addition, with reference to Griffith et al. (2014) along with other related studies such as Dischinger and Riedel (2011), Karkinsky and Riedel (2012), Ernst et al. (2014), we control for the effect of a country's market size and its total R&D expenditure on the intellectual property location choices. Hence, we include gross domestic product (GDP) in our regression estimation as a proxy for a country's market size. Data on GDP was collected from

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[208] See *Cadbury Schweppes plc and Cadbury Schweppes Overseas Ltd v. Commissioners of Inland Revenue*, C-196/04 (2006).

[209] Denmark is the only exception in this case. After the ECJ *Cadbury Schweppes* case in 2006, Denmark did not relax the CFC rules for EU member states as other states did but instead enhanced them to include domestic companies. See Schmidt (2014) for more information.

[210] We do not have data on this variable in the case of trademarks.

[211] Available at: http://www.heritage.org/index/

the World Bank's *Development Indicators.*[212] *BERD* measures country *j*'s business expenditure on research and development (BERD) as a percentage of its GDP and represents its level of innovative activity. Statistics on BERD are from the OECD database *Main Science and Technology Indicators.*[213] Table 5.3 contains descriptive statistics on all variables used in the regression analysis. Panel A summarizes data for patents and Panel B shows statistics for trademarks.

Table 5.3 Descriptive Statistics

Panel A. Patents

Variable	Obs.	Mean	Std. Dev.	Min	Max
Tax Rate	25,444,980	0.28	0.11	0.00	0.45
Quality	25,444,980	0.24	0.43	0.00	1.00
Real Activity	25,444,980	0.06	0.23	0.00	1.00
High IP Rights Protection	25,444,980	0.01	0.12	0.00	1.00
GDP	25,444,980	1.76	3.21	0.02	14.41
BERD	25,444,980	22.83	1.47	19.55	26.42

Panel B. Trademarks

Variable	Obs.	Mean	Std. Dev.	Min	Max
Tax Rate	9,372,015	0.31	0.08	0.06	0.45
Quality	9,372,015	0.06	0.23	0.00	1.00
High IP Rights Protection	9,372,015	0.01	0.12	0.00	1.00
GDP	9,372,015	1.70	3.09	0.02	14.23
BERD	9,372,015	22.83	1.47	19.55	26.42

Notes: The samples include 1,696,332 patent applications and 624,801 trademark applications. Multiplying the number of patent and trademark applications by 15 (the number of country choices) gives the number of observations in each sample (25,444,980 for patents and 9,372,015 for trademarks). *Tax Rate* stands for a host country's statutory tax rate levied on the income from intangible assets and incorporates taxation under IP Boxes and CFC rules. *Quality* is a dummy variable that indicates intangible assets of high quality (applications filed at multiple offices). *Real Activity* is a binary variable, which is equal to one if at least one of the intangible's inventors resides in the given country and takes on the value of zero otherwise. *High IP Rights Protection* represents an indicator of a country's level of intellectual property rights protection. *GDP* stands for gross domestic product. *BERD* denotes a country's business expenditure on research and development in relation to its GDP.

Moreover, in line with Griffith et al. (2014), we include location-industry-firm size fixed effects into the regression estimations. They control for the unobserved time-invariant heterogeneity

[212] See World Bank (2015).
[213] See OECD (2016d).

across countries, industries, and firm sizes. For example, companies might prefer to register an intangible asset in a particular country due to its geographical or historical characteristics. Alternatively, firms in certain industries may face specific rules concerning the development and registration of intangible assets. Various 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 result in unobserved heterogeneity, which is taken into account by the corresponding fixed effects.

5.5 Results

5.5.1 Baseline Results

The outcomes of the regression analysis described in section 5.3 are presented in Table 5.4 (see Panel A for patents and Panel B for trademarks). In all estimations, intellectual property location choice is a dependent variable. The final samples include 1,696,332 patent applications and 624,801 trademark applications. The results are shown separately for each industry and in accordance with different firm sizes. All estimations include location-industry-firm size fixed effects.[214]

According to Table 5.4, the mean marginal impact of a statutory tax rate on the intellectual property location choice is negative and statistically significant across all industries and firm-size groups. This finding is in line with the Hypothesis 1 of our study discussed in section 5.2. There appears to be a more negative effect of taxation on patent location choices for small and medium companies in comparison to large firms. Moreover, the tax impact seems to be more pronounced in the engineering sector than in the chemical and electrical industries. In the case of trademarks, intangibles owned by non-large companies appear to be more sensitive to taxation than those held by large enterprises. Here, the effect is more pronounced in the case of the electrical industry than in other sectors. A comparison of the results shown in Panels A and B of Table 5.4 suggests that taxation has a more negative effect on the location of trademarks than patents. This result confirms Hypothesis 2 of this paper, as it implies that in the case of trademarks firms are more sensitive to the taxation of royalty income than in the case of patents.

[214] Detailed results on the fixed-effects' coefficients are available upon request.

Table 5.4 Estimated Parameters

Panel A. Patents

Industry	Electrical		Engineering		Chemical	
Size	Large	Non-Large	Large	Non-Large	Large	Non-Large
Tax Rate	-2.122***	-2.779***	-4.362***	-4.969***	-3.657***	-3.197***
	(0.111)	(0.065)	(0.137)	(0.074)	(0.099)	(0.081)
*Tax Rate*Quality*	-1.739***	-2.488***	-2.918***	-2.804***	-0.280**	-2.493***
	(0.119)	(0.101)	(0.142)	(0.113)	(0.134)	(0.114)
Tax Rate (Std.Dev.)	5.851***	3.749***	4.018***	4.233***	4.604***	2.441***
	(0.108)	(0.092)	(0.173)	(0.102)	(0.142)	(0.168)
Real Activity	4.772***	6.427***	5.781***	8.362***	7.777***	8.872***
	(0.027)	(0.037)	(0.036)	(0.063)	(0.107)	(0.092)
Real Activity (Std.Dev.)	1.661***	2.911***	2.076***	4.273***	4.527***	4.373***
	(0.036)	(0.034)	(0.033)	(0.049)	(0.104)	(0.068)
High IP Rights Protection	0.190***	-0.151***	-0.424***	0.963***	-0.253***	-0.044
	(0.041)	(0.036)	(0.078)	(0.036)	(0.067)	(0.046)
GDP	-0.499***	0.465***	-0.564***	1.128***	1.108***	0.659***
	(0.019)	(0.017)	(0.028)	(0.019)	(0.029)	(0.019)
BERD	-0.934***	2.962***	1.243***	-0.517***	5.478***	0.970***
	(0.062)	(0.049)	(0.086)	(0.053)	(0.087)	(0.055)

Panel B. Trademarks

Industry	Electrical		Engineering		Chemical	
Size	Large	Non-Large	Large	Non-Large	Large	Non-Large
Tax Rate	-5.592***	-8.305***	-5.451***	-7.217***	-6.620***	-7.444***
	(0.163)	(0.111)	(0.159)	(0.114)	(0.152)	(0.111)
*Tax Rate*Quality*	-3.253***	-4.828***	-0.865***	-3.085***	-6.330***	-2.683***
	(0.287)	(0.216)	(0.310)	(0.262)	(0.231)	(0.261)
Tax Rate (Std.Dev.)	6.240***	6.247***	4.940***	6.235***	5.224***	7.055***
	(0.185)	(0.133)	(0.207)	(0.139)	(0.196)	(0.127)
High IP Rights Protection	0.347***	0.363***	0.321***	0.176***	0.212***	0.158***
	(0.070)	(0.044)	(0.058)	(0.041)	(0.056)	(0.043)
GDP	0.058***	-0.009*	0.010	0.001	-0.053***	-0.018***
	(0.008)	(0.005)	(0.008)	(0.006)	(0.009)	(0.006)
BERD	-0.236***	0.485***	0.413***	0.203***	0.041	0.174***
	(0.055)	(0.039)	(0.052)	(0.036)	(0.052)	(0.037)

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. The samples include 1,696,332 patent applications and 624,801 trademark applications (the number of observations is 25,444,980 for patents and 9,372,015 for trademarks). The dependent variable is location choice in one of the countries shown in Table 5.1. Location-industry-firm size fixed effects are included in all estimations. Large stands for companies with a total number of applications above the 80th percentile in their industry; Non-Large companies are enterprises of other sizes. *Tax Rate* stands for a host country's tax rate levied on the income from intangible assets and incorporates taxation under IP Boxes and CFC rules. *Quality* is a dummy variable that indicates intangible assets of high quality (applications filed at multiple offices). *Real Activity* is a binary variable, which is equal to one if at least one of the intangible's inventors resides in the given country and takes on the value of zero otherwise. *High IP Rights Protection* represents an indicator of a country's level of intellectual property rights protection. *GDP* denotes a country's gross domestic product. *BERD* stands for a country's business expenditure on R&D in relation to its GDP.

Furthermore, Table 5.4 shows that patents and trademarks of high quality are more sensitive to taxation than the low-quality intangibles. This effect is more pronounced in the case of trademarks compared to patents across almost all industry-firm size categories with the exception of large companies in the engineering sector. In addition, patents tend to be owned in countries where real R&D activity takes place. This is reflected by the positive coefficient on *Real Activity* in Panel A. As for the effects of other control variables shown in Table 5.4, stronger intellectual property rights protection seems to play a positive role in making a location decision across almost all industry groups and firm sizes. This result is in line with Karkinsky and Riedel (2012), Griffith et al. (2014), and other studies that find a positive association between a country's governance and its number of patents. A positive and statistically significant coefficient on *GDP* in most categories implies that more patents and trademarks are located in economies with large markets. However, the coefficient on GDP turns out to be negative in some cases, which implies that companies of these categories tend to locate their intangibles in stagnating economies with shrinking markets.

Moreover, Table 5.4 shows that *BERD*, which denotes a country's total business expenditure on research and development in relation to its GDP, has a positive and statistically significant impact on the location of patents and trademarks across almost all corporate groups. This implies that a greater share of investment in research and development positively affects the number of patent and trademark applications in the given country. However, the effect appears to be reversed in the case of large firms in some industries.

The regression results presented in Table 5.4 support Hypothesis 1 of this study. Namely, they show that taxation has a negative and statistically significant impact on the location choices of 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 in more detail, we calculate the own and cross-country tax elasticities of patent and trademark location choices using equation 5.5.

$$e_{pijh} = \frac{\Delta P_{pj}}{\Delta Tax_{ph}} \; \frac{Tax_{ph}}{P_{pj}} \tag{5.5}$$

In equation 5.5, e_{pijh} is the elasticity of the probability that an intangible asset p belonging to an idea i is located in country j with respect to a marginal change in the tax rate in location h. Tax_{ph} denotes a statutory tax rate in country h that is levied on the profits generated by intangible assets owned by firm f.[215] P_{pj} represents the predicted probability that an intangible asset p will be located in country j.[216] Equation 5.3 describes the formulation of P_{pj} in more detail. We aggregate the elasticities of the location choices that arise within each country and report the corresponding findings in Table 5.5. Panel A presents the outcomes for patents and Panel B shows the results for trademarks.

Panel A of Table 5.5 contains the elasticities of patent location choices with respect to a corporate income tax rate. The diagonal values depict the own tax elasticities, which are negative in all locations. The lowest (in absolute terms) own tax sensitivity of -0.1 is observed in Ireland and the highest, of -1.4, in the United States. This means that on average a one percent increase in the Irish tax rate leads to a -0.1% decrease in patent applications that arise from this country. A one percent rise in the US tax rate results on average in a -1.4% decrease in patent applications from the United States. The cross-country tax elasticities are positive, which implies that 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 5.5 presents tax elasticities in the case of trademarks and in comparison to the tax elasticities of patent location choices, these values appear to be more negative. For instance, a one percent tax rate increase in Ireland leads to a -1.4% decrease in trademark applications. In the case that the Danish tax rate increases by one percent, its number of trademarks will likely experience a -2.3% drop. Relatively low tax elasticities (in absolute terms) in some low-tax countries such as Ireland or Switzerland could result from the controlled foreign company rules. CFC rules often apply to these jurisdictions because many high-tax countries see them as tax havens. If this is the case, then a change in the tax rate in these low-tax countries does not attract additional ownership of intangible assets because the tax rate of the parent company applies to the income from the intangible assets anyway.

[215] ΔTax_{ph} equals the standard deviation of the residuals of Tax_{ph} divided by 1000. This implies that ΔTax_{ph} is close to the smallest possible change in the tax rate. Using a change of 1% instead does not alter the results.

[216] ΔP_{pj} is calculated through subtracting the predicted probabilities of the location choices before and after a tax change.

Table 5.5 Own and Cross-Country Elasticities of Location Choices with Respect to Changes in the Tax Rate

Panel A. Patents

	Belgium	Denmark	Finland	France	Germany	Ireland	Italy	Luxem-bourg	Nether-lands	Norway	Spain	Sweden	Switzer-land	UK	US
Belgium	-0.88	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
Denmark	0.01	-0.98	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	0.03	0.03	-0.80	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03	0.03
France	0.06	0.06	0.05	-0.66	0.06	0.05	0.06	0.06	0.06	0.05	0.06	0.05	0.05	0.06	0.06
Germany	0.69	0.69	0.54	0.69	-0.64	0.45	0.69	0.69	0.69	0.54	0.69	0.54	0.35	0.69	0.71
Ireland	0.00	0.00	0.00	0.00	0.00	-0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Italy	0.07	0.07	0.07	0.07	0.07	0.06	-1.11	0.07	0.07	0.07	0.07	0.07	0.05	0.07	0.07
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Netherlands	0.04	0.04	0.03	0.04	0.04	0.03	0.04	0.04	-0.77	0.03	0.04	0.03	0.03	0.04	0.04
Norway	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	-0.85	0.01	0.01	0.01	0.01	0.01
Spain	0.02	0.02	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.02	-0.93	0.02	0.01	0.02	0.02
Sweden	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.04	0.04	-0.81	0.03	0.04	0.04
Switzerland	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.04	0.04	0.04	-0.44	0.04	0.04
UK	0.05	0.05	0.05	0.05	0.06	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.04	-0.96	0.06
US	0.08	0.07	0.07	0.08	0.09	0.06	0.07	0.07	0.07	0.07	0.07	0.07	0.06	0.07	-1.35

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

Panel B. Trademarks

	Belgium	Denmark	Finland	France	Germany	Ireland	Italy	Luxem-bourg	Nether-lands	Norway	Spain	Sweden	Switzer-land	UK	US
Belgium	-2.14	0.04	0.04	0.03	0.03	0.04	0.03	0.04	0.04	0.04	0.03	0.04	0.03	0.04	0.02
Denmark	0.04	-2.31	0.05	0.04	0.04	0.06	0.04	0.06	0.05	0.05	0.04	0.05	0.05	0.05	0.03
Finland	0.02	0.03	-2.20	0.02	0.02	0.04	0.02	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.02
France	0.14	0.19	0.18	-2.05	0.13	0.18	0.16	0.18	0.17	0.18	0.16	0.18	0.17	0.18	0.12
Germany	0.40	0.54	0.52	0.41	-1.69	0.55	0.45	0.62	0.51	0.51	0.46	0.52	0.52	0.52	0.33
Ireland	0.01	0.02	0.02	0.01	0.01	-1.44	0.02	0.03	0.02	0.02	0.02	0.02	0.03	0.02	0.01
Italy	0.18	0.25	0.24	0.19	0.17	0.25	-2.07	0.26	0.23	0.24	0.21	0.24	0.23	0.24	0.15
Luxembourg	0.01	0.01	0.01	0.01	0.01	0.02	0.01	-1.86	0.01	0.01	0.01	0.01	0.01	0.01	0.00
Netherlands	0.09	0.13	0.13	0.09	0.09	0.15	0.10	0.15	-2.19	0.12	0.10	0.12	0.13	0.12	0.08
Norway	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	-2.24	0.01	0.01	0.01	0.01	0.01
Spain	0.13	0.18	0.18	0.14	0.13	0.19	0.15	0.19	0.17	0.17	-2.14	0.18	0.17	0.18	0.11
Sweden	0.06	0.08	0.09	0.06	0.05	0.10	0.07	0.09	0.08	0.09	0.07	-2.17	0.09	0.08	0.05
Switzerland	0.07	0.11	0.12	0.07	0.07	0.18	0.08	0.17	0.10	0.11	0.09	0.12	-1.54	0.11	0.06
UK	0.21	0.29	0.29	0.22	0.19	0.32	0.24	0.31	0.27	0.29	0.24	0.30	0.29	-2.07	0.18
US	0.58	0.74	0.72	0.60	0.53	0.65	0.64	0.71	0.69	0.72	0.65	0.72	0.64	0.74	-1.48

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

Finally, we calculate tax semi-elasticities of patent and trademark location choices in order to compare our results with the previous literature. Semi-elasticity represents a percentage change in the share of intangibles in a country in response to a one percentage point change in that country's tax rate. According to Table 5.6, the average tax semi-elasticity of a patent location choice is -2.8, whereas the average tax semi-elasticity of a trademark location is equal to -6.5. These findings are in line with Hypothesis 2 of our study, according to which trademarks are more sensitive to taxation than patents. The tax semi-elasticity of patents that we observe is very similar to the findings of the previous literature. For instance, Griffith et al. (2014) conclude that the tax semi-elasticity of a patent location choice is between -0.5 and -3.9, while Karkinsky and Riedel (2012) find this value to equal around -3.5. This implies that our results are within the range identified in earlier studies, even though the samples differ in terms of the years and countries which they cover.[217]

Table 5.6 Semi-Elasticities of Location Choices with Respect to a Tax Rate Change

	Patents	Trademarks
Belgium	-3.4	-5.9
Denmark	-3.4	-7.9
Finland	-2.7	-7.7
France	-3.1	-5.8
Germany	-1.7	-4.6
Ireland	-0.6	-6.7
Italy	-3.3	-6.1
Luxembourg	-3.4	-7.7
Netherlands	-3.2	-7.1
Norway	-2.8	-7.6
Spain	-3.3	-6.4
Sweden	-2.7	-7.5
Switzerland	-1.7	-6.3
UK	-3.2	-7.0
US	-3.4	-3.8

Notes: Semi-elasticity represents a percentage change in the patent or trademark applications relative to a unit (i.e. percentage-point) change in the tax rate. The average tax rates of the whole time period were used for these calculations.

[217] One difference is that our paper considers a more recent period of observation compared to the existing literature on patent location choices. In addition, earlier studies mainly concentrated on patent applications filed at the European patenting office, whereas we analyze the US patents and trademarks as well.

5.5.2 Robustness Checks

In order to check the robustness of our baseline results, we conduct a few tests and extensions and report the outcomes in Tables 5.7-5.9. This part of the analysis is carried out using only non-large firms of the engineering sector as a representative sample.[218] The results of all robustness checks are reported simultaneously for patents and trademarks in order to facilitate a direct comparison between the two types of IP.

As previously discussed, our benchmark estimations are carried out using the mixed logit model. In order to check the robustness of these findings, columns I-IV of Table 5.7 display the outcomes of applying two alternative multinomial logit models. In line with the benchmark model, the dependent variable in these estimations is a location choice for an intangible asset in one of the fifteen countries shown in Table 5.1. In addition, these specifications include location fixed effects. Columns I and II show the results of using a conditional logit model, in which the assumption of the independence of irrelevant alternatives is not relaxed. For this reason, the alternative location choices are assumed to be uncorrelated here. The outcomes of this alteration are similar to the baseline findings.

Columns III and IV present the results of a nested logit estimation. According to Hensher et al. (2005), this model relaxes the IIA assumption by clustering similar alternative location choices into nests. Hence, we divide our fifteen locations into five clusters according to their geographical region. To illustrate this point further, let us consider the possibility where a firm wants to place a patent in Sweden, but this country increases its statutory corporate tax rate. The company thus chooses an alternative location for the patent and we assume that it views other Nordic countries as preferred alternatives to Sweden and all other locations become inferior options. Allowing for such a correlation between alternative locations leads to more negative effects of taxation on location choices than the effects found in our baseline estimations.

[218] This industry-firm size category was chosen as a representative sample because it contains the largest number of observations 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.

Table 5.7 Robustness Tests

Panel A	Conditional Logit		Nested Logit		Negative Binominal		OLS	
	Patents	Trademarks	Patents	Trademarks	Patents	Trademarks	Patents	Trademarks
	I	II	III	IV	V	VI	VII	VIII
Tax Rate	-4.896***	-7.801***	-5.213***	-10.590***	-0.347***	-2.008***	-0.605***	-2.948***
	(0.065)	(0.129)	(0.063)	(0.496)	(0.063)	(0.079)	(0.0566)	(0.0830)
*Tax Rate*Quality*	-2.655***	-2.720***	-0.532***	0.686	-0.022	-0.130*	-1.293***	-0.744**
	(0.120)	(0.245)	(0.206)	(0.738)	(0.07)	(0.077)	(0.134)	(0.323)
Quality					0.432***	2.835***	1.884***	2.886***
					(0.025)	(0.027)	(0.0475)	(0.111)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects					Yes	Yes	Yes	Yes
Firm Fixed Effects					Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes				
Number of Intangibles	413,274	135,512	413,274	135,512				
Number of Observations	6,199,110	2,032,680	6,199,110	2,032,680	1,246,253	1,918,535	1,246,253	1,918,535

Panel B	No Controls		Only Firms with Both		Simple CIT		CIT Difference	
	Patents	Trademarks	Patents	Trademarks	Patents	Trademarks	Patents	Trademarks
	IX	X	XI	XII	XIII	XIV	XV	XVI
Tax Rate	-1.960***	-7.326***	-0.954***	-4.470***	-1.546***	-2.874***	-4.801***	-7.217***
	(0.048)	(0.105)	(0.150)	(0.188)	(0.116)	(0.162)	(0.076)	(0.114)
*Tax Rate*Quality*			-0.188	-2.212***	-2.532***	-5.903***	-2.264***	-3.085***
			(0.174)	(0.393)	(0.166)	(0.440)	(0.093)	(0.262)
Tax Rate (Std.Dev.)	6.654***	6.207***	8.242***	8.986***	10.970***	20.310***	4.313***	6.235***
	(0.056)	(0.133)	(0.136)	(0.232)	(0.152)	(0.216)	(0.101)	(0.139)
Controls	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Intangibles	413,274	135,512	212,695	48,659	413,274	135,512	413,274	135,512
Number of Observations	6,199,110	2,032,680	3,190,425	729,885	6,199,110	2,032,680	6,199,110	2,032,680

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Robustness tests are shown only for non-large firms of the engineering sector. In columns I-IV and IX-XVI, the dependent variable is location choice in one of the countries shown in Table 5.1. In columns V-VIII, the dependent variable is the number of intangibles held by a firm in the given year. *Tax Rate* in columns I-XII stands for a host country's tax rate levied on the income from intangible assets and incorporates taxation under IP Boxes and CFC rules. In columns XIII-XIV, it represents a simple CIT rate without taking IP Boxes and CFC rules into consideration. In columns XV-XVI, it represents the tax differential between the tax rate of the firm's host country and the tax rate of the country of its parent company. *Quality* is a dummy variable that indicates intangible assets of high quality (applications filed at multiple offices). *Controls* includes *High IP Rights Protection*, *GDP*, *BERD*, and *Real Activity* (for patents). Columns XI-XII show the results for firms that have at least one patent and one trademark.

Several previous papers on patent location choices adopted a different identification strategy from Griffith et al. (2014) and this study. For example, Karkinsky and Riedel (2012) conduct an analysis at a firm level rather than at the level of an intangible asset by applying estimators such as the negative binominal and ordinary least squares (OLS) models. In order to compare our results with this strand of literature, we implement an alternative identification strategy and display the results in columns V-VIII of Table 5.7. The dependent variable in these estimations is the number of patents or trademarks held by a firm in the given year. Columns V-VI display the results of using a negative binominal estimator and columns VII-VIII show the outcomes of the OLS estimation. Both firm and year fixed effects are included in these regressions, and 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 intangible assets owned by a firm. In addition, companies with patents and trademarks of high quality appear to be more sensitive to changes in taxation than firms with low-quality intangibles. The results we obtain using the negative binominal and OLS estimators are slightly lower in absolute terms but still of the same magnitude as the effects reported by Karkinsky and Riedel (2012) and other existing studies.[219]

Columns IX and X of Table 5.7 show the baseline results presented in Table 5.4 after the exclusion of all control variables and the inclusion of the main independent variables of interest only. It becomes apparent that this modification almost does not influence the main findings, leaving the coefficient on tax rate both negative and statistically significant. The effect of taxation remains more negative in the case of trademarks than in the case of patents. Furthermore, columns XI and XII show the results of considering only the firms that hold at least one patent and one trademark during the period of observation. The main effects for these companies seem to be less negative in comparison with the baseline estimations.

Finally, columns XIII-XVI of Table 5.7 modify the main independent variable of interest, namely the tax rate. Columns XIII-XIV include as the main independent variable of interest the statutory corporate income tax rate without incorporating a country's IP Box or controlled foreign company rules. The magnitude of the results appears to be smaller in absolute terms compared to the baseline model. Furthermore, estimations in columns XV-XVI include the tax differential between an affiliate and its parent firm as the main independent variable of interest.

[219] See as example: Karkinsky and Riedel (2012), Table 3 on p. 183 (columns 1-3 for OLS and columns 12-14 for negative binominal).

This alteration causes almost no change in the main regression outcomes and the impact of tax variables remains negative and statistically significant. Once again, the effect is more negative for trademarks than for patents.

5.5.3 Agglomeration of Patents vs Trademarks

In section 5.2, we give a few explanations for why the tax elasticity of trademark location choices might be different from the tax elasticity of patent location choices. Some of these explanations are based on differences in the nature of patents and trademarks and others arise from differences in the administrative procedures related to developing and registering these two types of intellectual property. In this section, we empirically test whether an agglomeration effect could serve as one of the explanations for a lower mobility of patents within a corporate group compared to the transferability of trademarks. In line with the robustness checks shown in the previous section, this part of the analysis is carried out using non-large firms of the engineering sector as a representative sample.

According to our argumentation in section 5.2, patents are more likely to be held together in a bundle, since multiple patents often belong to one family. In the baseline specification, we allow for some degree of correlation between related patents by grouping them into ideas. However, it may be the case that several ideas belong to one patent family and will therefore be registered in the same country where the first patent of the family is held. By contrast, trademarks are more often held independently or belong to smaller families and because of this are expected to depend less on the location of previous trademarks. We test this idea empirically and present the outcomes in Table 5.8. These specifications include *New Location*, which is a binary variable that acquires the value of one if a firm has never applied for an intangible asset[220] in the given country and equals zero otherwise. This variable turns out to be negative and statistically significant for both patents and trademarks, as columns I and III show. What this result suggests is that intangibles are indeed more likely to be registered in the countries where a company already holds some assets and are less likely to be located in completely new locations from a firm's point of view. Moreover, the coefficient on *New Location* is more negative in the case of patents compared to trademarks.

[220] Here, we consider previous patent applications in the same industry for patents and previous trademark applications in the same industry for trademarks.

Table 5.8 Extended Analysis: Agglomeration Effect

	Patents		Trademarks	
	I	II	III	IV
Tax Rate	-4.611***	-8.313***	-7.785***	-11.490***
	(0.107)	(0.128)	(0.118)	(0.236)
*Tax Rate*Quality*	-1.973***	-1.534***	-3.714***	-3.529***
	(0.193)	(0.194)	(0.267)	(0.269)
Tax Rate (Std.Dev.)	7.929***	7.639***	6.223***	6.343***
	(0.108)	(0.111)	(0.141)	(0.141)
New Location	-7.291***	-9.315***	-2.445***	-3.809***
	(0.034)	(0.057)	(0.017)	(0.078)
*Tax Rate*New Location*		6.782***		3.994***
		(0.135)		(0.221)
Real Activity	5.394***	5.350***		
	(0.026)	(0.025)		
Real Activity (Std.Dev.)	1.748***	1.717***		
	(0.024)	(0.023)		
High IP Rights Protection	1.111***	1.084***	0.155***	0.152***
	(0.049)	(0.049)	(0.042)	(0.042)
GDP	0.477***	0.517***	-0.006	-0.004
	(0.020)	(0.019)	(0.006)	(0.006)
BERD	-0.210***	-0.110	0.213***	0.217***
	(0.066)	(0.067)	(0.037)	(0.037)
Location Fixed Effects	Yes	Yes	Yes	Yes
Number of Intangibles	413,274	413,274	135,512	135,512
Number of Observations	6,199,110	6,199,110	2,032,680	2,032,680

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Results are based on non-large firms of the engineering sector. The dependent variable is location choice in one of the countries shown in Table 5.1. *Tax Rate* stands for the corporate income tax rate and incorporates taxation under IP Boxes and CFC rules. *Quality* is a dummy variable that indicates intangible assets of high quality (applications filed at multiple offices). *New Location* is a binary variable and acquires a value of one if a firm has never applied for intangible assets in the given country and zero otherwise. *Real Activity* is a binary variable, which is equal to one if at least one of the intangible's inventors resides in the given country and takes on the value of zero otherwise. *High IP Rights Protection* represents an indicator of a country's level of intellectual property rights protection. *GDP* denotes a country's gross domestic product. *BERD* stands for a country's business expenditure on R&D in relation to its GDP.

Furthermore, columns II and IV of Table 5.8 include an additional interaction term between *New Location* and the tax rate. The coefficient on this term is positive and the effect seems to be more pronounced in the case of patents than trademarks. The tax sensitivity of trademarks in new and old locations is almost the same. By contrast, patents appear to be substantially more sensitive to taxation in old locations compared to the new sites. This finding confirms our hypothesis of the agglomeration effect and shows that the agglomeration is stronger for patents than for trademarks. However, the results in Table 5.8 indicate that the agglomeration does not fully explain the gap between the tax elasticities of patents and trademarks. This implies that there are may be other factors that cause this gap, some of which are discussed in section 5.2.

5.5.4 Legal vs. Economic Ownership

The empirical analysis of this study employs data on patent and trademark applications filed at several international application offices. These patent and trademark applications contain information about their legal owners and we have assumed until now that the legal owner of a patent or a trademark is the only possible owner. However, according to Markham (2005), several OECD members provide a few different IP ownership options. The author argues that the legal owner of an intangible asset is usually the recognized owner in law on the basis of the legal registration of patents, trademarks, designs, copyrights, and other intangibles. By contrast, the economic owner is the one that bears the greatest share of the development expenses as well as the greatest risk, should an intangible fail to deliver value.[221] In some countries, it is the economic owner who is entitled to the income attributable to intangible assets and is therefore relevant from a taxation point of view.[222]

The issue of legal and economic ownership of an intangible asset is regulated in many countries on a national level and there are also attempts being made to settle this issue on an international level. As an example, the OECD (2010) has addressed the separation of IP ownership in its transfer pricing guidelines, arguing that the economic owner is the correct owner of intellectual property. This is because the economic owner bears the costs and risks associated with the development of an intangible asset. Similar conclusions have been made in the OECD Action Plan on base erosion and profit shifting (BEPS).[223] According to Actions 8-10 of this plan, the functional or economic owner of an intangible asset should be entitled to the returns which remain after the legal owner has been remunerated for its own functions, assets, and risks related to the R&D process. Table 5.9 provides a detailed overview of the treatment of economic and legal ownership concepts in the countries analyzed in this study. According to Table 5.9, most countries in our dataset distinguish between legal and economic ownership concepts and the majority of them follow the transfer pricing guidelines and the Actions 8-9 of the Action Plan on BEPS.

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[221] Please note that different ownership options exist not only for patents but also for other types of intangibles, including trademarks.
[222] van Gorp (2012) gives a thorough review of further IP ownership types such as contract-based ownership, control ownership, functional ownership, and beneficial ownership. These are similar to the concept of economic ownership.
[223] See OECD (2015b).

Since this study investigates the influence of taxation on the location of intangible assets, we are interested in identifying the economic owner of patents and trademarks. If this owner receives returns generated by intangibles, it is also subject to taxation on those returns. However, since we observe only the legal and not economic owners in our data, we have to assume in the baseline analysis that they are the same. This assumption is plausible, since a separation of the two types of ownership may be difficult and unwanted due to the potentially high costs. To give an example, if there is a court dispute involving an intangible asset, then all of its owners must not only participate in legal proceedings but also have to reach an agreement regarding the case.

Furthermore, in most countries tax authorities require thoroughly documented evidence for granting an ownership status. They might also challenge this status, as demonstrated in the *DHL* and *H Group Holding* court cases. Foreign subsidiaries of *DHL*[224] and *H Group Holding*[225] contributed to the promotion and maintenance of the parent companies' intellectual property. In the *DHL* case, the tax court decided that the legal owner (which was the parent company) is entitled to income generated by IP. However, the court of appeal overruled this decision by stating that the subsidiary must be considered as the intangibles' true owner, since it performed excessive development activities and covered substantial costs and risks related to the IP development. By contrast, in the *H Group Holding* case, the court did not recognize the subsidiary as the ultimate beneficiary of income generated by IP, as the development and maintenance costs that the subsidiary covered were not extraordinarily. Hence, the subsidiary was entitled to compensation for its services and the parent was recognized as the sole owner of intellectual property. These court cases show that the separation of IP ownership might be risky and therefore unwanted from a multinational's point of view.

[224] See United States Tax Court (1998).
[225] See United States Tax Court (1999).

Table 5.9 Legal vs. Economic Ownership of Intangible Assets

Country	Separation Exists	Details
Belgium	Yes	Adopts the OECD TP guidelines on economic and legal ownership.
Denmark	No	Denmark gives preference to legal ownership but refers to the control ownership when it is difficult to determine a legal owner of intellectual property.
Finland	Yes	Adopts the OECD TP guidelines on economic and legal ownership.
France	No	Does not recognize economic ownership concept, only recognizes legal ownership.
Germany	Yes	Adopts the OECD TP guidelines on economic and legal ownership.
Ireland	Yes	Adopts the OECD TP guidelines on economic and legal ownership.
Italy	No	Does not recognize economic ownership concept, only recognizes legal ownership.
Luxembourg	Yes	Adopts the OECD TP guidelines on economic and legal ownership.
Netherlands	Yes	Adopts the OECD TP guidelines on economic and legal ownership.
Norway	No	There is no distinction between economic and legal ownership written in the civil and tax law.
Spain	No	Under Spanish CIT law, there is no specific regulation on the treatment of IP ownership (in terms of legal/economic ownership).
Sweden	Yes	Adopts the OECD TP guidelines on economic and legal ownership.
Switzerland	Yes	Adopts the OECD TP guidelines on economic and legal ownership.
UK	Yes	Recognizes legal and beneficial ownership but gives preference to economic ownership.
US	Yes	Adopts the OECD TP guidelines on economic and legal ownership.

Notes: See OECD (2010) for OECD TP guidelines. TP stands for transfer pricing. CIT stands for corporate income tax rate. IP means intellectual property. Sources: van Gorp (2012) and our own survey of the Big 4 taxation experts.

In order to evaluate the importance of the distinction between legal and economic ownership in our data, we carry out a further robustness check. More precisely, we generate a binary variable *Separation*, which is equal to one if a country recognizes legal and economic ownership and takes on the value of zero otherwise. We interact this variable with the tax rate and include it in our baseline specification.[226] The results are displayed in Table 5.10 and according to columns I-II of this table, the coefficient on the interaction *Tax Rate*Separation* is positive and statistically significant for patents and trademarks. Based on these results, the existence of economic ownership significantly diminishes the tax sensitivity of legal ownership. For example, the marginal effect of taxation on a patent location choice is -14.4 if no distinction between ownership concepts is made and -4.2 if a separation exists. In the case of trademarks, these effects are equal to -16.6 and -7.3 respectively. This implies that the legal ownership which we observe in our data is less sensitive to changes in taxation in countries that recognize the concept of economic ownership. This result could be due to firms that separate their economic and legal ownership in response to taxation, since changes in the economic ownership are not documented in our dataset. Hence, the estimates of our benchmark analysis might represent only a lower bound of the true impact of taxation on the location of patents and trademarks.

Moreover, in columns III and V of Table 5.10 we control for the agglomeration effect and the distinction between ownership concepts at the same time. According to these findings, the impact of ownership separation remains almost unchanged once we simultaneously control for the agglomeration effect. Finally, columns IV and VI add a triple interaction term between the tax rate, the separation dummy, and the new location variable to the benchmark model. According to the regression outcomes, a distinction between different IP ownership concepts in new locations further decreases the tax sensitivity of patent location choices. This might indicate that companies tend to separate economic and legal ownership of their patents more often in new locations than in the old sites. At the same time, no statistically significant effect of the interaction between taxation, *Separation*, and *New Location* is observed in the case of trademarks, as column VI shows.

[226] In line with the robustness checks and extended analysis shown above, this part of the study is carried out using only non-large firms of the engineering sector as a representative sample.

Table 5.10 Extended Analysis: Legal vs. Economic Ownership

	Separation of Ownership		Separation and Agglomeration			
	Patents	Trademarks	Patents		Trademarks	
	I	II	III	IV	V	VI
Tax Rate	-14.430***	-16.590***	-13.410***	-14.470***	-20.680***	-21.160***
	(0.195)	(0.297)	(0.211)	(0.265)	(0.367)	(1.027)
*Tax Rate*Quality*	-2.694***	-3.060***	-1.566***	-1.389***	-3.490***	-3.470***
	(0.110)	(0.262)	(0.193)	(0.196)	(0.269)	(0.268)
Tax Rate (Std.Dev.)	3.683***	6.212***	7.478***	7.669***	6.349***	6.248***
	(0.104)	(0.137)	(0.111)	(0.110)	(0.138)	(0.139)
*Tax Rate*Separation*	10.260***	9.293***	6.137***	6.535***	8.955***	9.678***
	(0.184)	(0.269)	(0.192)	(0.269)	(0.272)	(1.031)
New Location			-9.270***	-8.685***	-3.884***	-4.290***
			(0.056)	(0.077)	(0.078)	(0.337)
*Tax Rate*New Location*			6.690***	7.149***	4.246***	4.792***
			(0.134)	(0.247)	(0.222)	(1.015)
*Separation*New Location*				-1.667***		0.581*
				(0.077)		(0.342)
*Tax Rate*Separation*New Location*				1.903***		-0.824
				(0.261)		(1.028)
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Location Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of Intangibles	413,274	135,512	413,274	413,274	135,512	135,512
Number of Observations	6,199,110	2,032,680	6,199,110	6,199,110	2,032,680	2,032,680

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Results are based on non-large firms of the engineering sector. The dependent variable is location choice in one of the countries shown in Table 5.1. *Tax Rate* stands for the corporate income tax rate and incorporates taxation under IP Boxes and CFC rules. *Quality* is a dummy variable that indicates intangible assets of high quality (applications filed at multiple offices). *Separation* is a binary variable and it is based on information in Table 5.9; it is equal to one if the separation between the concepts of legal and economic ownership exists in a country and to zero otherwise. *New Location* is a binary variable and acquires a value of one if a firm has never applied for intangible assets in the given country and zero otherwise. *Controls* includes *High IP Rights Protection*, *GDP*, *BERD*, and *Real Activity* (for patents).

5.6 Conclusion

The aim of this paper is to analyze the strategic allocation of different types of intangible assets within corporate groups. As presented in section 5.2, Hypothesis 1 states that corporate groups register a greater number of intangibles through their subsidiaries that are located in countries with low statutory corporate income tax rates, rather than through affiliates in countries with high tax rates. This idea has already been supported by 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), Bradley et al. (2015), and Dinkel and Schanz (2015). The main contribution of this analysis to the previous literature is its ability to distinguish between different types of intangible assets – patents and trademarks – and to compare their tax elasticities. Trademarks are usually easier to register and are less costly to develop in comparison to patents. Their creation does not typically require detailed documentation and they are less likely to depend on the location of other intangibles in the same family, as it can often be the case with patens. Therefore, according to Hypothesis 2 of this study, trademark location choices are more responsive to taxation than patent location choices.

In order to empirically test these hypotheses, we employ the Orbis database provided by the Bureau van Dijk. It contains information on all patent and trademark applications filed at the European Union Intellectual Property Office, the European Patent Office, and the United States Patent and Trademark Office. These patent and trademark applications provide information on their owners, which allows us to determine the location of patents and trademarks within corporate groups. Our sample includes patent and trademark applications filed by 162,640 firms during the period between 1996 and 2012. These enterprises are located in one of the following fifteen countries: Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Spain, Sweden, Switzerland, the United Kingdom, and the United States. In total, they applied for 1,696,332 patents and 624,801 trademarks during our period of observation.

The main findings of our empirical analysis support the initial hypotheses of the study, as we find a negative relationship between tax rates and the location of intangible assets. Moreover, the tax elasticity of a trademark location choice is more negative than that of a patent location choice. Our key findings suggest that on average a one percent increase in the tax rate leads to a decrease of -0.1% to -1.4% in the number of patents and a drop between -1.4% and -2.3% in the number of trademarks held in the given country.

Our findings are comparable to the prior literature on the impact of taxation on patent location choices. For example, we use the same identification strategy as Griffith et al. (2014), who find that the tax semi-elasticity of patent location choices varies between -0.5 and -3.9. We replicate the results reported by Griffith et al. (2014) in appendix C1 and show that extending the sample to include additional years of observation and the USPTO data does not change the main findings. Namely, our empirical analysis indicates that an average tax semi-elasticity of patent location choices is equal to -2.8. 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 analyze the connection between a country's taxation of royalty income and the quantity or quality of patents held in that country. 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 at a firm level. By contrast, Griffith et al. (2014) as well as this paper both carry out an investigation at the level of an intangible through the application of a multinomial choice model. Despite using different identification strategies, our results are still comparable to those found in this area 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 country's patent applications. According to our findings, on average a one percentage point increase in the tax rate on royalty income leads to a -2.8% drop in patent applications and a -6.5% decrease in trademark applications in the given country, holding other factors constant.

Moreover, we conduct a further empirical analysis in an attempt to explain the gap between tax elasticities of patents and trademarks. In accordance with our results, the less negative tax elasticity of patents compared to trademarks might be at least partially due to the agglomeration effect. In other words, patents may be less sensitive to taxation than trademarks because they are more likely to be registered in the country where the rest of the patent family is located. In addition, we show that our results might represent only the lower bound of the true profit shifting by means of intangible assets because multinationals might separate the economic and legal ownership of their IP, which is not always reflected in the intangibles' applications. However, further research is needed in order to investigate the magnitude of this issue and its exact influence on the elasticity of patent and trademark location choices.

As for the policy implications of this study, a few conclusions can be drawn. First, companies seem to use intangible assets as a means of base erosion and profit shifting, which is why effective international regulations are necessary to ensure that taxation is based on real economic activity and value creation. 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 corporate group than a patent and for this reason trademarks have a greater potential to be used as a means of profit shifting in comparison to patents. Therefore, tax regulations and policies should take into consideration the differences between intangible assets and should be designed or adjusted in accordance with these differences. This would, for example, imply that current IP Boxes that allow a preferential tax treatment for both patents and trademarks (Cyprus, Hungary, Liechtenstein, Malta) should be reconsidered and follow the example of the IP Boxes that concentrate on patens only (Belgium, the Netherlands, Portugal, Spain, the UK).

Chapter 6

Tax Incentives for Research and Development and Their Use in Tax Planning

6.1 Introduction

State support of research and development (R&D) is not only economically justified in numerous theoretical and empirical studies but is also enforced in many countries around the world. Fiscal incentives constitute one of the key instruments of state support of R&D, as they are easier to implement and are less complex to monitor than, for example, direct R&D grants or subsidies. There are various types of fiscal incentives for research and development, some of which focus on supporting the development or input phase of a research process, whereas others concentrate on the income-generating output phase. The first group of R&D tax incentives includes tax credits and tax super-deductions, which are more widely distributed on an international level than the second category. However, in recent years output-oriented fiscal incentives, which include intellectual property (IP) Boxes, seem to have been gaining popularity, especially in Europe. Fourteen European countries currently have IP Box regimes and several others are considering their introduction.

Even though R&D tax incentives have already been analyzed in the previous literature, the main aim of this study is to carry out a comprehensive analysis of various aspects of R&D tax incentives, including not only well-researched issues but also topics which have been studied to a lesser extent. The focus of this study is on the potential use of R&D tax incentives for tax planning by multinational enterprises (MNEs). We distinguish between input- und output-oriented fostering of R&D and concentrate on those incentives that apply to large companies, as opposed to the incentives which are available to small and medium enterprises. The study also focuses on those incentives that are available in member states of the European Union (EU) and the European Free Trade Area (EFTA) which includes Iceland, Liechtenstein, Norway, and Switzerland.

The methodology of our analysis is diverse. First, we carry out a thorough review of the existing R&D tax incentives and find that Germany, Estonia, and Sweden are currently the only countries in Europe that do not offer any R&D tax incentives. Secondly, we examine the empirical literature on the outcomes of an implementation of R&D tax incentives. According to the literature review, numerous studies find that input-oriented tax incentives boost firms' innovation and performance. However, there is no such strong evidence on the role of output-oriented fiscal incentives in supporting real R&D activity. Thirdly, we use the Devereux and Griffith (1999, 2003) approach to compute the effective average tax burden in the EU and EFTA member states in 2012. Furthermore, we follow the conceptual framework of Spengel and Elschner (2010) and Evers et al. (2015a) to incorporate various types of R&D tax incentives in the Devereux and Griffith model. In addition to a domestic investment scenario, a cross-border investment is introduced into the model in order to show that R&D tax incentives may be used by multinationals for tax planning. Finally, we test this hypothesis in an empirical analysis by employing data on international collaboration in patents provided by the Organization for Economic Co-Operation and Development (OECD). This data contains information on patents that have been developed in one country and relocated to another one afterwards. According to our main findings, a negative correlation exists between taxation and the probability of countries entering into a co-operation in patent development. In addition, the probability and the intensity of collaboration in patents increases with a growing generosity of R&D tax incentives, which further supports our hypothesis. Hence, we conclude that input-oriented R&D tax incentives, such as tax credits and tax super-deductions, constitute a more suitable instrument for fostering research and development than output-oriented fiscal incentives, such as IP Boxes.

The study is organized as follows: section 6.2 presents the economic justification behind the state support of R&D and introduces the main types of R&D tax incentives. In addition, an overview of the existing incentives in the EU and EFTA member states in 2012 is given. Section 6.3 includes a review of empirical literature on the outcomes of an implementation of R&D tax incentives. Section 6.4 explains the standard case of the Devereux and Griffith model and presents its extension to include input- and output-oriented R&D tax incentives. Moreover, this section further develops the model to demonstrate the role of fiscal incentives in tax planning strategies of multinational firms. Section 6.5 presents our empirical analysis and discusses the key results, with the final section summarizing the main findings of our study and drawing several conclusions.

6.2 State Support of Research and Development

6.2.1 Economic Justification

According to the OECD (2002), research and development can be defined as "creative work undertaken on a systematic basis in order to increase the stock of knowledge […] and the use of this stock of knowledge to devise new applications."[227] There is an established view among policy makers and in academia that R&D leads to technological development, which in turn stimulates economic growth. Solow (1956) was among the first economists to develop a theoretical model that illustrates this idea. According to the author, technological progress increases a country's productivity and proves to be more effective in fostering economic growth than other factors of production, such as labor and capital. Since technological progress plays an important role in the economic development of a country, it is natural that governments have an interest in supporting research and development, as Arginelli (2015) notes.

The two major economic justifications for the state support of research and development are positive spillovers from R&D and an existence of asymmetric information. According to Mankiw and Taylor (2014), positive spillovers from R&D occur because companies may use outcomes of research and development without there being rivalry or exclusion. As an example, different firms may apply research findings in product development at the same time while avoiding the possibility of limiting each other's research. This results in a lack of rivalry occurring between the firms. All companies can typically take advantage of the knowledge acquired through R&D, which implies that there is no exclusion. Spengel and Wiegard (2011) argue that positive spillovers from R&D may occur even in the case of a patent protecting the research outcomes, because firms could imitate new products or production processes of their competitors even if they are patented. Furthermore, companies may also benefit from hiring experienced employees who have previously worked for their competitors and have gained the required knowledge needed to imitate these products. In addition, even if the outcomes of research and development are not successful and no new inventions result from a research

[227] See OECD (2002), p. 30.

project, there is still a positive spillover effect for the industry. Namely, other firms can learn from unsuccessful attempts made by their competitors and either avoid repeating the same mistake in the future or plan their research differently from the very beginning. Hence, the social benefits from research and development might exceed the private returns. Hansson and Brokelind (2014) investigate the consequences of introducing R&D incentives in the European Union, placing an emphasis on Sweden. The authors argue that the EU should subsidize only R&D projects which have a potential to yield higher social benefits than private returns. According to Hansson and Brokelind (2014), firms are likely to undertake projects with high private return regardless of any support measures which are available.

The second justification for the state support of research and development is the existence of asymmetric information. According to Spengel and Wiegard (2011), the problem of asymmetric information is typical for credit markets where some economic agents have better access to information than the others. This is particularly true in the case of financing R&D, because investments in this area are often deemed to be high-risk and creditors do not have the sufficient information to decide whether or not they should finance them. This results in adverse selection, whereby it is only low-risk R&D projects that receive financing with the other projects being overlooked, even if their potential returns are high. In addition, Arginelli (2015) argues that the issue of asymmetric information in capital markets may be selective and only give a disadvantage to certain types of firms. For example, small companies might have to pay higher interest rates and may have narrower access to the capital market compared to large firms. State support of research and development cannot prevent the problem of asymmetric information, but it can reduce the need for external means in R&D financing.

6.2.2 Types of R&D Support

State support of research and development can take various forms and target different phases of an R&D process. For example, governments may support R&D either directly or indirectly and in the case of direct measures, these may be taken in the form of subsidies, allowances, and grants. Even though this type of R&D support has a direct influence on the liquidity of an investing firm, its application process is often bureaucratic, complex, and lengthy. In addition, Cunningham et al. (2013) note that the provision of direct R&D funding might be quite subjective and based on certain characteristics of a firm, such as its age or experience in a certain field of research. Indirect measures include fiscal incentives for research and development and it is this type of state support of R&D which this study will focus upon.

Furthermore, R&D support can be classified according to the phase of the research process to which it applies. According to Arginelli (2015), a research project typically has two major stages. During a so-called input phase, a firm plans and conducts the research and it is during this stage where the majority of costs related to an R&D process arise. After an intangible asset has been created, the output phase begins which includes managing the profits that an intangible generates or dealing with the losses that have occurred in the case of an unsuccessful investment. This study analyzes both input- and output-oriented R&D tax incentives.

6.2.2.1 Input-Oriented R&D Tax Incentives

R&D tax incentives that apply to the first phase of the research process aim to alleviate the financial burden of a company as R&D expenses occur but income is yet to be generated or is completely uncertain. There are different approaches to support companies in this phase of investment. Some of the support measures aim to reduce a firm's tax liability, while others target its tax base. The first category includes an R&D tax credit, which can be defined as a direct offset against the amount of a company's tax liability.[228] The second group comprises a tax super-deduction and an accelerated depreciation of assets used in research and development. The OECD (2014a) defines a tax super-deduction as a tax measure that reduces a firm's tax base by allowing for an inflation of the R&D expenditure base.[229] An accelerated depreciation scheme is defined as a tax incentive that permits fixed assets used in R&D to be depreciated at higher rates than usual in the first years of their useful life.[230] As the OECD (2014a) notes, this type of R&D support decreases the overall taxable income of a company and provides it with some additional liquidity in certain periods of an R&D process. However, the payment of taxes in this case is not completely repealed but rather postponed. According to Spengel and Wiegard (2011), the attractiveness of R&D tax incentives that target a company's tax base rises as a country's statutory corporate income tax (CIT) rate increases. This is due to a larger effect of the fiscal incentives on the tax base when a tax rate is higher.

[228] See OECD (2017a).
[229] See OECD (2014a), p. 51-52.
[230] See OECD (2014a), p. 52.

These R&D tax incentives can be further divided according to their attributes. Arginelli (2015) gives a detailed overview of input-oriented R&D tax incentives with respect to their targeting dimensions, such as the type of income which they support as well as intangible assets, business sectors, and firm sizes they apply to. For example, some countries offer incremental tax credits and tax deductions, which depend on the volumes of R&D expenses in previous periods and therefore should intensify an increase in a firm's spending on research and development. Moreover, R&D tax incentives may differ according to the type of expenses they support. For example, some of them target current expenses such as labor costs or maintenance expenditure, while others support capital expenses such as costs associated with the construction of a laboratory or a building. As a concluding point, it should be taken into account that the incentives may vary based on their treatment of losses that result from an R&D process. Some countries allow unused tax incentives to be carried forward, while other countries offer a refund in the case of losses, which is equal to a cash grant.

6.2.2.2 Output-Oriented R&D Tax Incentives

In addition to the input-oriented R&D incentives, there are also tax incentives that target the second stage of research and development. In particular, they aim to provide a favorable tax treatment for the income generated from intangible assets. IP Boxes serve as a prominent example of this type of R&D incentives. Atkinson and Andes (2011) define an IP Box as a tax incentive that allows corporate income from the sale or licensing of intangible assets to be taxed at a lower rate than other types of income.[231]

In their overview of the existing IP Boxes, Evers et al. (2015a) demonstrate a great variety of these regimes. For instance, IP Boxes differ according to the type of income, intangible assets, and R&D expenses that they cover. Some regimes allow a deduction of current R&D expenditure from the tax base of a reduced tax rate, which is known as a net approach. By contrast, other IP Boxes permit the deduction from the tax base of a standard statutory tax rate, defined as a gross approach. The latter method is to the benefit of the investing companies, since here the profits generated by an intangible are taxed at the reduced tax rate, although the expenses associated with its development are deducted at the higher statutory tax rate. In addition, IP Boxes may differ in their treatment of the R&D expenditure that occurred in the

[231] Atkinson and Andes (2011), p. 3.

past. For example, the past expenses on research and development may be ignored (a no recapture approach) or it may be necessary to reconsider them (a recapture approach). In the case of a recapture approach, it may either be required to deduct the past expenses at the reduced IP Box tax rate (a threshold method) or to capitalize them (a capitalization method).[232]

Furthermore, some IP Boxes only apply to intangible assets that have been developed within a country's borders, whereas others support IP acquired from abroad as well. In the case of the latter, an IP Box does not have to foster domestic research and development but might rather be used by multinational enterprises for tax planning. The OECD has attempted to fix this problem by imposing the Nexus Approach in 2015.[233] According to this regulation, all current and new IP Boxes should facilitate the taxation of profits from the transfer or use of intangible assets in the place of their creation. However, the enforcement of this requirement still depends on the willingness of individual countries to co-operate.

Spengel (2016) identifies that another issue related to the lawfulness of IP Boxes is their potentially selective treatment of certain companies or industries. The author argues that IP Boxes give an advantage to multinational enterprises compared to the purely domestic firms. A multinational might develop an intangible in a high-tax country and afterwards strategically relocate it to a subsidiary in a country with an IP Box, whereas a domestic firm does not have this opportunity. Moreover, IP Boxes distort competition by giving an unfair advantage to companies that operate within certain industries. As an example, firms within some industries may develop an intangible asset and then license it to other related and non-related companies, whereby the resulting license fees will typically be eligible for beneficial tax treatment under an IP Box regime. By contrast, companies within other industries may use their intangible assets only themselves and are not able to license them to other parties. As a result, forms in the second category are not able to benefit from using an IP Box in comparison to their counterparts in the first category. Therefore, Spengel (2016) concludes that the selective treatment of IP Boxes does not comply with the state aid principles of the European Union.

[232] See Evers et al. (2015a) for more information.
[233] See OECD (2015a).

6.2.3 An Overview of R&D Tax Incentives in Europe

This section gives an overview of the current input- and output-oriented R&D tax incentives in the 28 member states of the European Union and four countries that are non-EU members but belong to the European Free Trade Area (Iceland, Liechtenstein, Norway, and Switzerland).[234] Figure 6.1 presents the distribution of the R&D tax incentives across these countries in 2012 and what is evident from this figure is that the majority of European countries offer either input- or output-oriented fiscal incentives. It is worth noting that some countries have even implemented both types of R&D tax incentives. For example, France offers both a generous tax credit on R&D expenditure and an IP Box. By contrast, Estonia, Germany, Greece, Latvia, Slovakia, and Sweden were the only countries in Europe that did not offer any kinds of R&D tax incentives in 2012. However, Greece, Latvia, and Slovakia have introduced super-deductions for R&D expenses in the years that followed, which resulted in Estonia, Germany, and Sweden currently remaining the only countries in Europe without fiscal incentives for research and development.

6.2.3.1 Input-Oriented R&D Tax Incentives

Table 6.1 gives an overview of the existing input-oriented R&D tax incentives in Europe. It focuses on the incentives that are available for large corporations; however, many countries have special R&D tax incentives for small and medium enterprises as well. In addition, it is worth noting that Table 6.1 summarizes fiscal incentives available for internal R&D spending, since in our further analysis we assume that a company conducts research itself and does not outsource it to other parties (which would result in external R&D spending).

According to Table 6.1, only a few European countries such as Cyprus, Estonia, Germany, Greece, Liechtenstein, Slovakia, and Sweden do not offer any input-oriented incentives for R&D. In addition to input-oriented incentives, most countries do not require an immediate capitalization of self-developed intangible assets for tax purposes. However, a few countries such as Cyprus, Norway, and Slovakia enforce this requirement and thereby create a liquidity disadvantage for firms that carry out research and development.

[234] In what follows, we refer to the EU and EFTA members as Europe.

Figure 6.1 Existing Input- and Output-Oriented R&D Tax Incentives in Europe, 2012

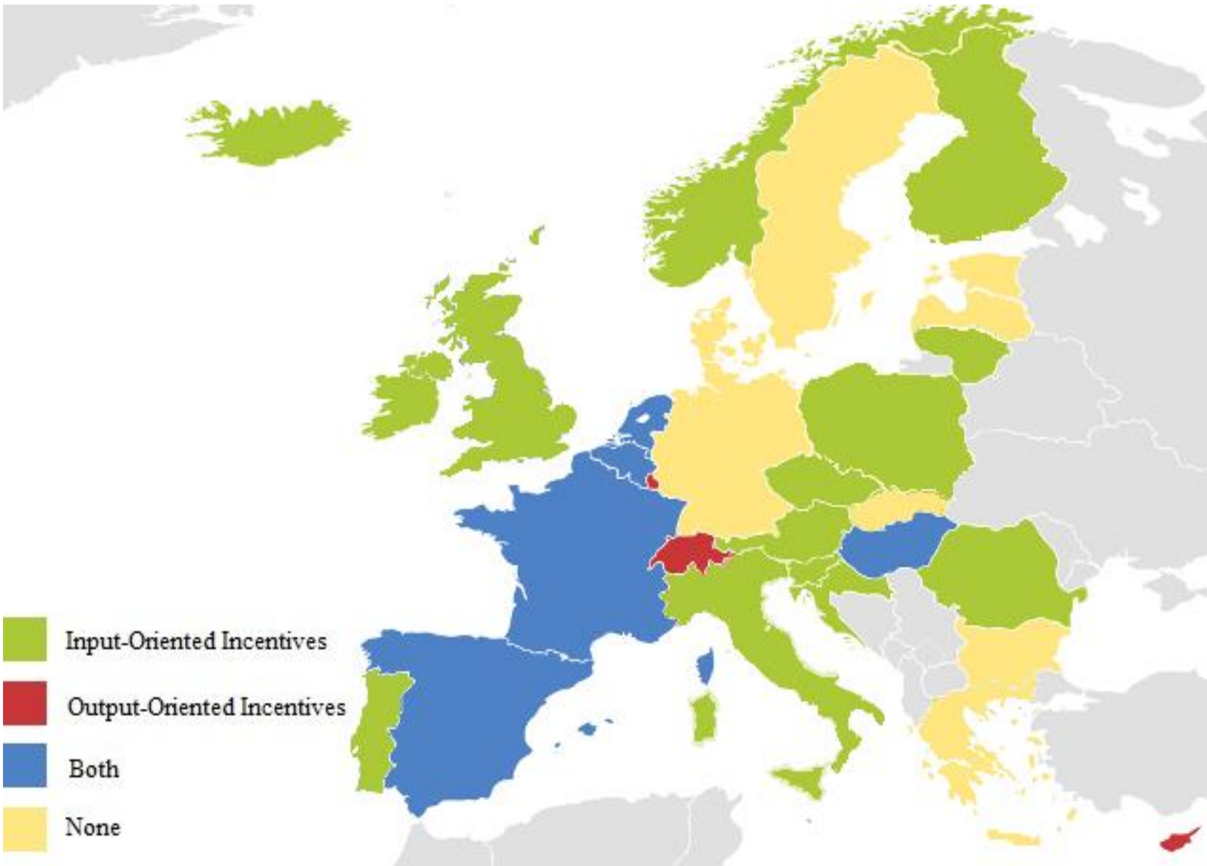


Table 6.1 shows that most European countries offer either a tax credit or a tax super-deduction for R&D expenditure. In line with Spengel and Elschner (2010), we distinguish between current and capital expenditure on research and development and observe that the majority of countries in Table 6.1 offer tax incentives for both current and capital expenses. Furthermore, almost half of the countries under analysis allow for an accelerated depreciation of machinery, buildings, intangibles, and other types of assets used in research and development. As discussed in section 6.2.2.1, accelerated depreciation gives firms a liquidity advantage in the first years of research and development. In the case of losses, most countries permit their tax incentives to be carried forward and only a few of them offer a refund. A few countries offer both options for the treatment of losses.

Table 6.1 An Overview of Input-Oriented R&D Tax Incentives in Europe, 2012

	Tax Credit, %	Super-Deduction, %	Qualifying Expenses		Accelerated Depreciation	Losses	
			Current	Capital		Carry Forward	Refund
Austria	10[1]	-	x	x	-	-	x
Belgium	13.5[2]	13.5[2]	x	-	-	-	-
Bulgaria	-	-	-	-	x[16]	-	-
Croatia	-	100[13]	x	x	-	-	-
Cyprus	-	-	-	-	-	-	-
Czech Republic	-	100[14]	x	x	-	x	-
Denmark	-[3]	-	-	-	x	-	x
Estonia	-	-	-	-	-	-	-
Finland	-	-	-	-	x	-	-
France	30[4]	-	x	x	x[17]	x	x[22]
Germany	-	-	-	-	-	-	-
Greece	-	-	-	-	-	-	-
Hungary	-[5]	100	x	x	-	-	-
Iceland	20[6]	-	x	x	-	-	-
Ireland	25	-	x	x	x[16]	x	-
Italy	-[7]	-	-	-	x[16]	x	-
Latvia	-	-	-	-	-	-	-
Liechtenstein	-	-	-	-	-	-	-
Lithuania	-	200	x	x	x	x	-
Luxembourg	-	-	-	-	x[18]	-	-
Malta	15[8]	50[8]	x	x	-	x	-
Netherlands	-	40	x	x	-	x	-
Norway	18[9]	-	x	x	-	-	x
Poland	-	-[15]	-	-	x[19]	-	-
Portugal	32.5[10]	-	x	x	-	x	-
Romania	-	20	x	x	x[20]	x	-
Slovakia	-	-	-	-	-	-	-
Slovenia	-	40	x	x	-	x	-
Spain	25[11]	-	x	x	x[16]	x	-
Sweden	-	-	-	-	-	-	-
Switzerland	-	-	-	-	x[21]	-	-
UK	-[12]	30	x	x	x[16]	x	x

Notes: [1]Approval of the Austrian Research Promotion Agency is required. [2]These R&D incentives are available only for green investments and are mutually exclusive. [3]Tax credit is capped and is available only for firms encountering R&D-related losses. [4]30% up to 100 million EUR, 5% above. The rate is increased to 40% in the first year and to 35% in the second year for companies that benefit from the tax credit for the first time or did not benefit from it during the five years before they request the credit. [5]A tax credit of up to 80% for investments in underdeveloped regions and free entrepreneurial zones is available. [6]An approval of the Icelandic Centre for Research is required; minimum 1 million ISK, maximum 100 million ISK per project and firm. [7]There is no general tax credit, although there is a 10%-credit on R&D expenses that do not exceed 50 million EUR. [8]Not allowed if an IP box applies. [9]The credit is generally given to small and medium companies but may also apply to other firms upon an approval of the Research Council of Norway. [10]An additional incremental credit of 50% applies if expenses exceed the average R&D expenditure of the previous two fiscal years. [11]If expenses exceed an average amount of the previous two years, a rate of 25% applies to the average amount and a rate of 42% applies to the exceeding amount. [12]A taxable 11%-tax credit is available in certain cases but not for the expenses on patents. [13]This amount ranges between 100% and 150% depending on a type of research. [14]The rate increases to 110% for incremental R&D expenses. [15]Application is possible if certain conditions are fulfilled. [16]An immediate write-off. [17]Degressive instead of straight-line depreciation is possible if a resulting asset stays in the enterprise for at least 3 years. [18]Accelerated depreciation for machinery and equipment; buildings are excluded. [19]Accelerated depreciation is not limited to assets used in research and development. [20]A write-off of 50% in the first year is available for machinery and equipment if the resulting IP stays in Romania. [21]Varies on the cantonal level, with most cantons offering an immediate or accelerated depreciation for machinery, buildings, and intangible assets. These tax incentives are not limited to the assets used in R&D. [22]A unutilized tax credit may be carried forward for three years, afterwards a refund is available.

6.2.3.2 Output-Oriented R&D Tax Incentives

Table 6.2 provides an overview of the output-oriented R&D tax incentives represented by IP Boxes. Similarly to the input-oriented instruments, the scope of Table 6.2 includes countries of the European Union and the European Free Trade Area in 2012. The output-oriented R&D incentives have become rather popular in recent years, as shown by the fact that ten European countries offered them in the year 2012. Four more countries have introduced IP Boxes in the years following on from 2012 (Ireland in 2016, Italy in 2015, Portugal in 2014, and the United Kingdom in 2013) and several others are considering the possibility of doing so.

According to Table 6.2, all IP Boxes significantly decrease taxation of profits generated by intangible assets. For example, in Malta the standard corporate income tax rate reaches 35%, while the reduced IP Box tax rate equals 0%. As shown in Table 6.2 and as discussed in section 6.2.2.2, before the implementation of the OECD Nexus Approach in 2015, the majority of IP Boxes were open for acquired IP as well. Furthermore, according to Table 6.2, some IP Boxes enable a preferential tax treatment of the existing intangibles in addition to the newly created ones. Belgium and Hungary are the only two countries that permit a gross approach in the treatment of current R&D expenses. As described in section 6.2.2.2, this method is beneficial from a company’s point of view, since it allows firms to deduct R&D expenditure at a regular tax rate.

Table 6.2 An Overview of Output-Oriented R&D Tax Incentives in Europe, 2012

	Date of Implementation	IP Box Tax Rate, %	Statutory Tax Rate, %	Type of Eligible IP		Treatment of Expenses	
				Acquired	Existing	Current	Occurred in the Past
Austria	-	-	25	-	-	-	-
Belgium	2007	6.8	33.9	N	N	Gross	No recapture
Bulgaria	-	-	10	-	-	-	-
Croatia	-	-	20	-	-	-	-
Cyprus	2012	2.5	10	Y	Y	Net	Recapture (Capitalization)
Czech Republic	-	-	19	-	-	-	-
Denmark	-	-	25	-	-	-	-
Estonia	-	-	21	-	-	-	-
Finland	-	-	24.5	-	-	-	-
France	2000	15.5	34.4	Y[3]	Y	Net	No recapture
Germany	-	-	29.8	-	-	-	-
Greece	-	-	20	-	-	-	-
Hungary	2003	9.5	19	Y	Y	Gross	No recapture
Iceland	-	-	20	-	-	-	-
Ireland[1]	-	-	12.5	-	-	-	-
Italy[1]	-	-	31.4	-	-	-	-
Latvia	-	-	15	-	-	-	-
Liechtenstein	2011	2.5	12.5	Y	N	Net	Recapture (Threshold)
Lithuania	-	-	15	-	-	-	-
Luxembourg	2008	5.9	28.8	Y[3]	Y	Net	Recapture (Capitalization)
Malta	2010	0	35	Y	N	Not deductible	Not if costs were deducted
Netherlands	2007	5	25	N	N	Net	Recapture (Threshold)
Norway	-	-	28	-	-	-	-
Poland	-	-	19	-	-	-	-
Portugal[1]	-	-	25	-	-	-	-
Romania	-	-	16	-	-	-	-
Slovakia	-	-	19	-	-	-	-
Slovenia	-	-	18	-	-	-	-
Spain	2008	11.2	30	N	Y	Net	No recapture
Sweden	-	-	26.3	-	-	-	-
Switzerland[2]	2011	8.8	18	Y	Y	Net	No recapture
UK[1]	-	-	24	-	-	-	-

Notes: [1]Ireland has introduced an IP Box in 2016, Italy in 2015, Portugal in 2014, and the UK in 2013. [2]Only in Nidwalden. [3]In France and Luxembourg acquired IP is admitted to the IP Box only under certain circumstances. The statutory tax rates correspond to corporate income tax rates including any surcharges, local taxes, or other taxes. Abbreviations: Y: yes, N: no.

As for the research expenses that occurred in the past, around half of the existing IP Boxes do not require a recapture of previous R&D expenses, as Table 6.2 shows. By contrast, in Liechtenstein and the Netherlands they have to be recaptured in accordance with the threshold approach and in Cyprus and Luxembourg they have to be reconsidered following the capitalization method. In Malta, R&D expenses are not allowed to be deducted if an IP Box regime applies. In this case, a company has to decide whether to deduct its R&D expenditure and benefit from the input-oriented R&D tax incentives or to apply for an IP Box and achieve a full tax exemption of profits generated by intangible assets.

6.3 A Review of Empirical Literature on the Effectiveness of R&D Tax Incentives

6.3.1 The Impact of Input-Oriented R&D Tax Incentives

Numerous empirical papers have evaluated the effectiveness of input-oriented R&D tax incentives. Table 6.3 presents an overview of studies conducted in this field of research between 2002 and 2016. These studies make use of different data samples and econometric techniques and nevertheless all of them identify a positive correlation between input-oriented R&D tax incentives and the private sector's innovative activity. Panel A of Table 6.3 shows an overview of papers that evaluate an influence of the user costs of R&D or the B-Index on research and development, whereas Panel B focuses on literature that estimates the outcomes of reforms that have introduced input-oriented tax incentives.

6.3.1.1 The Impact of User Costs and B-Index

In studies shown in Panel A, the dependent variable – a private sector's innovative activity – is often proxied by firms' R&D expenditure or a number of new patent registrations. The main independent variable of interest in these papers is expressed either through the user costs of R&D or the B-Index. Jorgenson (1963) introduced the first of the two measures and Hall and Jorgenson (1967) further developed it. The user costs of R&D reflect the breakeven cost-benefit ratio of a marginal R&D investment after tax. Hence, this measure incorporates the reduction in a firm's corporate tax liability associated with each euro invested in R&D. Warda (2001) introduced the B-Index, which is an alternative measure of R&D costs.

$$B\_Index \ = \frac{1 \ - \ (A\,\tau)}{(1 \ - \ \tau)} \tag{6.1}$$

In equation 6.1, τ denotes statutory corporate income tax rate, whereas A represents a combined net present value of allowances and tax credits applied to R&D expenses. If an R&D investment is fully expensed in a fiscal year, both A and the B_Index are equal to one. Tax credits, tax deductions or any other kind of input-oriented tax incentives increase A, which results in the B_Index being smaller than one. Consequently, the lower the B-Index, the more attractive the tax system is for R&D investment and vice versa.

As shown in Panel A of Table 6.3, one of the first studies to estimate the effect of increasing user costs on innovation was Bloom et al. (2002). The authors use data from nine OECD countries over the years 1979-1997 and develop a measure for the user costs of R&D that contains depreciation allowances on R&D investments, net present value of R&D tax credits, and corporate income tax rates. In the empirical part of their analysis, Bloom et al. (2002) estimate a model in which the dependent variable equals the aggregate R&D expenses, while the independent variables include user costs of R&D, output, time- and country-specific fixed effects. In the baseline specification, the authors apply an instrumental variable approach and find a significant impact of fiscal incentives on R&D expenditure with a short-term elasticity of -0.1 and a long-term elasticity of -1.0. This implies that on average a 1% reduction in R&D user costs leads to a 0.1% increase in the R&D expenses in the short run and a 1% increase in the long run.

A positive impact of decreasing user costs on R&D expenditure has been confirmed in numerous further studies using country- and firm-level data (see as examples: Baghana and Mohnen (2009), Wilson (2009), Lokshin and Mohnen (2012), Mulkay and Mairesse (2013), Thomson (2015)). Some authors have taken a step further by investigating the heterogeneity of this effect for different firm sizes and industry classes. For example, Baghana and Mohnen (2009) argue that the positive impact of decreasing R&D user costs on R&D spending is larger for small firms than for large companies.

Table 6.3 An Overview of Empirical Studies on the Effectiveness of Input-Oriented R&D Tax Incentives

Panel A. The Impact of User Costs and B-Index

Paper		Sample			
Authors	Year	Countries	Time Period	Empirical Model	Results
Bloom et al.	2002	9 OECD countries	1979-1977	OLS, IV	A positive effect of decreasing user costs on the level of R&D. The effect is larger in a long run than in a short run.
Falk	2006	21 OECD countries	1975-2002	GMM	A positive effect of decreasing B-Index on business R&D spending.
Baghana and Mohnen	2009	Canada, Quebec Manufacturing Firms	1997-2003	OLS, GMM	A positive effect of decreasing user costs on the level of R&D. The effect is larger in a long run than in a short run. In addition, the effect is larger for small firms than large companies.
Wilson	2009	the United States	1981-2004	OLS	A positive effect of decreasing user costs on the level of a state's R&D.
Corchuelo and Martínez-Ros	2010	Spain	2002	PSM, IV	A positive effect of decreasing B-Index on the level of R&D. Large firms in tech sectors benefit most from tax incentives for innovation.
Ernst and Spengel	2011	20 EU countries	1998-2007	OLS, Logit, Negative Binominal	A positive effect of decreasing B-Index on the probability to invest in R&D.
Lokshin and Mohnen	2012	Netherlands	1996-2004	IV	A positive effect of decreasing user costs on a firm's investment in R&D.
Mulkay and Mairesse	2013	France	2000-2007	GMM	A positive effect of decreasing user costs on a firm's investment in R&D.
Westmore	2013	19 OECD countries	1983-2008	mean-group estimator	A positive effect of decreasing B-Index on R&D expenditure and the number of new patent applications.
Ernst et al.	2014	members of the EPO	1995-2007	OLS, Diff-in-Diff	A positive effect of decreasing B-Index on the quality of patents.

Thomson	2015	26 OECD countries	1987-2006	OLS	A positive effect of decreasing user costs on R&D financed by the business sector.

A Meta-Study

Gaillard-Ladinska et al.	2015	16 articles, 82 effect estimates	Studies published between 1990 and 2014	A meta-regression analysis	A positive effect of decreasing user costs on a firm's stock of R&D capital and flow of R&D expenditure.

Notes: OLS stands for ordinary least squares, IV stands for instrumental variable, GMM denotes generalized method of moments, PSM stands for propensity score matching, Diff-in-Diff denotes a difference-in-difference estimation, EPO stands for the European Patent Office.

Panel B. Evaluation of a Treatment Effect

Paper		Sample		Empirical Model	Results
Authors	Year	Countries	Time Period		
Klassen et al.	2004	Canada, the United States	1991-1997	OLS	A positive effect of a tax credit reform on R&D spending. The impact is stronger in the US than in Canada.
Haegeland and Moen	2007	Norway	1993-2005	GLS, Diff-in-Diff	A positive effect of a tax credit reform on the R&D investment.
Lee	2011	Canada, Japan, Korea, Taiwan, China, India	1997	GMM, IV	A positive effect of a tax credit reform on the R&D investment. The effect varies across firms, industries, and country characteristics.
Yang et al.	2012	Taiwan	2001-2005	OLS, Logit, IV, GMM	A positive effect of a tax credit reform on a firm's R&D spending.
Bozio et al.	2014	France	2004-2010	Logit, Diff-in-Diff, PSM	A positive effect of a tax credit reform on the R&D investment but a possible lower impact on its innovation than could have been expected.
Kasahara et al.	2014	Japan	2000-2003	GMM	A positive effect of a tax credit reform on the level of R&D.
Kobayashi	2014	Japan	2009	Probit, PSM	A positive effect of a tax credit reform on the R&D spending of SMEs.
Guceri	2017	UK	2003-2012	Logit, Diff-in-Diff, PSM	A positive effect of a tax credit reform on the R&D spending.

A Meta-Study					
Castellacci and Lie	2015	34 articles, 404 effect estimates	Studies published between 1991 and 2013	A meta-regression analysis	A positive effect of a tax credit reform on the R&D investment. The effect is stronger for SMEs, firms in service sectors, and firms in low-tech sectors in countries with an incremental scheme.

Notes: OLS stands for ordinary least squares, GLS stands for generalized least squares, IV denotes instrumental variable, GMM means generalized method of moments, PSM stands for propensity score matching, Diff-in-Diff denotes a difference-in-difference estimation, SME stands for a small or medium enterprise.

Falk (2006), Corchuelo and Martínez-Ros (2010), Ernst and Spengel (2011), Westmore (2013), Ernst et al. (2014) find a positive impact of decreasing B-Index on a firm's R&D expenses and its probability to invest in research and development. Westmore (2013) argues that the declining B-Index has a positive effect not only on R&D expenditure but also on its innovation, measured as a number of new patent applications. Ernst et al. (2014) develop this idea further and state that the B-Index is negatively correlated with both the number of patent applications and also their quality. Finally, Gaillard-Ladinska et al. (2015) conduct a meta-study that analyzes 82 estimates from 16 empirical studies within this field of literature. The authors argue in favor of a positive effect of decreasing user costs on a firm's stock of R&D capital and its R&D expenditure. In addition, the effects found in the earlier and more recent studies are of approximately the same magnitude.

6.3.1.2 Evaluation of a Treatment Effect

Panel B of Table 6.3 presents an overview of empirical studies that evaluate effects of the reforms that have introduced input-oriented R&D tax incentives. These papers differ from those described in the previous section mainly through their identification strategy. Namely, they focus on a particular reform that changed (or introduced) fiscal incentives and compare the outcomes for treated and non-treated firms. However, many of the earlier studies in this area disregard the problem of a selection bias, according to which the recipients of R&D tax credits or super-deductions might systematically differ from the non-recipients. For this reason, recent studies such as Yang et al. (2012), Bozio et al. (2014), Kobayashi (2014), Guceri (2017) have estimated the effect of R&D tax incentives after meticulously correcting a possible selection bias using the propensity score matching (PSM) technique. This strategy helps to identify comparable companies and to classify and divide them into treatment and control groups.

A recent study by Guceri (2017) estimates the effect of R&D tax incentives in a quasi-experimental setting. The author exploits a recent reform in the UK, which increased a threshold for small or medium enterprises (SMEs) from 250 to 500 employees. This reform changed the composition of companies that were eligible for an R&D tax credit and therefore created a suitable design for an empirical investigation of the treatment effect. Using firm-level data from the UK over the period between 2003 and 2012, Guceri (2017) argues that tax incentives help to increase R&D spending at a company level. The author finds a user costs elasticity of -1.2, which implies that an introduction of an R&D tax incentive that decreases user costs by 1% leads to a 1.2% increase in R&D spending. Comparable results were found by other authors who conducted similar empirical analyses employing data on different countries and years of observation, such as Klassen et al. (2004), Haegeland and Moen (2007), Lee (2011), Yang et al. (2012), Kasahara et al. (2014), Bozio et al. (2014), and Kobayashi (2014). In addition, the effects found in the earlier and more recent studies are of around the same magnitude. Castellacci and Lie (2015) conduct a meta-study using 404 effect estimates from 34 empirical papers in this field of research. The authors are able to identify a positive effect of tax credit reforms on R&D investment. In addition, they argue that on average R&D tax credits have a stronger impact on SMEs, firms in service sectors, and firms in low-tech industries in countries with an incremental credit scheme.

6.3.2 The Impact of Output-Oriented R&D Tax Incentives

As discussed in section 6.2.3.2, several European countries have introduced IP Boxes to encourage innovation. An IP Box significantly reduces the taxation of income generated by qualifying intellectual property and in some cases it offers a beneficial treatment of R&D expenditure. Evers et al. (2015a) give a detailed overview of the current IP Boxes in Europe and show the tax reductions they cause. Since in most cases IP Boxes are fairly new regulations, the empirical research on their effectiveness or outcomes is rather scarce. A few papers that attempt to evaluate the influence of IP Boxes on a firm’s innovative activity are presented in Table 6.4.

Ernst et al. (2014) incorporate IP Boxes into their measurement of the taxation of royalty payments and argue that they contribute towards attracting patent ownership. Similar results are found by Griffith et al. (2014) who ex-ante estimate the impact of IP Boxes with data running until 2005 (most current IP Boxes have been introduced afterwards). The authors conclude that even though a greater number of patent applications are to be expected in countries with IP Boxes, these regimes likely lead to substantial revenue losses not only in countries where they have been introduced but also in the neighboring jurisdictions.

Bradley et al. (2015) employ country-level data on patent applications filed at all major international patent offices and investigate the impact of an IP Box implementation on a country's innovation. The authors find that on average a one percentage point decrease in the tax rate on patent income leads to a 3% increase in the new patent applications. However, Bradley et al. (2015) note that an increase in patent applications following an implementation of an IP Box does not necessarily imply an increase in innovation. They argue that an IP Box may encourage the patenting of pre-existing unpatented intangibles in addition to incentivizing new research activity.

Alstadsæter et al. (2015) and Dudar et al. (2015) segregate various attributes of IP Boxes and investigate their potential effects. Dudar et al. (2015) conclude that IP Boxes that recognize acquired intellectual property are indeed likely to attract royalty inflows into the countries of their implementation. However, the authors do not find a similar result for the IP Boxes applicable exclusively to self-developed intangibles and therefore they argue that multinationals might use certain types of IP Boxes as a means of profit shifting rather than a tool for boosting their innovation. Alstadsæter et al. (2015) conduct a detailed empirical investigation of the effects that IP Boxes have on a firm's patenting and its actual R&D activity. In line with previous studies, they find that IP Boxes have a strong effect on attracting patents, especially those of high quality. Consistent with Dudar et al. (2015), the authors find that the effect is stronger for IP Boxes that are applicable to acquired intangible assets. Furthermore, Alstadsæter et al. (2015) find that the existence of an IP Box encourages multinationals to relocate their patents without a corresponding increase in the number of inventors or a shift in research activities. Once again, this implies that IP Boxes do not provide enough incentives for companies to conduct local research and multinationals might view them as a means of profit shifting instead.

Table 6.4 An Overview of Empirical Studies on the Effectiveness of Output-Oriented R&D Tax Incentives

Paper		Sample			
Authors	Year	Countries	Time Period	Empirical Model	Results
Ernst et al.	2014	members of the EPO	1995-2007	OLS, Diff-in-Diff	IP Boxes contribute to attracting patent ownership.
Griffith et al.	2014	14 EU countries and the United States	1985–2005	Ex-ante analysis, Mixed Logit	IP Boxes are likely to have a positive effect on the number of patent registrations. They could also lead to a substantial reduction in tax revenues.
Alstadsæter et al.	2015	33 countries worldwide	2000-2011	Negative Binomial Logit	IP Boxes attract intangibles, especially high-quality patents. The effect is stronger for IP Boxes that are applicable to acquired IP. However, the existence of an IP Box incentivizes multinationals to shift the location of their patents without a corresponding increase in the number of inventors or a shift of research activities.
Dudar et al.	2015	61 countries worldwide	1990-2012	Poisson	IP Boxes that are applicable to acquired IP seem to attract royalty inflows. However, IP Boxes that are applicable only to self-developed IP do not appear to affect international royalty flows.
Bradley et al.	2015	71 countries worldwide	1990-2012	OLS	IP Boxes lead to an increased patenting activity in a country of their implementation.

Notes: OLS stands for ordinary least squares, Diff-in-Diff denotes a difference-in-difference estimation, and EPO stands for the European Patent Office.

The empirical evidence on the effectiveness of IP Boxes shows that this type of R&D tax incentives is likely to be used for profit shifting rather than to increase real R&D activity. However, it is worth noting that one of the largest loopholes in the construction of IP Boxes is about to change. This is because the misuse of IP Boxes for profit shifting is possible primarily in the cases where not only self-developed but also acquired intangibles are eligible for a preferential tax treatment. Hence, companies may develop an intangible in a high-tax country and then register it in a country with an IP Box just to take advantage of the reduced taxation of income generated by this asset. However, as mentioned in section 6.2.2.2, the OECD now requires all existing and planned IP Boxes to follow the Nexus Approach, according to which IP Boxes should favor only intangible assets that were locally developed.[235]

In summary, the empirical evidence on input-oriented R&D tax incentives, such as tax credits or tax super-deductions, is extensive and has a long history. The authors in this field of research find a strong positive effect of introducing or changing input-oriented fiscal incentives on the innovative activity of companies and this effect is of around the same magnitude in the earlier and more recent studies. In contrast, the literature on output-oriented R&D tax incentives is rather limited, because IP Boxes are fairly new regulations. Here, the authors usually find a positive effect of IP Boxes on a number of patents held in a country. However, as yet there is no robust evidence to show that an increase in the real R&D activity is caused by the introduction of an IP Box. Therefore, multinationals might view output-oriented R&D tax incentives not only as a way of fostering research and development but also as a means of tax planning.

6.4 The Use of R&D Tax Incentives in Tax Planning: A Theoretical Analysis

The previous two sections have introduced the main types of R&D tax incentives and discussed the outcomes of their implementation. The primary aim of this part of the paper is to analyze a less researched aspect of R&D tax support; namely, its potential use by multinational enterprises for tax planning. Thus, this section initially explains a standard set-up of the Devereux and Griffith model[236] and goes on to incorporate input- and output-oriented R&D tax incentives into the model, following the framework developed by Spengel and Elschner (2010) and Evers et al. (2015a). Furthermore, two main settings are identified in our theoretical analysis: to begin with, a domestic investment case is presented, in which an intangible asset is developed and afterwards kept in the same country. Following on from this, a cross-border investment scenario is introduced, where an intangible asset is developed in one country and then sold to another one. The scope of our analysis covers the EU and EFTA member states in 2012.

[235] See OECD (2015a).
[236] See Devereux and Griffith (1999, 2003).

6.4.1 Domestic Investment

6.4.1.1 Devereux and Griffith Model for Calculating Effective Tax Burden

Statutory corporate income tax rates are usually inadequate in capturing the true tax burden that an investing company faces. Therefore, there are several theoretical approaches to measure effective tax rates. For example, Devereux and Griffith (1999, 2003) expand on the earlier work by Jorgensen (1963), Hall and Jorgensen (1967), as well as King and Fullerton (1984) and formulate a model that incorporates various aspects of a tax system and therefore reflects a country's effective corporate tax burden.

The key assumptions of the Devereux and Griffith model comprise perfect capital mobility under certainty and a successful outcome of real investment. Furthermore, the Devereux and Griffith approach is based on the assumption of a hypothetical investment that takes place in one period and generates returns in the next period. In a standard setting of the model, it is assumed that the investment flows into five different assets such as machinery, industrial buildings, financial assets, inventory, and intangible assets. However, in line with Evers and Spengel (2014) this study focuses only on the investment in an intangible asset, namely a self-developed patent.

Furthermore, a standard case of the Devereux and Griffith approach incorporates three different sources of investment financing such as retained earnings, borrowed capital, and new equity. Referring to Evers and Spengel (2014) and for reasons of simplification, this study assumes that a patent is financed only by the means of equity. Moreover, it is assumed that R&D expenditure only consists of current R&D expenses, such as costs of R&D personnel. This assumption is plausible, since according to the OECD data on R&D spending, during the last few years current expenses constituted the majority of the total expenditure on research and development in most OECD countries.[237] Table 6.5 summarizes the most important assumptions of the Devereux and Griffith model and gives an overview of economic parameters applied in our study.[238]

[237] See OECD (2016c).
[238] The robustness of the economic parameters in the Devereux and Griffith model has been tested in several studies (see European Commission/ZEW (2016)).

Table 6.5 Summary of the Assumptions

Assumption on		Value
Legal form		Corporation
Industry		Manufacturing industry
Economic good		A self-developed patent
Source of financing		Equity
Economic depreciation	δ	Declining 15.35%
Real market interest rate	r	5%
Inflation rate	π	2%
Nominal interest rate	i	7.1%[1]
Real pre-tax return	p	20%
Useful life of an asset	ul	10 years

Notes: [1]$i = (1 + r)(1 + \pi) - 1$. The assumptions about economic parameters and depreciation rules are based on the ZEW work on effective tax rates.[239]

The Devereux and Griffith approach allows us to calculate several measures of the effective tax burden. For instance, the cost of capital and the effective marginal tax rate (EMTR) show an effective taxation of a marginal investment. The net present value (NPV) of a marginal investment is equal to zero, which implies that the returns from this investment are just sufficient but do not exceed the returns of an alternative capital-market investment.[240] However, since this study concentrates on modelling tax planning opportunities of profitable multinational firms, we assume that a company's investment is lucrative. Therefore, we rely on calculating and comparing the effective average tax rates (EATRs), which show an effective tax burden on profitable investments and are relevant for a firm's investment location decisions. As shown in equation 6.2, EATR is calculated as a percentage difference between the net present value of an investment in the absence and in the presence of taxation.

$$EATR = (R^* - R) / \left(\frac{p}{(1+r)}\right) \tag{6.2}$$

In equation 6.2, R^* represents the net present value of an investment in the absence of taxes and R shows its NPV in the presence of taxation. The denominator represents the NPV of a total pre-tax income stream net of the rate of return. The net present value in the presence of taxation R is in turn calculated as follows:[241]

[239] See ZEW (2016).
[240] In this study, an alternative capital-market investment is a financial asset that yields a real market interest rate (which is equal to 5%, as shown in Table 6.5).
[241] For more details regarding the model, see Devereux and Griffith (1999, 2003), Spengel and Lammersen (2001), Schreiber et al. (2002), and Evers et al. (2015a).

$$R = \underbrace{-(1 - \mathrm{A})}_{\substack{\textit{R\&D expenses, tax} \\ \textit{depreciation}}} + \underbrace{\frac{(p + \delta)(1 + \pi)}{(1 + i)} (1 - \tau)}_{\substack{\textit{Returns generated} \\ \textit{by a patent}}} + \underbrace{\frac{(1 - \delta)(1 + \pi)}{(1 + i)} (1 - A)}_{\textit{Reduction in capital stock}} \tag{6.3}$$

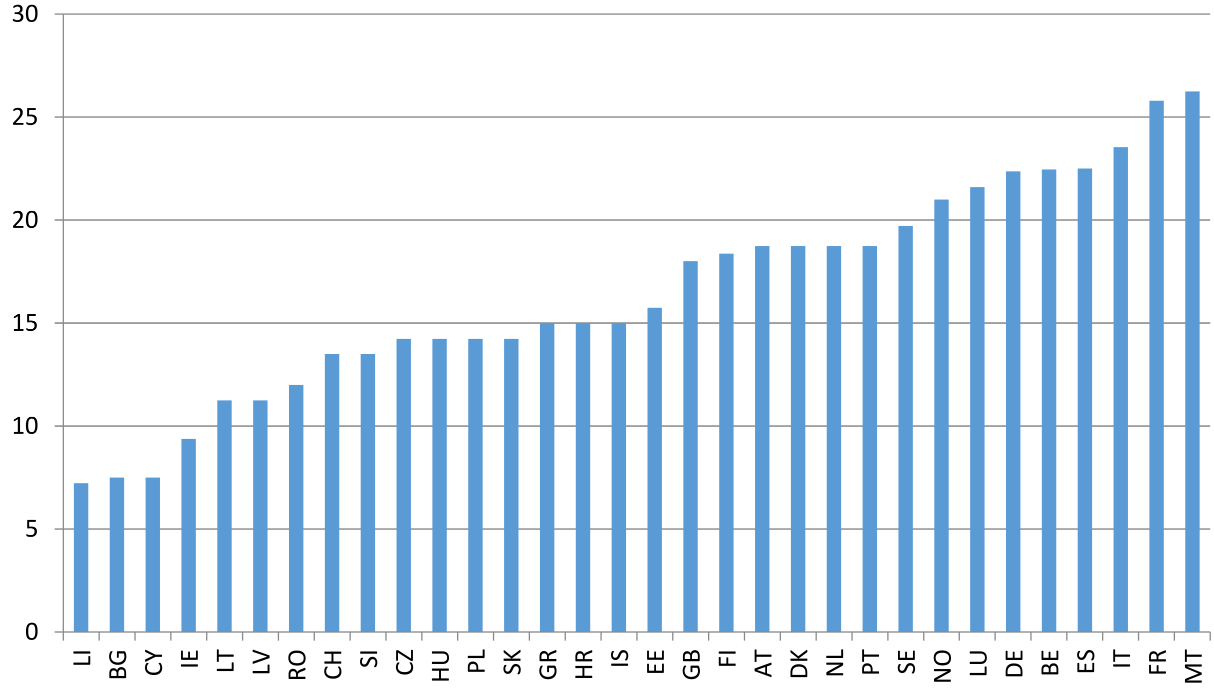
As noted above, the Devereux and Griffith model is based on the assumption of a hypothetical investment that lasts two periods. The first term of equation 6.3 reflects the investment implemented in the first period, with A denoting the tax allowances. The next two terms represent the changes in the second period of a hypothetical investment. Hence, the second term shows the returns from the investment, whereby p represents a real return on investment, δ stands for the cost of depreciation, π denotes the rate of inflation, i denotes the interest rate, and τ represents the tax rate. Finally, the third term shows a reduction in the capital stock to its initial level, so that the stock of capital remains unchanged between the two periods. After the calculation of the after-tax net present value of an investment, we compute the effective average tax rate using equation 6.2.

Furthermore, in Belgium and Liechtenstein a notional interest deduction (NID) for equity capital is available. This tax instrument allows companies to deduct a certain percentage of the qualifying equity capital from their taxable profits. The objective of NID is to even out the tax treatment of two major sources of investment financing – equity and debt. From a tax point of view, debt might be seen as a preferable financing way compared to equity, because interest payments are tax deductible in most countries and therefore minimize a company's overall tax liability. NID gives a similar kind of advantage to equity financing. This tax measure is incorporated into the Devereux and Griffith model by adding NID expressed in equation 6.4 to equation 6.3. In equation 6.4, i^{NID}represents the notional interest rate, with other terms corresponding to the ones in equation 6.3.

$$NID = \frac{(1 - A)(i^{NID}\tau)}{1 + i} \tag{6.4}$$

Figure 6.2 summarizes effective average tax rates in Europe in 2012, which we have calculated using the Devereux and Griffith model. These tax rates represent the effective tax burden that a large company faces when developing and subsequently holding a patent. The results presented in Figure 6.2 were calculated without the consideration of any available R&D tax incentives. According to Figure 6.2, the EATRs of the EU and EFTA member states range from 7.2% in Liechtenstein to 25.8% in France and 26.3% in Malta. The Eastern European countries along with Liechtenstein, Ireland, and Switzerland (Kanton Nidwalden) offer the lowest tax burden for companies developing a patent in Europe. By contrast, the western and northern European countries along with Malta appear to have comparatively high effective tax rates.

Figure 6.2 Effective Average Tax Rates in Europe, Domestic Investment, 2012, %



Notes: The rates represent an effective tax burden of developing and holding only one asset – a patent. A regular tax system, no R&D tax incentives are considered here. Country codes and the corresponding country names are in the list of country abbreviations.

6.4.1.2 Incorporating R&D Tax Incentives into the Devereux and Griffith Model

This section covers the conceptual framework developed by Spengel and Elschner (2010) and Evers et al. (2015a) to incorporate input- and output-oriented R&D tax incentives from Tables 6.1 and 6.2 into the Devereux and Griffith model. It is assumed in the model that a large multinational corporation carries out a hypothetical investment and for this reason only R&D tax incentives for large firms are considered here. In addition, we assume that a hypothetical investment is profitable and thus the R&D tax incentives in the case of losses are not taken into account. Furthermore, it is assumed that the investment only consists of current and not capital expenditure and therefore only the incentives that apply to current expenses on research and development are taken into consideration. As discussed in section 6.4.1.1, this type of expenses constitutes the majority of R&D spending in the OECD countries.[242]

We incorporate the input- and output-oriented R&D tax incentives into the Devereux and Griffith methodology through the alterations of factor A, which represents tax allowances on an asset. As mentioned in section 6.2.3.1, most countries do not require a mandatory capitalization of self-created intangible assets for tax purposes and allow an immediate deduction of R&D expenditure at the regular corporate income tax rate. For simplification reasons, we assume that this rule applies to all countries under consideration[243] and on this basis factor A is defined in the absence of R&D tax incentives as follows:

$$A = \varphi_0 \, \tau \tag{6.5}$$

In equation 6.5, φ_0 represents a share of R&D expenses that are immediately deductible. In all countries analyzed in our study, it is equal to 100%. τ denotes statutory tax rate on corporate income.

6.4.1.2.1 Input-Oriented R&D Tax Incentives

As previously mentioned, this study is based on the assumption that R&D expenses of a model company consist of current and not capital expenditure. Therefore, this section focuses on using the framework developed by Spengel and Elschner (2010) to include input-oriented R&D tax incentives that apply to current expenses such as tax credits and tax super-deductions in the Devereux and Griffith model. For example, if a tax credit applies, A in equation 6.3 is defined as follows:

$$A = \varphi_0 \, \tau + \phi \tag{6.6}$$

Equation 6.6 is similar to equation 6.5, except it includes factor ϕ, which represents the amount of a tax credit. As a result, a tax credit is subtracted from the company's tax liability. In the case of a tax deduction that exceeds the usual 100% (also known as a super-deduction), tax allowance A can be expressed this way in equation 6.3:

[242] In addition, we do not consider incentives that have incremental character.
[243] This assumption has also been made by Evers and Spengel (2014).

$$A = \varphi_0 \, \tau \, (1 + \gamma) \tag{6.7}$$

where γ represents a factor of super-deduction. In contrast to a tax credit, a tax super-deduction reduced not the company's tax liability but rather its taxable income. If a country offers both types of input-oriented tax incentives, namely a tax credit and a tax super-deduction, they are combined as follows:[244]

$$A = \varphi_0 \, \tau \, (1 + \gamma) + \phi \tag{6.8}$$

6.4.1.2.2 Output-Oriented R&D Tax Incentives

This part of the analysis incorporates IP Box regimes into the Devereux and Griffith model following the approach suggested by Evers et al. (2015a). The presence of an IP Box in a country alters equation 6.3 in two ways. First, the reduced IP Box tax rate τ^{IP} applies to the profits generated by an intangible asset instead of the statutory CIT rate τ. Secondly, it changes tax allowance A in a similar way as the input-oriented R&D incentives. Factor A in equation 6.3 depends on how the R&D expenditure is treated within an IP Box. According to Table 6.2, some countries require a recapture of the R&D expenses which occurred in the past, whereas other countries do not. If no recapture is enforced, factor A is defined through equation 6.5. By contrast, if a recapture mechanism is present, the past R&D expenses cannot be deducted at the standard CIT rate and have to be either capitalized or deducted in accordance with the threshold approach. If R&D spending is recaptured according to a threshold approach, then factor A is defined through equation 6.5; however, instead of the standard CIT rate τ, a reduced IP Box tax rate τ^{IP} enters the formula. In some countries, previous R&D expenses have to be capitalized and amortized over the useful life of an intangible, in which case A is defined as follows:

$$\mathrm{A} = \varphi_0 \, \tau - \varphi_0 \, \tau + \tau^{\mathrm{IP}} \varphi \sum_{t=1}^{ul} \left(\frac{1}{1+i}\right)^{t} \tag{6.9}$$

In equation 6.9, R&D expenses are capitalized at the IP Box tax rate τ^{IP} in accordance with factor φ, which represents the percentagewise amortization rate in period t. As shown in Table

[244] See Spengel and Elschner (2010) for further details on modelling input-oriented R&D tax incentives in the Devereux and Griffith model.

6.5, we assume that the useful life of a patent ul equals 10 years. Since φ is defined as $1/\,ul$, this parameter amounts to 10% in our analysis.

6.4.1.2.3 A Combination of Input- and Output-Oriented R&D Tax Incentives

According to Evers et al. (2015a), all countries except Malta allow the application of both input- and output-oriented R&D tax incentives.[245] If this is the case, factor A in equation 6.3 depends simultaneously on a country's tax credit, super-deduction, as well as on its IP Box. For example, if an IP Box does not require a recapture of the past R&D expenses, parameter A is equal to the one defined in equation 6.8. If the recapture is implemented in line with a threshold approach, it is also calculated as the one defined in equation 6.8 with the statutory CIT rate τ being replaced by a reduced IP Box tax rate τ^{IP}. If a recapture of the previous R&D expenditure occurs through their capitalization, equations 6.8 and 6.9 are combined as shown in equation 6.10.

$$A = \varphi_0\,\tau - \varphi_0\,\tau + (\tau^{IP}\,(1+\gamma) + \phi)\,\varphi \sum_{t=1}^{ul}\left(\frac{1}{1+i}\right)^{t} \tag{6.10}$$

Figure 6.3 presents the results of using the Devereux and Griffith model to calculate the effective average tax rates in the EU and EFTA member states in 2012. In contrast to Figure 6.2, Figure 6.3 illustrates not just a tax burden under the regular tax system but rather an effective taxation after incorporating all existing input- and output-oriented R&D tax incentives. If a country offers both input- and output-oriented incentives, they are combined as described above.[246] Figure 6.3 shows substantially lower effective average tax rates than Figure 6.2 in all countries with R&D tax incentives. There are exceptions to this, whereby the effective tax burden remains the same in Germany and Estonia, where no fiscal incentives are in place. Hence, Italy and Germany become countries with the highest effective tax rates once R&D incentives are considered.[247] Moreover, it is worth noting that some countries acquire a negative EATR when tax incentives are incorporated into the model. The negative values of the effective

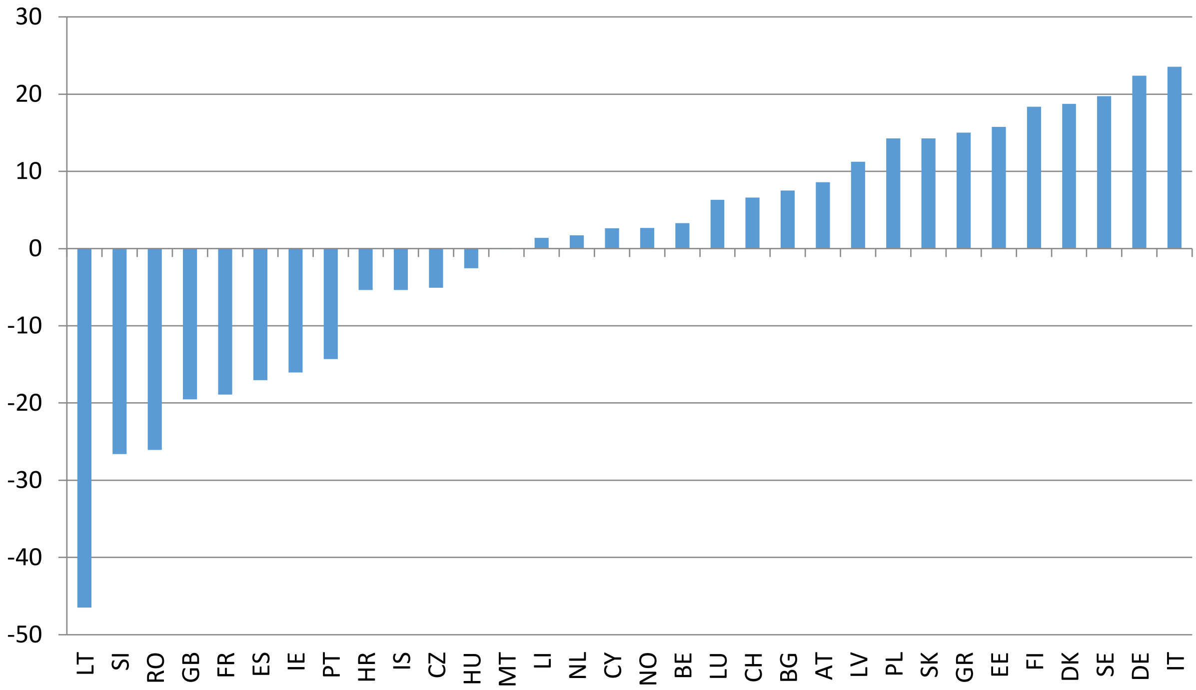
[245] See Evers et al. (2015a), p. 512.

[246] Since Malta is the only country that does not allow a combination of input- and output-oriented incentives, we assume that a hypothetical firm opts for an IP Box in this country. This is because an IP Box leads to a lower effective tax burden than the Maltese input-oriented tax incentives.

[247] Italy has introduced an IP Box in 2015, which implies that Germany currently has the highest effective taxation of R&D once fiscal incentives for research and development are considered in the Devereux and Griffith model.

average tax burden imply that the tax treatment provides a subsidy for developing and holding a patent.

Figure 6.3 Effective Average Tax Rates in Europe (with R&D Tax Incentives), Domestic Investment, 2012, %



Notes: The rates represent an effective tax burden of developing and holding only one asset – a patent. Input- and output-oriented R&D tax incentives are included. Country codes and the corresponding country names are in the list of country abbreviations.

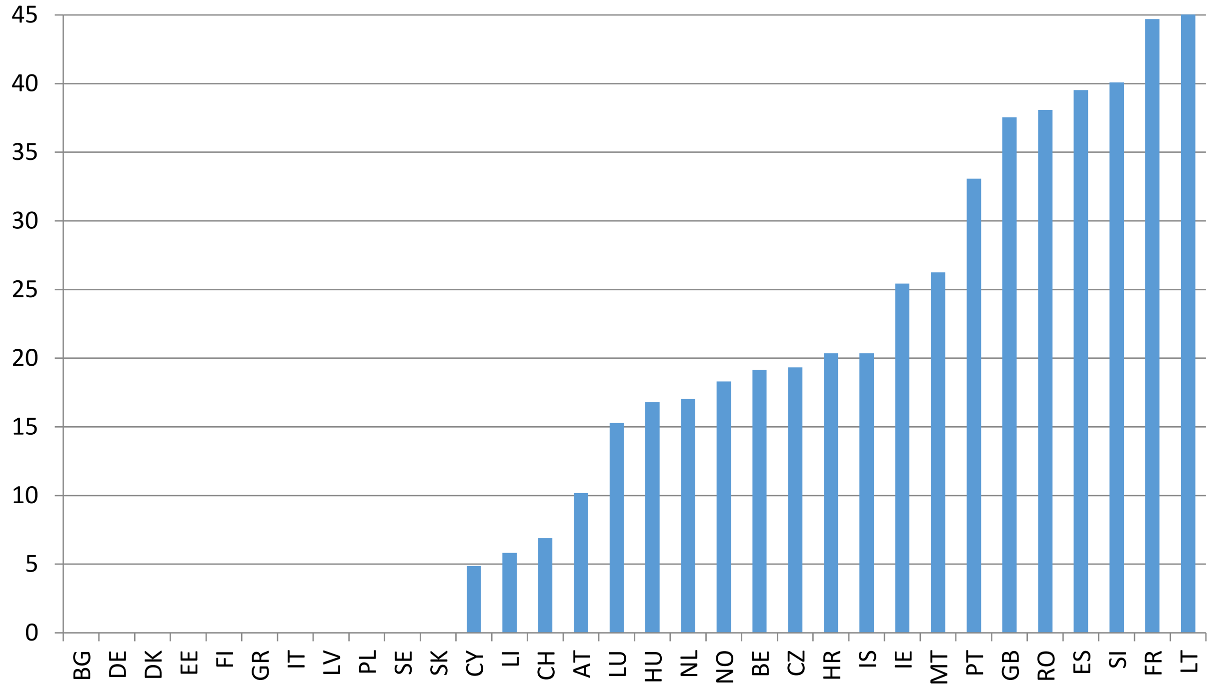
Our measure of the effective tax burden after the consideration of R&D tax incentives is comparable to the B-Index discussed in section 6.3.1.1. Warda (2001) has developed this measure and multiple research papers have calculated it for various countries, industries, firm sizes, and time periods (see as examples: Ernst and Spengel (2011), Thomson (2013), and Chen and Dauchy (2015)). As Spengel and Elschner (2010) note, the OECD also uses the B-Index in order to compare the attractiveness of OECD countries for R&D investment. The B-Index is calculated using the formula presented in equation 6.1. As explained in section 6.3.1.1, if an R&D investment is fully expensed in a given fiscal year, then the B-Index is equal to one. However, if a country offers a super-deduction which allows a double deduction of the actual R&D expenditure, the B-Index will be smaller than one. Therefore, the B-Index reflects the costs of research and development and its lower values correspond to a more attractive tax system for R&D investment. The main difference between the B-Index and our measure of an effective tax burden after the consideration of R&D tax incentives is the coverage of R&D tax incentives. The B-Index concentrates on input-oriented R&D tax incentives, whereas the approach used in this study also incorporates output-oriented incentives and additionally allows for a combination of the two. Furthermore, we rely on the theoretical framework of Devereux and Griffith (1999, 2003), in which a transaction of a patent from one firm to another can be modelled in a cross-border investment case in addition to the domestic investment scenario reflected in the B-Index.

6.4.1.3 The Impact of R&D Tax Incentives on Effective Tax Burdens

Figure 6.4 shows how much the effective average tax rates are reduced by once input- and output-oriented R&D tax incentives are introduced in the Devereux and Griffith Model. According to Figure 6.4, R&D tax incentives lead to the largest decrease (in absolute terms) in effective tax rates in Lithuania, France, Slovenia, and Spain. It should be pointed out that France and Spain offer generous R&D tax credits as well as IP Boxes. The combination of these input- and output-oriented R&D incentives results in a large tax shield for companies and leads to EATRs acquiring negative values. Lithuania and Slovenia have relatively low EATRs under their regular tax systems, as Figure 6.2 shows. However, taking into account the R&D super-deductions of 300% in Lithuania and 140% in Slovenia leads to an even further decrease of the effective tax rates in these countries. The EATR reduction in Malta is solely due to an IP Box regime, since the input-oriented incentives are not taken into consideration in this country, as discussed in the previous section. In summary, Figure 6.4 demonstrates that a significant reduction in the effective tax rate can result from either input- or output-oriented R&D tax incentives as well as from their combination.

Some countries do not show any decrease in the effective average tax rates after the R&D tax incentives are considered. Germany, Greece, Estonia, Latvia, Slovakia, and Sweden did not offer any fiscal incentives in 2012, which means that their EATRs under a regular tax system are equal to the EATRs that are calculated after taking R&D tax incentives into consideration. In addition, Bulgaria, Denmark, Italy, Finland, and Poland offer input-oriented R&D tax incentives, which are not taken into account by the model presented in this study because these incentives either apply to capital expenses (Bulgaria and Finland), have a purely incremental character (Italy), or are not available for all firms (Denmark and Poland).

Figure 6.4 Reductions in EATRs after Including R&D Tax Incentives into the Devereux and Griffith Model, Domestic Investment, Percentage Points



Notes: The figure shows the differences between EATRs in Figure 6.2 and EATRs in Figure 6.3. It illustrates how much the effective tax rates are reduced by when R&D tax incentives are introduced in the Devereux and Griffith model. Country codes and the corresponding country names are in the list of country abbreviations.

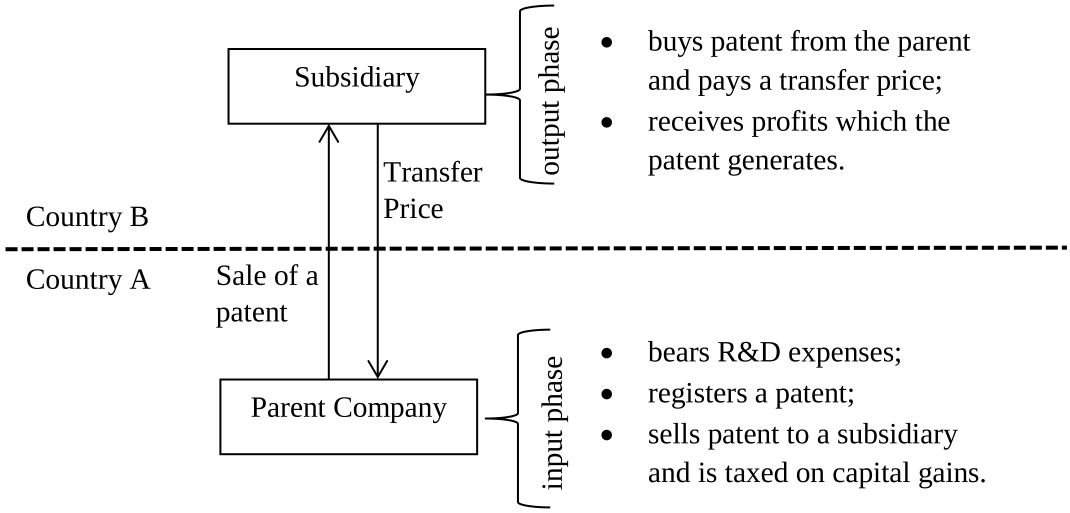
6.4.2 Cross-Border Investment

6.4.2.1 Devereux and Griffith Model for Calculating Effective Tax Burden

The calculation of effective average tax rates across the EU and EFTA member states in the case of a domestic investment has been discussed in the previous section. It was assumed that the input and output phases of an R&D process occur in the same country. However, the main aim of this study is to investigate whether R&D tax incentives can be used as a means of tax planning. According to Arginelli (2015), input-oriented R&D tax incentives do not always lead to an increase in a company's taxable income, productivity, or its employment. The author argues that this is because intangibles created in a country that provides generous input-oriented tax incentives might be transferred abroad or be used in the production process in other countries. Fuest et al. (2013) give an overview of profit shifting and its main financial and non-financial channels. The authors argue that a strategic location or relocation of intangible assets plays an important role in tax avoidance and aggressive tax planning[248] of multinational firms. For this reason, this section focuses on calculating the effective tax burden in the case of a cross-border sale of an intangible asset. The sale of a patent implies a transfer of its economic and legal ownership from one company to another.[249] If the effective tax burden of a multinational firm decreases after it sets apart the location where the patent was created from the location where its profits are generated, an MNE might use various input- and output-oriented R&D tax incentives for tax planning.

Figure 6.5 demonstrates the structure of a model company, whose effective cross-border tax burden is calculated using the extended Devereux and Griffith approach. The assumption is that the parent company and its subsidiary are located in two different countries (A and B). The input phase of an R&D process occurs at the parent firm in country A, which develops a patent and therefore bears the associated R&D expenditure and financial risks. Once the patent has been created, it is registered and sold to a subsidiary in country B. In most countries, it is a general requirement that a capital gains tax is paid on the transfer price that the parent firm receives. This tax rate usually equals a country's statutory corporate income tax rate.

Figure 6.5 Structure of a Model Multinational Company



As a result of the transaction shown in Figure 6.5, the output phase of an R&D process takes place at the subsidiary in country B. Hence, if a patent generates royalties or license fees, the

[248] See Piantavigna (2017) for the definition and discussion of these terms.

[249] It is assumed that dividends are exempt from withholding and corporate income taxes. This assumption is made towards countries in the EU and EFTA due to the EU Parent and Subsidiary Directive (see European Commission (2003a)).

subsidiary receives these payments and includes them into its tax base. From a tax perspective, this procedure gives the multinational an incentive to develop a patent in a high-tax country, where it can reduce its tax liability by deducting the R&D expenditure. The patent can then be transferred to the subsidiary in a low-tax jurisdiction, which would profit from a beneficial taxation of the profits generated by the intangible. Such a separation of the places where a patent is developed and held could lead to a significant reduction in the MNE's overall tax liability.

In order to calculate an effective tax burden of the multinational company presented in Figure 6.5 by using the Devereux and Griffith model, we have to adjust equation 6.2. The adjustment should reflect the deduction of R&D expenses by the parent, the taxation of profits generated by an asset at the subsidiary, as well as the taxation of a transactional sale. This is done in equation 6.11.

$$R = -\overbrace{\left(1 - A_P - A_S^{TP}\right)}^{\textit{R\&D expenses, tax depreciation}} + \overbrace{\frac{(p+\delta)\,(1+\pi)}{(1+i)}\left(1-\tau_s\right)}^{\textit{Returns generated by a patent}} - \overbrace{\tau_p\,TP}^{\textit{Capital gains taxation}} + \underbrace{+\frac{(1-\delta)\,(1+\pi)}{(1+i)}\left(1 - A_P - A_S^{TP} + \tau_p TP\right)}_{\textit{Reduction in capital stock}} \tag{6.11}$$

Equation 6.11 mirrors equation 6.2 and includes a few new components at the same time. For instance, the first term of the equation reflects not only the treatment of R&D expenses at the parent's level A_P but also the tax depreciation of the patent at the subsidiary A_S^{TP}, since acquired intangible assets have to be capitalized in countries under analysis. As shown in Figure 6.5, the parent sells the patent to the subsidiary after it has been developed. Therefore, the second term of equation 6.11 shows the treatment of the returns generated by a patent in the country of the subsidiary. For example, τ_s represents the income tax rate that applies in the subsidiary's host country and corresponds to the ordinary CIT rate in most cases. However, if a subsidiary's country offers an IP Box that is applicable to acquired intangibles, then a reduced tax rate applies to the income generated by the acquired patent.

Furthermore, the sale of a patent triggers capital gains taxation, which is reflected in the third term of equation 6.11. Here, τ_p stands for the capital gains tax in the parent's country and TP represents the transfer price on this transaction. Table 6.6 summarizes the effective capital gains tax rates that apply in the countries under analysis. According to Table 6.6, the statutory corporate income tax rate is levied in most countries on the sale price of a patent. However, a reduced capital gains tax applies in some countries that offer an IP Box. As for the transfer price TP, it is defined following Evers and Spengel (2014) as:

$$TP = \alpha(p + \delta) \frac{(1 + \pi)}{(i + \delta * (1 + \pi) - \pi)} \quad (6.12)$$

Equation 6.12 includes economic parameters of the Devereux and Griffith model shown in Table 6.5 and an additional parameter α, which stands for the share of fair value. If α is larger or smaller than one, the transfer price TP is higher or lower than the fair price according to the arm's length principle. In this study, it is assumed that α is equal to one and so that the transfer price is fair.[250] The last term of equation 6.11 represents a reduction in the stock of capital, which is similar to equation 6.2. All other parameters of equation 6.11 are the same as those described in the previous section.

Table 6.6 An Overview of Capital Gains Tax Rates on Selling a Patent, 2012

	Tax Rate, %		Tax Rate, %
Austria	25	Latvia	15
Belgium	33.9	Liechtenstein	2.5
Bulgaria	10	Lithuania	15
Croatia	20	Luxembourg	5.9
Cyprus	2.5	Malta	35
Czech Republic	19	Netherlands	5
Denmark	25	Norway	28
Estonia	21	Poland	19
Finland	24.5	Portugal	25
France	34.4	Romania	16
Germany	29.8[1]	Slovakia	19
Greece	20	Slovenia	18
Hungary	0[2]	Spain	30[3]
Iceland	20	Sweden	26.3
Ireland	12.5	Switzerland	8.8[4]
Italy	31.4	UK	10

Notes: [1]Includes 15% CIT, 14% trade tax rate, and 5.5% solidarity surcharge. [2]Capital gains from intangible assets of Hungarian taxpayers are tax exempt if reported to tax authorities and after holding for a period of 1 year (does not apply for repurchased intangibles that are already subject to an exemption). [3]The reduced rate of 11.2% applies if transfer is carried out between independent entities and if there are valid business reasons for the transaction. [4]The rate refers to the canton of Nidwalden.

The input-oriented R&D tax incentives are included in our model solely through factor A_P in equation 6.11. In contrast, output-oriented R&D incentives may enter equation 6.11 multiple

[250] See Evers and Spengel (2014) for the discussion on variations in this assumption.

times. For example, an IP Box may affect A_P if a parent firm is located in a country with an IP Box and is therefore able to benefit from a preferential tax treatment of its R&D expenditure. In addition, a reduced IP Box tax rate may enter the second term of equation 6.11 if an IP Box applicable to acquired intangibles exists in a country of the subsidiary. Lastly, if an IP Box offers beneficial capital gains taxation, a reduced tax rate will be used in the third term of equation 6.11.

Notional interest deduction is incorporated by adding NID_S to equation 6.11 if the parent company resides in Belgium or Lichtenstein. If the subsidiary is allowed to deduct notional interest, the calculation of NID_S is based on a subsidiary's expenses on the acquisition of a patent instead of the parent's R&D expenditure. Hence, in line with equation 6.3, NID_S is expressed as follows:

$$NID_S = \frac{(1 - A_S^{TP})(i^{NID}\tau_S)}{1 + i} \tag{6.13}$$

Table 6.7 presents the effective tax rates that apply in the EU and EFTA member states in 2012 in the case of a cross-border investment. Since R&D tax incentives are not considered here, the effective tax burden represents taxation under a regular tax system. The countries listed in the first column of Table 6.7 represent the location of a parent firm that conducts R&D, while countries in the top row show the location of a subsidiary that receives profits generated by an intangible. To give an example, the EATR of 34.2% between Austria and Belgium implies that a parent develops a patent in Austria and sells it to a subsidiary in Belgium. A capital gains tax on this transaction is then paid in Austria. The effective average tax rates which are indicated through the diagonal line highlighted in red in Table 6.7 show the effective taxation in the case when a parent firm keeps the patent. These values correspond to the domestic investment scenario shown in Figure 6.2.

Table 6.7 shows the effective taxation under a regular tax system, which implies that no fiscal incentives are included in the calculation of these rates. For example, if an Austrian firm conducts R&D and keeps the asset afterwards, its effective tax rate amounts to 18.8%. If a cross-border scenario is considered, as shown in Figure 6.5, the countries where a patent is developed and where it is possessed will differ. For instance, if an Austrian parent develops an intangible and proceeds to sell it to the subsidiary in Belgium, the effective tax burden amounts to 34.2%. The sale of a patent to a subsidiary in Bulgaria will result in an EATR of 24.1% and

Table 6.7 Effective Average Tax Rates in Europe, Cross-Border Investment, 2012, %

	AT	BE	BG	CH	CY	CZ	DE	DK	EE	ES	FI	FR	GB	GR	HR	HU	IE	IS	IT	LI	LT	LU	LV	MT	NL	NO	PL	PT	RO	SE	SI	SK
AT	18.8	34.2	24.1	28.3	24.1	28.9	34.6	32.0	29.9	34.7	31.8	37.0	31.5	29.4	29.4	28.9	25.4	29.4	35.4	23.3	26.7	34.1	26.7	37.4	32.0	33.6	28.9	32.0	27.3	32.7	28.3	28.9
BE	35.7	22.5	27.8	32.0	27.8	32.6	38.3	35.7	33.6	38.4	35.5	40.7	35.2	33.1	33.1	32.6	29.1	33.1	39.2	27.0	30.4	37.8	30.4	41.1	35.7	37.3	32.6	35.7	31.0	36.4	32.0	32.6
BG	20.8	23.0	7.5	17.1	12.8	17.6	23.4	20.8	18.7	23.5	20.5	25.8	20.3	18.1	18.1	17.6	14.1	18.1	24.2	12.1	15.5	22.8	15.5	26.1	20.8	22.4	17.6	20.8	16.0	21.5	17.1	17.6
CH	26.8	29.0	18.8	13.5	18.8	23.6	29.4	26.8	24.7	29.5	26.5	31.8	26.3	24.1	24.1	23.6	20.1	24.1	30.2	18.1	21.5	28.8	21.5	32.1	26.8	28.4	23.6	26.8	22.0	27.5	23.1	23.6
CY	15.8	18.0	7.9	12.1	7.5	12.7	18.4	15.8	13.7	18.5	15.6	20.8	15.3	13.2	13.2	12.7	9.2	13.2	19.2	7.1	10.5	17.9	10.5	21.2	15.8	17.4	12.7	15.8	11.1	16.5	12.1	12.7
CZ	27.5	29.7	19.6	23.8	19.6	14.2	30.1	27.5	25.4	30.2	27.3	32.5	27.0	24.9	24.9	24.4	20.9	24.9	30.9	18.8	22.2	29.6	22.2	32.9	27.5	29.1	24.4	27.5	22.8	28.2	23.8	24.4
DE	35.7	37.8	27.7	31.9	27.7	32.5	22.4	35.7	33.5	38.3	35.4	40.7	35.1	33.0	38.3	32.5	29.0	33.0	39.1	26.9	30.3	37.7	30.3	41.0	35.7	37.3	32.5	35.7	30.9	36.4	31.9	32.5
DK	32.0	34.2	24.1	28.3	24.1	28.9	34.6	18.8	29.9	34.7	31.8	37.0	31.5	29.4	29.4	28.9	25.4	29.4	35.4	23.3	26.7	34.1	26.7	37.4	32.0	33.6	28.9	32.0	27.3	32.7	28.3	28.9
EE	29.0	31.2	21.1	25.3	21.1	25.9	31.6	29.0	15.8	31.7	28.8	34.0	28.5	26.4	26.4	25.9	22.4	26.4	32.4	20.3	23.7	31.1	23.7	34.4	29.0	30.6	25.9	29.0	24.3	29.7	25.3	25.9
ES	35.8	38.0	27.8	32.1	27.8	32.6	38.4	35.8	33.7	22.5	35.5	40.8	35.3	33.1	33.1	32.6	29.1	33.1	39.2	27.1	30.5	37.8	30.5	41.1	35.8	37.4	32.6	35.8	31.0	36.5	32.1	32.6
FI	31.7	33.8	23.7	27.9	23.7	28.5	34.2	31.7	29.5	34.3	18.4	36.7	31.1	29.0	29.0	28.5	25.0	29.0	35.1	22.9	26.4	33.7	26.4	37.0	31.7	33.3	28.5	31.7	26.9	32.4	27.9	28.5
FR	39.1	41.3	31.1	35.4	31.1	35.9	41.7	39.1	37.0	41.8	38.8	25.8	38.6	36.4	36.4	35.9	32.4	36.4	42.5	30.4	33.8	41.1	33.8	44.4	39.1	40.7	35.9	39.1	34.3	39.8	35.4	35.9
GB	31.3	33.5	23.3	27.6	23.3	28.1	33.9	31.3	29.2	34.0	31.0	36.3	18.0	28.6	28.6	28.1	24.6	28.6	34.7	22.6	26.0	33.3	26.0	36.6	31.3	32.9	28.1	31.3	26.5	32.0	27.6	28.1
GR	28.3	30.5	20.3	24.6	20.3	25.1	30.9	28.3	26.2	31.0	28.0	33.3	27.8	15.0	25.6	25.1	21.6	25.6	31.7	19.6	23.0	30.3	23.0	33.6	28.3	29.9	25.1	28.3	23.5	29.0	24.6	25.1
HR	28.3	30.5	20.3	24.6	20.3	25.1	30.9	28.3	26.2	31.0	28.0	33.3	27.8	25.6	15.0	25.1	21.6	25.6	31.7	19.6	23.0	30.3	23.0	33.6	28.3	29.9	25.1	28.3	23.5	29.0	24.6	25.1
HU	27.5	29.7	19.6	23.8	19.6	24.4	30.1	27.5	25.4	30.2	27.3	32.5	27.0	24.9	24.9	14.2	20.9	24.9	30.9	18.8	22.2	29.6	22.2	32.9	27.5	29.1	24.4	27.5	22.8	28.2	23.8	24.4
IE	22.7	24.8	14.7	18.9	14.7	19.5	25.2	22.7	20.5	25.3	22.4	27.7	22.1	20.0	20.0	19.5	9.4	20.0	26.1	13.9	17.4	24.7	17.4	28.0	22.7	24.3	19.5	22.7	17.9	23.4	18.9	19.5
IS	28.3	30.5	20.3	24.6	20.3	25.1	30.9	28.3	26.2	31.0	28.0	33.3	27.8	25.6	25.6	25.1	21.6	15.0	31.7	19.6	23.0	30.3	23.0	33.6	28.3	29.9	25.1	28.3	23.5	29.0	24.6	25.1
IT	36.8	39.0	28.9	33.1	28.9	33.7	39.4	36.8	34.7	39.5	36.6	41.8	36.3	34.2	34.2	33.7	30.2	34.2	23.6	28.1	31.5	38.9	31.5	42.2	36.8	38.4	33.7	36.8	32.1	37.5	33.1	33.7
LI	20.5	22.7	12.5	16.8	12.5	17.3	23.1	20.5	18.4	23.2	20.3	25.5	20.0	17.9	17.9	17.3	13.9	17.9	23.9	7.2	15.2	22.5	15.2	25.8	20.5	22.1	17.3	20.5	15.7	21.2	16.8	17.3
LT	24.5	26.7	16.6	20.8	16.6	21.4	27.1	24.5	22.4	27.2	24.3	29.5	24.0	21.9	21.9	21.4	17.9	21.9	27.9	15.8	11.3	26.6	19.2	29.9	24.5	26.1	21.4	24.5	19.8	25.2	20.8	21.4
LU	20.6	22.8	12.7	16.9	12.7	17.4	23.2	20.6	18.5	23.3	20.4	25.6	20.1	18.0	18.0	17.4	14.0	18.0	24.0	11.9	15.3	21.6	15.3	25.9	20.6	22.2	17.4	20.6	15.8	21.3	16.9	17.4
LV	24.5	26.7	16.6	20.8	16.6	21.4	27.1	24.5	22.4	27.2	24.3	29.5	24.0	21.9	21.9	21.4	17.9	21.9	27.9	15.8	19.2	26.6	11.3	29.9	24.5	26.1	21.4	24.5	19.8	25.2	20.8	21.4
MT	39.5	41.7	31.6	35.8	31.6	36.4	42.1	39.5	37.4	42.2	39.3	44.5	39.0	36.9	36.9	36.4	32.9	36.9	42.9	30.8	34.2	41.6	34.2	26.3	39.5	41.1	36.4	39.5	34.8	40.2	35.8	36.4
NL	32.0	34.2	24.1	28.3	24.1	28.9	34.6	32.0	29.9	34.7	31.8	37.0	31.5	29.4	29.4	28.9	25.4	29.4	35.4	23.3	26.7	34.1	26.7	37.4	18.8	33.6	28.9	32.0	27.3	32.7	28.3	28.9
NO	34.3	36.5	26.3	30.6	26.3	31.1	36.9	34.3	32.2	37.0	34.0	39.3	33.8	31.6	31.6	31.1	27.6	31.6	37.7	25.6	29.0	36.3	29.0	39.6	34.3	21.0	31.1	34.3	29.5	35.0	30.6	31.1
PL	27.5	29.7	19.6	23.8	19.6	24.4	30.1	27.5	25.4	30.2	27.3	32.5	27.0	24.9	24.9	24.4	20.9	24.9	30.9	18.8	22.2	29.6	22.2	32.9	27.5	29.1	14.2	27.5	22.8	28.2	23.8	24.4
PT	32.0	34.2	24.1	28.3	24.1	28.9	34.6	32.0	29.9	34.7	31.8	37.0	31.5	29.4	29.4	28.9	25.4	29.4	35.4	23.3	26.7	34.1	26.7	37.4	32.0	33.6	28.9	18.8	27.3	32.7	28.3	28.9
RO	25.3	27.5	17.3	21.6	17.3	22.1	27.9	25.3	23.2	28.0	25.0	30.3	24.8	22.6	22.6	22.1	18.6	22.6	28.7	16.6	20.0	27.3	20.0	30.6	25.3	26.9	22.1	25.3	12.0	26.0	21.6	22.1
SE	33.0	35.2	25.0	29.3	25.0	29.8	35.6	33.0	30.9	35.7	32.8	38.0	32.5	30.4	30.4	29.8	26.4	30.4	36.4	24.3	27.7	35.0	27.7	38.3	33.0	34.6	29.8	33.0	28.2	19.7	29.3	29.8
SI	26.8	29.0	18.8	23.1	18.8	23.6	29.4	26.8	24.7	29.5	26.5	31.8	26.3	24.1	24.1	23.6	20.1	24.1	30.2	18.1	21.5	28.8	21.5	32.1	26.8	28.4	23.6	26.8	22.0	27.5	13.5	23.6
SK	27.5	29.7	19.6	23.8	19.6	24.4	30.1	27.5	25.4	30.2	27.3	32.5	27.0	24.9	24.9	24.4	20.9	24.9	30.9	18.8	22.2	29.6	22.2	32.9	27.5	29.1	24.4	27.5	22.8	28.2	23.8	14.2

Notes: The rates represent an effective tax burden of developing a patent in country indicated in the first column and afterwards selling it to the country shown in the top row. Values on the diagonal correspond to the domestic investment scenario presented in Figure 6.2. A regular tax system implies that no R&D tax incentives are considered here. Country codes and the corresponding country names are in the list of country abbreviations.

a sale to a subsidiary in Switzerland will result in a rate of 25.5%. In all countries, effective taxation is higher in the cross-border case compared to a domestic investment (diagonal line of Table 6.7). This is due to the capital gains tax, which is paid when a patent is sold from one country to another and which is why a multinational firm under a regular tax system profits the most if it keeps a patent in the country where it was developed.

6.4.2.2 Incorporating R&D Tax Incentives into the Devereux and Griffith Model

Table 6.7 contains the effective tax rates that are due under a regular tax system. By contrast, Table 6.8 presents the results of calculating the effective cross-border taxation of patent development and sale after taking into consideration R&D tax incentives shown in Tables 6.1 and 6.2. The difference between these two cases represents a reduction in the effective tax burden caused by the R&D tax incentives. It is important to note that in a cross-border case the input-oriented fiscal incentives are only relevant for a parent firm which conducts R&D, whereas the output-oriented incentives are relevant not only for a parent firm but also for its subsidiary which receives profits generated by a patent in the output phase. This is especially true if the country of a subsidiary offers an IP Box that is applicable to an acquired IP, therefore enabling the patent to be developed elsewhere while still receiving the benefits of a local preferential tax treatment.

In line with Table 6.7, the diagonal line highlighted in red in Table 6.8 shows the effective tax rates under the domestic investment scenario. The only difference is the inclusion of R&D tax incentives in Table 6.8. Hence, the values on the diagonal correspond to the ones shown in Figure 6.3. The EATRs that are not represented on the diagonal line reflect the effective taxation in a cross-border case. Here, countries where a patent is developed are shown on the left and countries where it is held afterwards are depicted on the top. As an example, if a patent has been developed in Austria and kept there afterwards, the EATR in this domestic investment scenario equals 8.6%. If an Austrian firm has a subsidiary in Belgium, for instance, and sells a patent to this company, then the effective tax burden in this cross-border case will amount to 24%. The sale of a patent to Bulgaria will result in an EATR of 13.9% and the sale to Switzerland in an EATR of 13.3%.

Table 6.8 Effective Average Tax Rates in Europe (with R&D Tax Incentives), Cross-Border Investment, 2012, %

	AT	BE	BG	CH	CY	CZ	DE	DK	EE	ES	FI	FR	GB	GR	HR	HU	IE	IS	IT	LI	LT	LU	LV	MT	NL	NO	PL	PT	RO	SE	SI	SK
AT	8.6	24.0	13.9	13.3	9.9	18.7	24.4	21.9	19.7	24.5	21.6	26.9	21.3	19.2	19.2	1.9	15.2	19.2	25.3	9.4	16.6	23.9	16.6	8.6	21.9	23.5	18.7	21.9	17.1	22.6	18.1	18.7
BE	31.3	3.3	23.3	22.7	19.3	28.1	33.9	31.3	29.2	33.9	31.0	36.3	30.8	28.6	28.6	11.3	24.6	28.6	34.7	18.9	26.0	33.3	26.0	18.0	31.3	32.9	28.1	31.3	26.5	32.0	27.6	28.1
BG	20.8	23.0	7.5	12.2	8.8	17.6	23.4	20.8	18.7	23.5	20.5	25.8	20.3	18.1	18.1	0.8	14.1	18.1	24.2	8.4	15.5	22.8	15.5	7.5	20.8	22.4	17.6	20.8	16.0	21.5	17.1	17.6
CH	10.5	12.7	2.6	6.6	-1.4	7.3	13.1	10.5	8.4	13.2	10.3	15.5	10.0	7.9	7.9	-9.4	3.9	7.9	13.9	-1.9	5.2	12.6	5.2	-2.8	10.5	12.1	7.3	10.5	5.7	11.2	6.8	7.3
CY	13.9	16.1	6.0	5.3	2.6	10.7	16.5	13.9	11.8	16.6	13.7	18.9	13.4	11.3	11.3	-6.1	7.3	11.3	17.3	5.2	8.6	16.0	8.6	0.6	13.9	15.5	10.7	13.9	9.1	14.6	10.2	10.7
CZ	8.2	10.4	0.2	-0.4	-3.8	-5.1	10.8	8.2	6.1	10.9	7.9	13.2	7.7	5.6	5.6	-11.8	1.6	5.6	11.6	-4.2	2.9	10.2	2.9	-5.1	8.2	9.8	5.0	8.2	3.4	8.9	4.5	5.0
DE	35.7	37.8	27.7	27.0	23.7	32.5	22.4	35.7	33.5	38.3	35.4	40.7	35.1	33.0	38.3	15.7	29.0	33.0	39.1	23.2	30.3	37.7	30.3	22.4	35.7	37.3	32.5	35.7	30.9	36.4	31.9	32.5
DK	32.0	34.2	24.1	23.4	20.1	28.9	34.6	18.8	29.9	34.7	31.8	37.0	31.5	29.4	29.4	12.1	25.4	29.4	35.4	19.6	26.7	34.1	26.7	18.8	32.0	33.6	28.9	32.0	27.3	32.7	28.3	28.9
EE	29.0	31.2	21.1	20.4	17.1	25.9	31.6	29.0	15.8	31.7	28.8	34.0	28.5	26.4	26.4	9.1	22.4	26.4	32.4	16.6	23.7	31.1	23.7	15.8	29.0	30.6	25.9	29.0	24.3	29.7	25.3	25.9
ES	10.4	12.5	2.4	1.7	-1.6	7.2	12.9	10.4	8.2	-17.0	10.1	15.4	9.8	7.7	7.7	-9.6	3.7	7.7	13.8	-2.1	5.0	12.4	5.0	-2.9	10.4	12.0	7.2	10.4	5.6	11.0	6.6	7.2
FI	31.7	33.8	23.7	23.1	19.7	28.5	34.2	31.7	29.5	34.3	18.4	36.7	31.1	29.0	29.0	11.7	25.0	29.0	35.1	19.2	26.4	33.7	26.4	18.4	31.7	33.3	28.5	31.7	26.9	32.4	27.9	28.5
FR	8.6	10.7	0.6	0.0	-3.4	5.4	11.1	8.6	6.4	11.2	8.3	-18.9	8.0	5.9	5.9	-11.4	1.9	5.9	12.0	-3.9	3.3	10.6	3.3	-4.7	8.6	10.2	5.4	8.6	3.8	9.3	4.8	5.4
GB	24.0	26.1	16.0	15.4	12.0	20.8	26.5	24.0	21.8	26.6	23.7	29.0	-19.5	21.3	21.3	4.0	17.3	21.3	27.4	11.5	18.7	26.0	18.7	10.7	24.0	25.6	20.8	24.0	19.2	24.7	20.2	20.8
GR	28.3	30.5	20.3	19.7	16.3	25.1	30.9	28.3	26.2	31.0	28.0	33.3	27.8	15.0	25.6	8.3	21.6	25.6	31.7	15.9	23.0	30.3	23.0	15.0	28.3	29.9	25.1	28.3	23.5	29.0	24.6	25.1
HR	7.9	10.1	0.0	-0.7	-4.0	4.8	10.5	7.9	5.8	10.6	7.7	12.9	7.4	5.3	-5.4	-12.0	1.3	5.3	11.3	-4.5	2.6	10.0	2.6	-5.4	7.9	9.5	4.8	7.9	3.2	8.6	4.2	4.8
HU	8.2	10.4	0.2	-0.4	-3.8	5.0	10.8	8.2	6.1	10.9	7.9	13.2	7.7	5.6	5.6	-2.5	1.6	5.6	11.6	-4.2	2.9	10.2	2.9	-5.1	8.2	9.8	5.0	8.2	3.4	8.9	4.5	5.0
IE	-2.8	-0.6	-10.7	-11.4	-14.7	-6.0	-0.2	-2.8	-4.9	-0.1	-3.0	2.2	-3.3	-5.4	-5.4	-22.7	-16.1	-5.4	0.6	-15.2	-8.1	-0.7	-8.1	-16.1	-2.8	-1.2	-6.0	-2.8	-7.6	-2.1	-6.5	-6.0
IS	7.9	10.1	0.0	-0.7	-4.0	4.8	10.5	7.9	5.8	10.6	7.7	12.9	7.4	5.3	5.3	-12.0	1.3	-5.4	11.3	-4.5	2.6	10.0	2.6	-5.4	7.9	9.5	4.8	7.9	3.2	8.6	4.2	4.8
IT	36.8	39.0	28.9	28.2	24.9	33.7	39.4	36.8	34.7	39.5	36.6	41.8	36.3	34.2	34.2	16.9	30.2	34.2	23.6	24.4	31.5	38.9	31.5	23.5	36.8	38.4	33.7	36.8	32.1	37.5	33.1	33.7
LI	14.7	16.9	6.7	6.1	2.7	11.5	17.3	14.7	12.6	17.4	14.4	19.7	14.2	12.0	12.0	-5.3	8.0	12.0	18.1	1.4	9.4	16.7	9.4	1.4	14.7	16.3	11.5	14.7	9.9	15.4	11.0	11.5
LT	-6.0	-3.8	-14.0	-14.6	-17.9	-9.2	-3.4	-6.0	-8.1	-3.3	-6.2	-1.0	-6.5	-8.6	-8.6	-26.0	-12.6	-8.6	-2.6	-18.4	-46.5	-4.0	-11.3	-19.3	-6.0	-4.4	-9.2	-6.0	-10.8	-5.3	-9.7	-9.2
LU	14.8	17.0	6.8	6.2	2.9	11.6	17.4	14.8	12.7	17.5	14.6	19.8	14.3	12.2	12.2	-5.2	8.2	12.2	18.2	2.4	9.5	6.3	9.5	1.5	14.8	16.4	11.6	14.8	10.0	15.5	11.1	11.6
LV	24.5	26.7	16.6	15.9	12.6	21.4	27.1	24.5	22.4	27.2	24.3	29.5	24.0	21.9	21.9	4.6	17.9	21.9	27.9	12.1	19.2	26.6	11.3	11.2	24.5	26.1	21.4	24.5	19.8	25.2	20.8	21.4
MT	13.3	15.5	5.3	4.7	1.3	10.1	15.9	13.3	11.2	16.0	13.0	18.3	12.8	10.6	10.6	-6.7	6.6	10.6	16.7	0.9	8.0	15.3	8.0	0.0	13.3	14.9	10.1	13.3	8.5	14.0	9.6	10.1
NL	15.0	17.2	7.0	6.4	3.0	11.8	17.6	15.0	12.9	17.7	14.7	20.0	14.5	12.4	12.4	-5.0	8.4	12.4	18.4	2.6	9.7	17.0	9.7	1.7	1.7	16.6	11.8	15.0	10.2	15.7	11.3	11.8
NO	16.0	18.1	8.0	7.4	4.0	12.8	18.5	16.0	13.9	18.6	15.7	21.0	15.4	13.3	13.3	-4.0	9.3	13.3	19.4	3.5	10.7	18.0	10.7	2.7	16.0	2.7	-20.8	16.0	11.2	16.7	12.3	12.8
PL	27.5	29.7	19.6	18.9	15.6	24.4	30.1	27.5	25.4	30.2	27.3	32.5	27.0	24.9	24.9	7.6	20.9	24.9	30.9	15.1	22.2	29.6	22.2	14.3	27.5	29.1	14.2	27.5	22.8	28.2	23.8	24.4
PT	-1.0	1.1	-9.0	-9.6	-13.0	-4.2	1.5	-1.0	-3.2	1.6	-1.3	4.0	-1.6	-3.7	-3.7	-21.0	-7.7	-3.7	2.4	-13.5	-6.3	1.0	-6.3	-14.3	-1.0	0.6	-4.2	-14.3	-5.8	-0.3	-4.7	-4.2
RO	22.0	24.2	14.1	13.4	10.1	18.8	24.6	22.0	19.9	24.7	21.8	27.0	21.5	19.4	19.4	2.1	15.4	19.4	25.4	9.6	16.7	24.1	16.7	8.7	22.0	23.6	18.8	22.0	-26.1	22.7	18.3	18.8
SE	33.0	35.2	25.0	24.4	21.1	29.8	35.6	33.0	30.9	35.7	32.8	38.0	32.5	30.4	30.4	13.0	26.4	30.4	36.4	20.6	27.7	35.0	27.7	19.7	33.0	34.6	29.8	33.0	28.2	19.7	29.3	29.8
SI	19.5	21.6	11.5	10.9	7.5	16.3	22.0	19.5	17.3	22.1	19.2	24.5	18.9	16.8	16.8	-0.5	12.8	16.8	22.9	7.0	14.2	21.5	14.2	6.2	19.5	21.1	16.3	19.5	14.7	20.2	-26.6	16.3
SK	27.5	29.7	19.6	18.9	15.6	24.4	30.1	27.5	25.4	30.2	27.3	32.5	27.0	24.9	24.9	7.6	20.9	24.9	30.9	15.1	22.2	29.6	22.2	14.3	27.5	29.1	24.4	27.5	22.8	28.2	23.8	14.2

Notes: The rates represent an effective tax burden of developing a patent in country indicated in the first column and afterwards selling it to the country shown in the top row. Values on the diagonal correspond to the domestic investment scenario presented in Figure 6.3. Input- and output-oriented R&D tax incentives are included. Country codes and the corresponding country names are in the list of country abbreviations.

6.4.2.3 The Impact of R&D Tax Incentives on Effective Tax Burdens

In order to see the magnitude of the advantage that R&D tax incentives are giving companies, Table 6.9 presents the differentials between the EATRs shown in Table 6.7 and Table 6.8. They can be interpreted as the reductions in the effective tax burden caused by R&D tax incentives. Parallel to Tables 6.7 and 6.8, the diagonal values of Table 6.9 show the decreases in the effective taxation under a domestic investment scenario. The non-diagonal values represent reductions in a cross-border case. For example, if an Austrian firm develops a patent and keeps it afterwards, the Austrian R&D tax credit reduces its effective tax rate by 10.2 percentage points. If this firm decides to sell the patent to a company in Belgium or Bulgaria, the effective tax burden decreases by 10.2 percentage points as well. However, if it sells the intangible to a subsidiary in Switzerland, the EATR decreases by 15.1 percentage points.

Two main conclusions can be drawn from Table 6.9. First, R&D tax incentives in the country of a patent's development (shown in the first column of Table 6.9) reduce the effective taxation of a cross-border investment. This reduction mitigates the unfavorable effect of the capital gains tax on a cross-border sale of a patent. Therefore, the separation of a patent's development from the location of its further ownership becomes more attractive for multinational enterprises when R&D tax incentives are in place. However, these incentives do not fully make up for the capital gains tax and because of this a domestic investment remains more favorable for a company than a cross-border one, as demonstrated in the case of an Austrian parent and its Belgian subsidiary. Even though the effective tax burden of a cross-border investment between Austria and Belgium is reduced by 10.2 percentage points after the introduction of an R&D tax credit (see Table 6.9), the effective tax rate in this cross-border case is 24% and is therefore still higher than the EATR of 8.6% under a domestic investment scenario (see Table 6.8).

Secondly, IP Boxes in the countries of a patent's final owner (shown in the top row of Table 6.9) might further reduce the effective tax burden of a cross-border investment. This occurs when the beneficial tax treatment applies to both the self-developed and acquired patents. According to Table 6.2, countries which offer such IP Boxes include Cyprus, Hungary, Liechtenstein, Malta, and Switzerland. These IP Boxes are so generous that the total reduction of the EATR in cross-border investment often exceeds the one in a domestic investment case. For example, if an Austrian firm decides to sell a patent to its Hungarian subsidiary, the consideration of R&D tax incentives in both countries reduces the EATR by 27 percentage

Table 6.9 Reductions in EATRs after Including R&D Tax Incentives into the Devereux and Griffith Model, Cross-Border Investment, Percentage Points

	AT	BE	BG	CH	CY	CZ	DE	DK	EE	ES	FI	FR	GB	GR	HR	HU	IE	IS	IT	LI	LT	LU	LV	MT	NL	NO	PL	PT	RO	SE	SI	SK
AT	10.2	10.2	10.2	15.1	14.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2	27.0	10.2	10.2	10.2	13.9	10.2	10.2	10.2	28.8	10.2	10.2	10.2	10.2	10.2	10.2	10.2	10.2
BE	4.5	19.1	4.5	9.4	8.4	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	21.2	4.5	4.5	4.5	8.2	4.5	4.5	4.5	23.1	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
BG	-	-	-	4.9	4.0	-	-	-	-	-	-	-	-	-	-	16.8	-	-	-	3.7	-	-	-	18.6	-	-	-	-	-	-	-	-
CH	16.3	16.3	16.3	6.9	20.2	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3	33.1	16.3	16.3	16.3	20.0	16.3	16.3	16.3	34.9	16.3	16.3	16.3	16.3	16.3	16.3	16.3	16.3
CY	1.9	1.9	1.9	6.8	4.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	18.7	1.9	1.9	1.9	1.9	1.9	1.9	1.9	20.5	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
CZ	19.3	19.3	19.3	24.2	23.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	36.1	19.3	19.3	19.3	23.0	19.3	19.3	19.3	37.9	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3
DE	-	-	-	4.9	4.0	-	-	-	-	-	-	-	-	-	-	16.8	-	-	-	3.7	-	-	-	18.6	-	-	-	-	-	-	-	-
DK	-	-	-	4.9	4.0	-	-	-	-	-	-	-	-	-	-	16.8	-	-	-	3.7	-	-	-	18.6	-	-	-	-	-	-	-	-
EE	-	-	-	4.9	4.0	-	-	-	-	-	-	-	-	-	-	16.8	-	-	-	3.7	-	-	-	18.6	-	-	-	-	-	-	-	-
ES	25.4	25.4	25.4	30.3	29.4	25.4	25.4	25.4	25.4	39.5	25.4	25.4	25.4	25.4	25.4	42.2	25.4	25.4	25.4	29.2	25.4	25.4	25.4	44.1	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4
FI	-	-	-	4.9	4.0	-	-	-	-	-	-	-	-	-	-	16.8	-	-	-	3.7	-	-	-	18.6	-	-	-	-	-	-	-	-
FR	30.5	30.5	30.5	35.4	34.5	30.5	30.5	30.5	30.5	30.5	30.5	44.7	30.5	30.5	30.5	47.3	30.5	30.5	30.5	34.2	30.5	30.5	30.5	49.1	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
GB	7.3	7.3	7.3	12.2	11.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	37.5	7.3	7.3	24.1	7.3	7.3	7.3	11.0	7.3	7.3	7.3	25.9	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
GR	-	-	-	4.9	4.0	-	-	-	-	-	-	-	-	-	-	16.8	-	-	-	3.7	-	-	-	18.6	-	-	-	-	-	-	-	-
HR	20.4	20.3	20.3	25.2	24.3	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.3	20.3	20.4	37.1	20.3	20.3	20.4	24.1	20.4	20.4	20.4	39.0	20.4	20.4	20.4	20.4	20.4	20.3	20.4	20.4
HU	19.3	19.3	19.3	24.2	23.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3	16.8	19.3	19.3	19.3	23.0	19.3	19.3	19.3	37.9	19.3	19.3	19.3	19.3	19.3	19.3	19.3	19.3
IE	25.4	25.4	25.4	30.3	29.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4	42.2	25.4	25.4	25.4	29.2	25.4	25.4	25.4	44.1	25.4	25.4	25.4	25.4	25.4	25.4	25.4	25.4
IS	20.4	20.3	20.3	25.2	24.3	20.4	20.4	20.4	20.4	20.4	20.4	20.4	20.3	20.3	20.3	37.1	20.3	20.4	20.4	24.1	20.4	20.4	20.4	39.0	20.4	20.4	20.4	20.4	20.4	20.3	20.4	20.4
IT	-	-	-	4.9	4.0	-	-	-	-	-	-	-	-	-	-	16.8	-	-	-	3.7	-	-	-	18.6	-	-	-	-	-	-	-	-
LI	5.8	5.8	5.8	10.7	9.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	22.6	5.8	5.8	5.8	5.8	5.8	5.8	5.8	24.4	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
LT	30.5	30.5	30.5	35.4	34.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5	47.3	30.5	30.5	30.5	34.2	57.7	30.5	30.5	49.1	30.5	30.5	30.5	30.5	30.5	30.5	30.5	30.5
LU	5.8	5.8	5.8	10.7	9.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	22.6	5.8	5.8	5.8	9.5	5.8	15.3	5.8	24.4	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8
LV	-	-	-	4.9	4.0	-	-	-	-	-	-	-	-	-	-	16.8	-	-	-	3.7	-	-	-	18.6	-	-	-	-	-	-	-	-
MT	26.3	26.3	26.3	31.1	30.2	26.3	26.3	26.3	26.3	26.3	26.2	26.2	26.3	26.2	26.2	43.0	26.3	26.2	26.2	30.0	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3
NL	17.0	17.0	17.0	21.9	21.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	33.8	17.0	17.0	17.0	20.7	17.0	17.0	17.0	35.6	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0
NO	18.3	18.3	18.3	23.2	22.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	35.1	18.3	18.3	18.3	22.0	18.3	18.3	18.3	36.9	18.3	18.3	51.9	18.3	18.3	18.3	18.3	18.3
PL	-	-	-	4.9	4.0	-	-	-	-	-	-	-	-	-	-	16.8	-	-	-	3.7	-	-	-	18.6	-	-	-	-	-	-	-	-
PT	33.1	33.1	33.1	38.0	37.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1	49.9	33.1	33.1	33.1	36.8	33.1	33.1	33.1	51.7	33.1	33.1	33.1	33.1	33.1	33.1	33.1	33.1
RO	3.3	3.3	3.3	8.1	7.2	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	20.0	3.3	3.3	3.3	7.0	3.3	3.3	3.3	21.9	3.3	3.3	3.3	3.3	38.1	3.3	3.3	3.3
SE	-	-	-	4.9	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.8	-	-	-	3.7	-	-	-	18.6	-	-	-	-	-	-	-	-
SI	7.3	7.3	7.3	12.2	11.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	24.1	7.3	7.3	7.3	11.0	7.3	7.3	7.3	25.9	7.3	7.3	7.3	7.3	7.3	7.3	40.1	7.3
SK	-	-	-	4.9	4.0	-	-	-	-	-	-	-	-	-	-	16.8	-	-	-	3.7	-	-	-	18.6	-	-	-	-	-	-	-	-

Notes: Table shows the differences between EATRs in Table 6.7 and EATRs in Table 6.8. It illustrates how much the effective tax rates are reduced by when R&D tax incentives are introduced in the Devereux and Griffith model. Values on the diagonal correspond to the domestic investment scenario shown in Figure 6.4. Country codes and the corresponding country names are in the list of country abbreviations.

points (see Table 6.9). The effective tax burden then becomes 1.9%, which is lower than the EATR of 8.6% under a domestic investment scenario (see Table 6.8).

In summary, the analyses presented in sections 6.4.1 and 6.4.2 show that R&D tax incentives lower the effective tax burdens of firms. This is particularly true in relation to the domestic investment scenario, where a patent is developed and afterwards held in the same country. If a patent is sold or transferred to another country (a cross-border investment), a capital gains tax applies on this transaction to compensate for the separation between the intangible's place of development and the location of where its profits are taxed. However, even with the capital gains taxation, a multinational may still take advantage of R&D tax incentives to minimize its effective tax burden in a cross-border investment scenario. For example, input-oriented tax incentives in a parent firm's country might mitigate the unfavorable effect of a capital gains tax by lowering the effective tax burden in a cross-border investment case. Moreover, the effective tax rate in a cross-border case might total an even lower rate than the EATR in a domestic investment scenario. This occurs when both the country of a patent's developer and the country of its final owner offer generous R&D tax incentives, such as IP Boxes for acquired intangible assets. As a result, these R&D tax incentives may not only contribute to fostering research and development in the countries of their implementation but could also be used by multinational enterprises for tax planning. However, as mentioned in section 6.2.2.2, the OECD Nexus Approach might close this loophole in tax regulations. Countries such as Belgium, the Netherlands, and Spain have already implemented this approach within the scope of their IP Boxes and as a result they now permit preferential tax treatment only for self-developed and not acquired intellectual property.

6.5 The Use of R&D Tax Incentives in Tax Planning: A Quantitative Analysis

6.5.1 Literature Review

The previous section has pointed out that R&D tax incentives might substantially reduce effective taxation of developing and relocating a patent. As a result, these incentives provide two major advantages for companies: the first advantage is that they reduce the costs of conducting research and development. The second advantage these incentives provide is the use they have in strategically relocating intangible assets with the purpose of reducing a multinational's overall tax liability. We test this hypothesis in this section by empirically analyzing whether R&D tax incentives are used by multinational enterprises for profit shifting and in doing so we contribute to two strands of empirical literature. The first one includes studies on the effectiveness of R&D tax incentives and their influence on a firm's productivity and innovation. The second strand of literature comprises empirical papers on profit shifting by multinational enterprises, in particular by means of intellectual property.

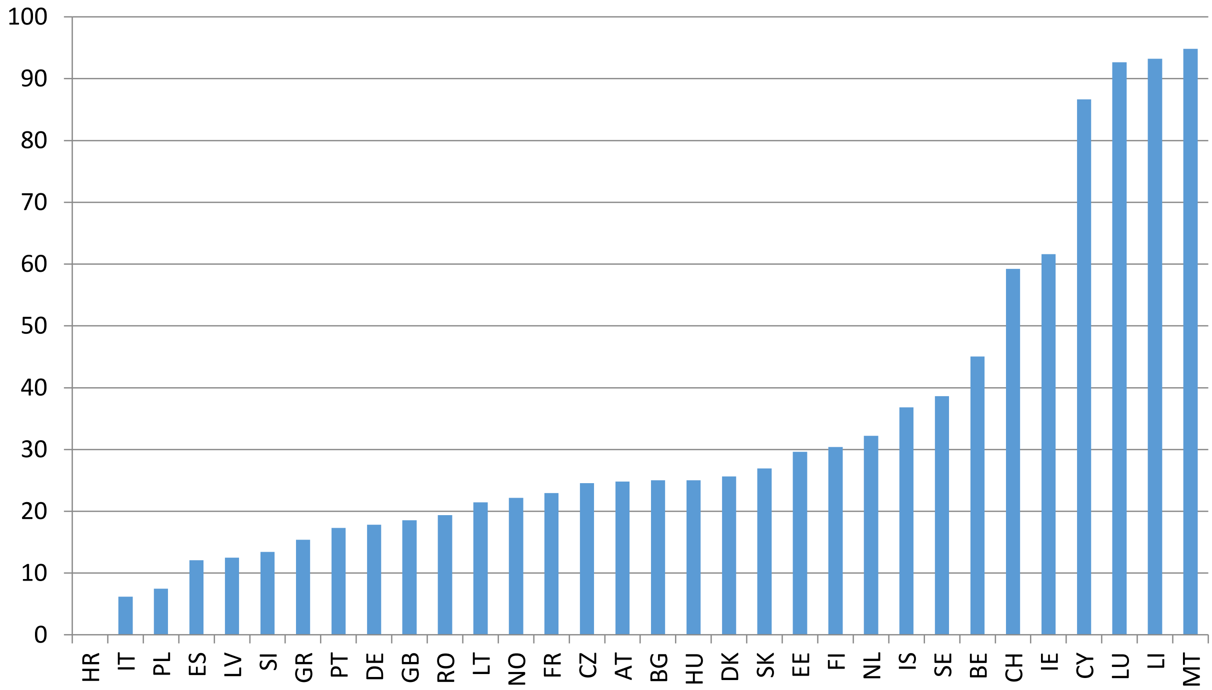
As described in section 6.3, Bloom et al. (2002), Baghana and Mohnen (2009), Ernst and Spengel (2011), Lokshin and Mohnen (2012), Thomson (2015), and many other studies have found a positive effect of decreasing user costs or the B-Index on R&D expenditure using firm-level or country-level data. These authors conclude that input-oriented fiscal incentives for R&D effectively foster research and development. Yang et al. (2012), Bozio et al. (2014), Kobayashi (2014), and Guceri (2017) confirm this finding by evaluating the effects of the reforms that have introduced input-oriented R&D tax incentives. By contrast, the literature on output-oriented tax incentives establishes that they have a positive effect on a firm's number of intangibles but does not confirm a simultaneous increase in real R&D activity, as Alstadsæter et al. (2015) conclude. While these studies investigate the impact of fiscal incentives on a company's innovative activity, we contribute to this literature by examining in more detail the use of tax incentives in profit shifting.

Numerous empirical and theoretical studies investigate the use of intangible assets in profit shifting. These studies argue that multinational enterprises strategically allocate intangible assets at low-tax subsidiaries in order to shift profits via royalty payments from high-tax to low-tax group members. Ernst and Spengel (2011), Karkinsky and Riedel (2012), Griffith et al. (2014), Alstadsæter et al. (2015), Böhm et al. (2015), Dinkel and Schanz (2015), and Bradley et al. (2015) investigate the association between corporate taxation and the location of intangible assets using data on patent applications at the international patent registration offices. This data contains information on companies that apply for an international protection of their inventions and therefore reveals patents' legal owners. According to these studies, an increasing statutory corporate income tax rate negatively influences the probability of patent ownership at MNE affiliates in this country. Our analysis closely relates to these studies and contributes to them by focusing not just on the strategic allocation of intellectual property but rather on the separation of IP ownership. Thus, we analyze whether, and if so, to what extent regular corporate tax systems and tax incentives for research and development influence the international collaboration in patents, which is defined as a patent's development in one country and its subsequent registration abroad.

6.5.2 Data

Our empirical analysis employs the OECD database *International Co-Operation in Patents*,[251] which includes bilateral data on the number of patents developed in one country and registered in another one afterwards. Following the qualitative analysis presented in the previous part of the paper, we focus on the 28 member states of the European Union and four members of the European Free Trade Association (Iceland, Liechtenstein, Norway, and Switzerland). Therefore, our sample includes 992 country-pairs and we observe the co-operation in patents between these countries in 2012 and compare it with the year 1995. Figure 6.6 presents descriptive statistics on international co-operation in patents in 2012.

Figure 6.6 A Ratio of Patents Developed Abroad in Relation to Total Patents, 2012, %



Notes: Country codes and the corresponding country names are in the list of country abbreviations. Source: OECD, database *International Co-operation in Patents.*

[251] See OECD (2016c).

Figure 6.6 shows a ratio of patents developed abroad in relation to total patents registered in a given country. What becomes apparent from the figure is that over 80% of the total patents held in Malta, Liechtenstein, Luxembourg, and Cyprus were developed elsewhere and over 40% of patents located in Ireland, Switzerland, and Belgium originated abroad. We investigate the relationship between taxation and the country's co-operation in patents further in our empirical analysis using information on international collaboration in patents as a dependent variable. Since in our dataset there is no exchange of patents between country-pairs in 65% of cases, we are interested in analyzing the extensive margin of the co-operation in patents. Hence, the dependent variable in this case is equal to one if there is any relocation of patents between two countries and equals zero otherwise. In order to investigate the intensive margin, we additionally use a total number of patents relocated from one country to another as a dependent variable. In addition, we normalize this variable by building a ratio of patents relocated from one country to another in relation to a total number of foreign patents held by a host country.

The effective tax rates with and without considering R&D tax incentives serve as the main independent variables of interest. We extract them from Tables 6.7 and 6.8 for 2012 and additionally calculate the corresponding values for 1995. Section 6.4 describes in detail the calculation of effective tax burden using the Devereux and Griffith model. Apart from this, we include a few further controls into our estimation. For example, in line with Dischinger and Riedel (2011), Karkinsky and Riedel (2012), and Griffith et al. (2014), we control for the level of innovation in a country where a patent is registered. This variable is proxied by a country's total R&D expenditure, the information on which comes from the OECD database called *Gross Domestic Expenditure on R-D by Sector of Performance and Source of Funds*.[252] Following Dischinger and Riedel (2011), Ernst and Spengel (2011), Karkinsky and Riedel (2012), Ernst et al. (2014), Griffith et al. (2014), we also control for a country's market size, its wealth, and governance situation. This is done by including into the estimation *Log(Population), Log(GDP/capita)*, and *Property Rights* respectively. We collected statistics on gross domestic product (GDP) per-capita and population from the World Bank's *Development Indicators*[253] and for data on intellectual property rights protection we consulted the Heritage Foundation.[254]

[252] See OECD (2016a).
[253] See World Bank (2015).
[254] See Heritage Foundation (2017).

Table 6.10 presents the key descriptive statistics of the variables that enter the regression estimation. The table is divided into two panels: Panel A shows statistics for the sample of 1995 and Panel B presents a summary for the sample of 2012. The first three variables are used as dependent variables in different specifications. As it can be seen from the table, the first one is a binary variable and the other two are strictly positive. The maximum number of patents developed in one country and registered in another one amounts to 374 in 1995 and 1,056 in 2012, while the average equals 4.21 in 1995 and 12.17 in 2012. What these results suggest is that international co-operation in patents seems to have grown during these years.

Table 6.10 Descriptive Statistics

Panel A. Sample of 1995

	Obs.	Mean	Std. Dev.	Min	Max
Dummy Patents	992	0.24	0.43	0.00	1.00
Number of Patents	992	4.21	20.19	0.00	374.00
Ratio of Patents	992	0.02	0.08	0.00	1.00
EATR_regular	992	0.42	0.12	0.07	0.69
EATR_with_incentives	992	0.40	0.12	0.05	0.69
Log(R&D Exp.)	992	6.96	2.09	2.41	10.82
Log(GDP/capita)	992	9.92	0.85	8.24	11.27
Log(Population)	992	15.54	1.72	10.34	18.22
Property Rights	992	68.63	16.78	30.00	90.00

Panel B. Sample of 2012

	Obs.	Mean	Std. Dev.	Min	Max
Dummy Patents	992	0.39	0.48	0.00	1.00
Number of Patents	992	12.17	57.12	0.00	1,056.00
Ratio of Patents	992	0.02	0.06	0.00	0.50
EATR_regular	992	0.27	0.07	0.07	0.45
EATR_with_incentives	992	0.15	0.12	-0.26	0.42
Log(R&D Exp.)	992	7.75	1.85	4.18	11.32
Log(GDP/capita)	992	10.31	0.71	8.86	11.85
Log(Population)	992	15.59	1.69	10.51	18.20
Property Rights	992	72.40	18.23	30.00	90.00

Notes: EATR stands for effective average tax rate. R&D stands for research and development. GDP denotes gross domestic product.

As for the main independent variables of interest, *EATR_regular* represents the effective tax burden on a cross-border collaboration in patents. The values of this variable in 2012 are shown in Table 6.7 and discussed in section 6.4.2.2 and the values for 1995 were calculated separately. *EATR_with_incentives* represents the effective tax burden on a bilateral co-operation in patents after the consideration of R&D tax incentives. The values of this variable are shown in Table 6.8 for 2012 and were additionally calculated for 1995. According to Table 6.10, the average regular EATR decreased from 42% in 1995 to 27% in 2012. The effective tax burden after the consideration of R&D tax incentives fell from 40% in 1995 to 15% in 2012. Hence, we conclude that taxation under a regular system substantially decreased between 1995 and 2012. However, fiscal incentives for research and development have contributed to an even greater fall in the effective corporate tax burden. As for the other control variables, the average spending on R&D, GDP per-capita, population, and a level of property rights protection all increased between 1995 and 2012.

6.5.3 Estimation Approach

The identification strategy of our empirical analysis is based on a difference regression. In other words, we estimate the influence of the change in taxation between 1995 and 2012 on the change in the bilateral co-operation in patent development. This method enables all factors that have remained constant between the two years (such as the distance between countries, their common language, history, culture, and other factors) to be effectively controlled for and is therefore comparable with a country-pair fixed effects estimation.

6.5.3.1 Extensive Margin

As mentioned in the previous section, in 65% of cases there is no exchange of patents between country-pairs in our sample. Hence, we are interested in analyzing the extensive margin of co-operation in patents, which is done using the following specification:

$$B_{ij2012} - B_{ij1995} = \beta_1(\mathrm{EATR_{ij2012}} - \mathrm{EATR_{ij1995}}) + \beta_2\,(\boldsymbol{X'}_{\mathrm{ij2012}} - \boldsymbol{X'}_{\mathrm{ij1995}}) + \\ + \left(\varepsilon_{ij2012} - \varepsilon_{ij1995}\right) \tag{6.14}$$

In equation 6.14, B_{ijt} is a binary variable that equals one if there is any co-operation in patents between country *i* and *j* in year *t* (*t* = 1995, 2012) and zero otherwise. $EATR_{ijt}$ represents either *EATR_regular* or *EATR_with_incentives*, which measure an effective tax burden on co-operation in patents between country *i* and *j*. The first variable reflects taxation under a regular tax system without considering R&D tax incentives and the second one denotes an effective tax burden after incorporating input- and output-oriented fiscal incentives for research and development. The calculation of these variables is described in detail in section 6.4. $\boldsymbol{X'_{ij}}$ is a vector of the host country's characteristics such as *Log(R&D Exp.)*, *Log(Population)*, *Log(GDP/capita)*, and *Property Rights*. Finally, ε_{ij} is an error term.

6.5.3.2 Intensive Margin

As a next step, we exploit the continuous information on co-operation in patents. In this part of the analysis, the model of estimation is defined as follows:

$$\begin{aligned} Patents_{ij2012} - Patents_{ij1995} = {} & \beta_1(\mathrm{EATR}_{\mathrm{ij2012}} - \mathrm{EATR}_{\mathrm{ij1995}}) + \\ & + \beta_2\,(\boldsymbol{X'}_{\mathrm{ij2012}} - \boldsymbol{X'}_{\mathrm{ij1995}}) + (\varepsilon_{ij2012} - \varepsilon_{ij1995}) \end{aligned} \tag{6.15}$$

In equation 6.15, the dependent variable $Patents_{ij}$ takes one of the following two forms: in the first form the variable equals the number of patents developed in country *i* and registered afterwards in country *j*. In the second form the variable equals the ratio of patents developed in *i* and registered in *j* in relation to the total number of patents that arise from international co-operation in patents in country *j*.[255] All other variables are identical to the ones included in equation 6.14.

6.5.4 Results

Table 6.11 presents results of our empirical analysis. In all specifications shown in this table, the units of observation are country-pairs. Panel A shows the outcomes of estimating equation 6.14, which examines the extensive margin of co-operation in patents. Panel B displays the results of estimating equation 6.15 and focuses on the intensive margin of international collaboration in patents. Since the dependent variable in the regressions of Panel A is binary, a

[255] This ratio is analyzed by employing the total number of patents that arise from international co-operation in patents in country *j* as an exposure variable.

Logit estimator is applied here. Columns I and II of Panel A present the outcomes of solely including the main independent variables into the estimation, while columns III and IV add further controls. According to the results, there is a negative correlation between taxation and the probability of two countries co-operating in patent development. The magnitude of the impact of regular taxation seems to be more pronounced than the influence of effective taxation after taking R&D tax incentives into account. This implies that country-pairs place greater emphasis on a regular tax system than on available R&D tax incentives when choosing a partner for collaboration in patent development. This outcome is in line with Ernst and Spengel (2011), Karkinsky and Riedel (2012), Griffith et al. (2014), Böhm et al. (2015), Dinkel and Schanz (2015), Bradley et al. (2015), and other previous studies which establish a significant negative impact of corporate income taxation on the location of intangible assets within multinational groups.

Panel B of Table 6.11 presents the results of analyzing the extensive margin of co-operation in patents. These calculations are carried out using the Poisson pseudo-maximum likelihood (PPML) estimator, which suits an estimation of data concentrated at zero, as Wooldridge (2002) and Westerlund and Wilhelmsson (2011) note. Columns V-VIII show the outcomes of defining the dependent variable as a number of patents developed in country i and registered in country j. Columns IX-XII present the outcomes of employing a ratio of patents originated in i and held in j in relation to a total number of patents of foreign origin registered in j as the dependent variable. In both cases there appears to be a negative and statistically significant correlation between taxation and the intensity of collaboration in patents. However, the economic and statistical importance of tax variables decreases once other controls are added to the specifications (see columns VII-VIII and XI-XII of Table 6.11). In addition, the coefficient on $EATR_{with\_incentives}$ appears to be more negative than the coefficient on $EATR_{regular}$ once other controls are included (see columns VIII and XII). This implies that fiscal incentives play an important role in determining the intensive margin or, in other words, the intensity of co-operation in patents. As for the other control variables, expenses on research and development seem to play a significant role in determining international collaboration in patents. GDP per-capita turns out to be statistically significant only in determining the extensive margin of the co-operation and the level of property rights protection appears to matter only for the intensive margin. The size of the population does not have a statistically significant impact on the international collaboration in patents.

Table 6.11 Empirical Results

Panel A. Extensive Margin

	I	II	III	IV
EATR_regular	-9.342***		-3.789**	
	(1.198)		(1.497)	
EATR_with_incentives		-6.487***		-2.655**
		(0.820)		(1.105)
Log(R&D Exp.)			1.040**	0.928*
			(0.511)	(0.515)
Log(GDP/capita)			2.393*	2.373*
			(1.298)	(1.284)
Log(Population)			0.567	0.207
			(2.636)	(2.600)
Property Rights			-0.015	-0.019
			(0.018)	(0.017)
Observations	992	992	992	992

Panel B. Intensive Margin	Number of Patent Applications				Ratio of Patent Applications			
	V	VI	VII	VIII	IX	X	XI	XII
EATRregular	-4.500***		-0.909*		-4.480***		-0.963**	
	(0.618)		(0.484)		(0.603)		(0.473)	
EATRwith_incentives		-3.353***		-1.115***		-3.321***		-1.125***
		(0.285)		(0.367)		(0.275)		(0.353)
Log(R&D Exp.)			1.007***	0.894***			1.001***	0.893***
			(0.329)	(0.305)			(0.330)	(0.304)
Log(GDP/capita)			0.793	0.505			0.726	0.441
			(0.672)	(0.650)			(0.679)	(0.648)
Log(Population)			0.809	0.682			0.843	0.733
			(0.963)	(0.839)			(0.925)	(0.808)
Property Rights			0.025***	0.025***			0.025***	0.025***
			(0.008)	(0.007)			(0.007)	(0.007)
Observations	992	992	992	992	992	992	992	992

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Robust standard errors are reported in parentheses. Logit model is applied in Panel A and Poisson pseudo-maximum likelihood estimator is used in Panel B. Observational units are country-pairs. The dependent variable in Panel A is binary; it equals one if there is co-operation in patens between a given country-pair and zero otherwise. The dependent variable in columns I-IV of Panel B is the number of patents that were developed in country *i* and registered in country *j*. The dependent variable in columns V-VIII of Panel B is the ratio of patents developed in country *i* and registered in country *j* in relation to a total number of patents with foreign origin registered in country *j*; this ratio is analyzed by employing the denominator as an exposure variable. *EATR_regular* and *EATR_with_incentives* are average effective tax rates on developing a patent in country *i* and holding it in country *j* afterwards; the first one does not include R&D tax incentives, whereas the second one does. *Log (R&D Exp.)* is a logarithm of a country's R&D expenditure. *Log (GDP/capita)* measures GDP per-capita. *Log (Population)* denotes a logarithm of total population. *Property Rights* represents a level of intellectual property rights protection.

6.6 Conclusion

The main objective of this study is to carry out a comprehensive analysis of diverse aspects of R&D tax incentives. To begin with, we examine the economic justification for the state support of research and development and conclude that this type of R&D fostering is necessary because of at least two following reasons. First, R&D causes positive spillovers, since companies may use outcomes of research and development without the possibility of any rivalry or exclusion happening. Even if the outcomes of an R&D process are not successful, there is still a positive spillover effect. Namely, other firms can learn from the unsuccessful experience and either avoid repeating the same mistake in the future or plan their research differently from the very beginning. Secondly, the issue of asymmetric information makes it difficult for creditors to finance risky R&D activities. As a consequence, it may only be low-risk R&D projects that receive financing with the other projects remaining overlooked, even if their potential returns are high.

In addition, the study concludes that fiscal incentives constitute an important part of the state support of R&D. This is because they are easier to implement and are less complex to monitor than, for example, direct R&D grants or subsidies. R&D tax incentives can be divided into two categories according to the stage of an R&D project that they support. Input-oriented incentives comprise tax credits, super-deductions, and other incentives that apply during the development phase of a research project. Output-oriented incentives include IP Boxes and apply during the second phase of an R&D process, which includes managing the profits that an intangible generates or dealing with the losses that have occurred in the case of an unsuccessful investment. We give a detailed overview of the existing input- and output-oriented R&D tax incentives in the EU and EFTA member states. The majority of these countries offer either input- or output-oriented tax incentives, while some countries have even implemented both types of incentives. By contrast, Germany, Estonia, and Sweden are currently the only countries in Europe that do not offer any R&D tax incentives.

Furthermore, the study presents a review of empirical literature on the outcomes of the implementation of input- and output-oriented R&D tax incentives. The empirical evidence on input-oriented R&D tax incentives usually points to a strong positive effect of their introduction on the innovative activity of companies. By contrast, the literature on output-oriented R&D tax incentives does not find robust evidence for an increase in the real R&D activity following an

IP Box introduction. According to the literature review, multinationals might see output-oriented R&D tax incentives as a means of tax planning rather than a tool for boosting their research and development.

Moreover, we apply the Devereux and Griffith model to calculate effective average tax rates with and without the inclusion of R&D tax incentives in the EU and EFTA member states in 2012. With the help of this model, we analyze two cases of an R&D investment. First, the effective tax burden in the case of a domestic investment is calculated. Here, intellectual property is assumed to be developed and afterwards held by the same company, so that the input and output phases of an R&D process take place in the same country. Secondly, the effective taxation in the case of a cross-border investment is determined. In this case, it is assumed that an intangible asset is developed in one country and then sold abroad and because of this the input and output stages of an R&D process occur in different countries. The calculation of effective tax rates using the Devereux and Griffith model shows that R&D tax incentives substantially lower a firm’s total tax burden. This is particularly the case in a domestic investment scenario. If a patent is sold or transferred to another country (a cross-border investment), a capital gains tax applies. However, even in this case input-oriented tax incentives mitigate the capital gains taxation by lowering a multinational’s overall effective tax burden. Moreover, output-oriented R&D tax incentives might lower the EATR in the cross-border case even below the EATR value in a domestic investment case. This occurs when a country allows an IP Box to apply to both the self-developed and acquired intangible assets. Therefore, multinational enterprises might use IP Boxes for tax planning in addition to viewing them as a means of fostering their research and development.

Finally, we employ the OECD data on international co-operation in patents to test whether taxation has an influence on the probability (and intensity) of patents to be developed in one country and subsequently registered in another. According to our main findings, both a regular tax system and R&D tax incentives contribute to the determination of the extensive and intensive margins of the international collaboration in patents. These findings are in line with Ernst and Spengel (2011), Karkinsky and Riedel (2012), Griffith et al. (2014), Böhm et al. (2015), Dinkel and Schanz (2015), and Bradley et al. (2015) and support the main hypothesis of our study showing that firms respond to taxation and fiscal incentives by strategically allocating their patents. This once again implies that some of the R&D tax incentives might be used for tax planning rather than fostering research and development.

As for the policy applications of this study, it can be concluded that R&D tax incentives constitute a vital part of supporting innovation and research and that the design of these incentives is crucial for their economic outcomes. For example, numerous empirical studies have found that input-oriented incentives have a positive impact on real R&D activity. However, this result was not confirmed in the case of output-oriented tax incentives. Output-oriented incentives might substantially reduce the effective tax burden of a cross-border R&D investment and may therefore be used for tax planning purposes by multinational enterprises. On that account, input-oriented R&D tax incentives should be seen as a preferred instrument for fostering research and development. As for the output-oriented incentives, thorough supervision and management are required to ensure that they are used properly by multinational firms and effectively reach their aim of boosting R&D.

Chapter 7

Conclusion

This doctoral thesis qualitatively and quantitatively examines different aspects of base erosion and profit shifting by multinational enterprises, focusing on research areas such as the substitution between profit shifting channels, the effectiveness of anti-avoidance legislation, and the role of intangible assets in BEPS. The thesis consists of five self-contained chapters, the key findings and policy implications of which are summarized in this section.

Chapter 2 defines profit shifting and related concepts, gives an overview of the empirical literature in the field of profit shifting, and discusses the main reform proposals which aim to improve the existing corporate tax system. The key conclusions of this chapter are the following:

- Corporate tax revenues represent a rather small part (around 5%-10%) of total tax revenues in most high-income countries and this trend has remained unchanged for years. Eliminating profit shifting by multinationals could increase this share, although there must be substantial changes in tax regulations in order to bring about a sizable rise in corporate tax revenues.
- The statutory and effective corporate tax rates have been steadily decreasing over the past few decades. However, tax rate decreases and tax policy changes have not been homogeneous in all countries. Nowadays European low-tax countries either have low statutory corporate income tax rates or offer tax regulations and legal arrangements that facilitate profit shifting. Thus, in comparison to members of the Benelux Union or Switzerland, Germany can be still considered a high-tax country.
- Numerous empirical studies confirm the existence of profit shifting by multinational enterprises and identify the main channels of BEPS to include a strategic use of internal debt and intra-firm trade. However, most empirical studies find a rather low (in absolute terms) tax elasticity of reported profits, which suggests that the magnitude of profit shifting is not large.

- There are multiple reform suggestions which aim to eliminate base erosion and profit shifting. While the OECD Action Plan on BEPS and the EU Anti-Tax Avoidance Package attempt to fix the loopholes in the existing tax system, the CCCTB proposal and a few other initiatives support its fundamental change.

Chapter 3 empirically analyzes the substitution between two profit shifting channels: a strategic use of intra-firm trade and related-party debt. The chapter concludes with the following findings:

- An enforcement of strict transfer pricing regulations in high-tax countries leads to an increase in earnings reported by its resident companies. At the same time, an introduction of strict interest deduction limitations in high-tax countries reduces firms' interest payments. These results confirm the effectiveness of these two types of anti-avoidance regulations when they are considered apart from each other.
- There is a substitution between profit shifting via debt and profit shifting via intra-firm trade. Policy makers should consider the substitution between different profit shifting channels when introducing new reforms, since one set of anti-avoidance regulations can prove to be ineffective if other profit shifting channels are left unrestricted.
- In line with Beer and Loeprick (2015), we conclude that IP-intensive companies can engage more easily in base erosion and profit shifting, because the arm's length price on the use of intangibles is often hard to determine and can therefore be more easily manipulated than transfer prices on other transactions or intra-group interest payments. However, the magnitudes of the tax elasticities of both profit shifting channels are rather low, even for IP-intensive firms.

Chapter 4 empirically tests the influence of taxation on bilateral royalty flows and draws the following conclusions and policy implications:

- Corporate taxation negatively influences bilateral royalty flows. In addition, we find that both statutory tax rates and tax differentials between countries affect international royalty exchange. This implies that royalty payments for the use of intellectual property are used by multinational enterprises to shift profits.
- We analyze several reform suggestions within the scope of the OECD Action Plan on BEPS and quantify their potential outcomes. According to our key findings, both rewarding and punitive tax policies suggested by the OECD appear to have an impact on bilateral royalty

flows. While an introduction of strict anti-avoidance regulations decreases bilateral royalty payments, a lack of input-oriented R&D tax incentives seems to encourage royalty outflows and some output-oriented fiscal incentives (such as IP Boxes that are available for acquired intellectual property) appear to attract royalty inflows. Therefore, we conclude that the OECD Action Plan on BEPS is likely to limit the strategic use of intellectual property for profit shifting and will therefore reduce bilateral royalty flows.

Chapter 5 empirically analyzes and compares a strategic allocation of two different types of intangible assets – patents and trademarks. Referring to the differences between these two types of intellectual property, the chapter draws the following conclusions:

- There is a negative relationship between taxation and the location of intangible assets. This outcome confirms the findings of the prior literature in this area of research, suggesting that companies use intangible assets as a means of base erosion and profit shifting. Therefore, effective international regulations are necessary to ensure that taxation of MNEs is based on real economic activity and value creation.
- Moreover, in line with our hypothesis we identify that the tax elasticity of a trademark location choice is more negative than that of a patent location choice. This result confirms that the differences between various types of intangible assets should not be ignored in tax policy considerations. The very nature of a trademark makes it more mobile within a corporate group than a patent and for this reason trademarks have a greater potential to be used as a means of profit shifting in comparison to patents. Therefore, tax regulations and policies should take into consideration the differences between intangible assets and should be designed or adjusted in accordance with these differences. This would, for example, imply that current IP Boxes that allow a preferential tax treatment for both patents and trademarks (Cyprus, Hungary, Liechtenstein, Malta) should be reconsidered and follow the example of the IP Boxes that concentrate on patens only (Belgium, the Netherlands, Portugal, Spain, the UK).
- We analyze several factors that might contribute to the differences in tax elasticities of patent and trademark location choices. For instance, trademarks are usually easier to register and are less costly to develop in comparison to patents. Their development does not typically require detailed documentation and they are less likely to depend on a country's endowment in physical or human capital. In addition to this, we find empirical evidence which suggests that the less negative tax elasticity of patents in comparison to trademarks

might be at least partially due to the agglomeration effect. In other words, patents may be less sensitive to taxation than trademarks because they are more likely to be registered in the country where the rest of the patent family is located.

Chapter 6 qualitatively and quantitatively examines diverse aspects of fiscal incentives for research and development. The main findings and policy implications of this chapter can be summarized as following:

- Economic justification for the state support of research and development includes the existence of positive spillovers from R&D and the presence of asymmetric information in the credit markets.
- Fiscal incentives constitute an important part of the state support of R&D and can be divided into input-oriented and output-oriented incentives, depending on the stage of an R&D process that they foster. A detailed overview of the existing fiscal incentives in the EU and EFTA member states shows that the majority of these countries offer either input- or output-oriented tax incentives, with some countries having implemented both. By contrast, Germany, Estonia, and Sweden are currently the only countries in Europe that do not offer any R&D tax incentives.
- A review of literature on the outcomes of R&D tax incentives indicates that the empirical evidence on input-oriented R&D tax incentives points to a strong positive effect of their introduction on the innovative activity of the corporate sector. By contrast, the literature on output-oriented R&D tax incentives does not find robust evidence for an increase in the real R&D activity following the introduction of IP Boxes.
- We apply the Devereux and Griffith model to calculate effective average tax rates with and without R&D tax incentives in Europe in 2012. According to our calculations, R&D tax incentives substantially lower a firm’s effective tax burden. This is particularly evident in a domestic investment scenario. If a patent is sold to another country (a cross-border investment), a capital gains tax applies and input-oriented tax incentives appear to mitigate the negative effect of the capital gains taxation by lowering a multinational’s overall effective tax burden. Moreover, output-oriented R&D tax incentives might lower the EATR in the cross-border case even below the EATR value in a domestic investment case. This occurs when a country allows an IP Box to apply to both the self-developed and acquired intangible assets.

- Finally, we empirically analyze the effects of fiscal incentives for research and development and find that both a regular tax system and R&D tax incentives contribute to the determination of the extensive and intensive margins of the international collaboration in patents. This finding indicates that firms respond to taxation and fiscal incentives by strategically allocating their patents, which implies that some types of R&D tax incentives might be used for tax planning.

In summary, the findings of this doctoral thesis point to the existence of profit shifting by multinational enterprises and confirm that intellectual property plays an important role in enabling BEPS. However, the tax elasticities found through multiple literature reviews and own empirical analyses are relatively small (in absolute terms) and therefore suggest that the magnitude of profit shifting might be over-estimated by policy makers. The conclusions of the thesis yield several valuable policy implications. The first implication suggests that the introduction of strict anti-avoidance rules in the European Union might prove to be less effective if one takes into consideration their negative influence on real investment in addition to their impact on profit shifting. As a second implication, the effectiveness of anti-avoidance legislation might be diminished through a substitution between profit shifting channels, which implies that there is an interdependency between different anti-avoidance rules. The third implication identifies that countermeasures against profit shifting are less effective in the case of IP-intensive firms. Royalty payments, IP rights, and even some types of R&D tax incentives might be used by IP-intensive multinationals for profit shifting, despite the existence of anti-avoidance legislation. These conclusions raise doubt about the effectiveness of tightening anti-avoidance rules in the European Union and indicate the need for rethinking the fundamentals of the current international tax system.

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Appendices

A Appendix to Chapter 3

Table A.1 Country Statistics

	Full Sample		IP		Non-IP	
Country	Obs.	%	Obs.	%	Obs.	%
Austria	9,017	1.67	6,129	1.88	2,888	1.34
Belgium	24,799	4.58	12,040	3.70	12,759	5.91
Bosnia-Herzegovina	1,177	0.22	634	0.19	543	0.25
Bulgaria	3,625	0.67	1,882	0.58	1,743	0.81
Croatia	5,525	1.02	3,044	0.94	2,481	1.15
Czech Republic	22,997	4.25	12,333	3.79	10,664	4.94
Denmark	10,766	1.99	4,956	1.52	5,810	2.69
Estonia	4,502	0.83	1,841	0.57	2,661	1.23
Finland	11,011	2.03	7,089	2.18	3,922	1.82
France	99,863	18.45	70,775	21.74	29,088	13.48
Germany	35,339	6.53	24,395	7.49	10,944	5.07
Hungary	2,850	0.53	1,938	0.60	912	0.42
Iceland	106	0.02	37	0.01	69	0.03
Ireland	581	0.11	229	0.07	352	0.16
Italy	54,878	10.14	45,782	14.07	9,096	4.21
Latvia	102	0.02	57	0.02	45	0.02
Luxembourg	2,160	0.40	1,112	0.34	1,048	0.49
Malta	6	0.00	5	0.00	1	0.00
Montenegro	15	0.00	9	0.00	6	0.00
Netherlands	8,437	1.56	3,456	1.06	4,981	2.31
Norway	21,620	3.99	15,117	4.64	6,503	3.01
Poland	20,952	3.87	11,751	3.61	9,201	4.26
Portugal	9,086	1.68	4,686	1.44	4,400	2.04
Romania	20,764	3.84	10,595	3.26	10,169	4.71
Serbia	6,248	1.15	2,909	0.89	3,339	1.55
Slovak Republic	5,675	1.05	3,311	1.02	2,364	1.10
Slovenia	3,310	0.61	2,298	0.71	1,012	0.47
Spain	55,495	10.25	34,309	10.54	21,186	9.82
Sweden	24,177	4.47	9,515	2.92	14,662	6.79
Switzerland	15	0.00	7	0.00	6	0.00
Ukraine	7,084	1.31	2,552	0.78	4,532	2.10
UK	69,141	12.77	30,701	9.43	38,440	17.81
Total	541,323	100	325,494	100	215,827	100

Notes: This table shows a distribution of observations across countries in the full sample as well as the sample of IP-intensive firms and the sample of non-IP firms. IP intensity is defined in section 3.5.3.

Table A.2 An Overview of Transfer Pricing Documentation Requirements

Country	Formal	Informal
Austria	-	All Sample Years
Belgium	-	All Sample Years
Bosnia-Herzegovina	-	Since 2008
Bulgaria	-	Since 2006
Croatia	Since 2005	-
Czech Republic	-	All Sample Years
Denmark	Since 2006	All Sample Years
Estonia	Since 2007	-
Finland	Since 2007	All Sample Years
France	Since 2010	All Sample Years
Germany	Since 2003	All Sample Years
Hungary	Since 2010	All Sample Years
Iceland	-	-
Ireland	Since 2011	-
Italy	Since 2010	All Sample Years
Latvia	-	Since 2007
Luxembourg	-	Since 2005
Malta	-	-
Montenegro	-	All Sample Years
Netherlands	Since 2002	-
Norway	Since 2008	All Sample Years
Poland	Since 2001	-
Portugal	Since 2002	-
Romania	Since 2007	All Sample Years
Serbia	-	All Sample Years
Slovak Republic	Since 2009	All Sample Years
Slovenia	Since 2005	-
Spain	Since 2009	All Sample Years
Sweden	Since 2007	All Sample Years
Switzerland	-	All Sample Years
Ukraine	-	-
UK	Since 2008	All Sample Years

Notes: Formal refers to transfer pricing documentation requirements that are explicitly stated in the national law. Informal refers to transfer pricing documentation requirements that are not explicitly introduced in the national law but are required to exist in practice.

Table A.3 An Overview of Debt-To-Equity Ratios under Thin Capitalization Rules

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012
Belgium	0	0	0	0	0	0	0	0	5
Bulgaria	2	2	2	3	3	3	3	3	3
Croatia	4	4	4	4	4	4	4	4	4
Czech Republic	4	4	4	4	2	4	4	4	4
Denmark	4	4	4	4	4	4	4	4	4
France	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Germany	1.5	1.5	1.5	1.5	-	-	-	-	-
Hungary	3	3	3	3	3	3	3	3	3
Italy	5	4	4	4	-	-	-	-	-
Latvia	4	4	4	4	4	4	4	4	4
Lithuania	4	4	4	4	2	4	4	4	4
Netherlands	3	3	3	3	3	3	3	3	3
Poland	3	3	3	3	3	3	3	3	3
Portugal	2	2	2	2	2	2	2	2	2
Romania	1	3	3	3	3	3	3	3	3
Serbia	4	4	4	4	4	4	4	4	4
Slovenia	0	8	8	8	6	6	6	5	4
Spain	3	3	3	3	3	3	3	3	-

Table A.4 Special Requirements Regarding Interest Deduction Limitations

Country	Rules
Belgium	7:1 debt-to-equity ratio if interest is tax-exempt or taxed at a reduced rate at the level of a lender.
France	2004-2006: applicable only to payments to non-EU parent companies that are not resident in one of the treaty-exempted countries.
Luxembourg	85:15 debt-to-equity ratio if debt is used for the funding of participations or real estate located in Luxembourg.
Portugal	2006-2012: applicable only to payments to non-EU parent companies. Before: an escape possible if a debt-to-equity ratio is considered to be at arm's length.
Spain	2004-2011: applicable only to payments to non-EU parent companies.
Sweden	No deduction of interest paid on intra-group debt relating to the intra-group acquisition of shares if there are no justifying business or commercial reasons and the income is not subject to tax of at least 10%.
Ukraine	Interest deductible up to a firm's own interest income and 50% of other income if paid to a foreign company.
UK	Included in transfer pricing regulations; generally a 1:1 ratio is used as a guideline.

Table A.5 Three-Stage Indicator of Interest Deduction Restrictions

Country	2004	2005	2006	2007	2008	2009	2010	2011	2012
Austria	0	0	0	0	0	0	0	0	0
Belgium	1	1	1	1	1	1	1	1	1
Bosnia-Herzegovina	0	0	0	0	0	0	0	0	0
Bulgaria	2	2	2	2	2	2	2	2	2
Croatia	0	1	1	1	1	1	1	1	1
Czech Republic	1	1	1	1	2	1	1	1	1
Denmark	1	1	1	1	1	1	1	1	1
Estonia	0	0	0	0	0	0	0	0	0
Finland	0	0	0	0	0	0	0	0	0
France	1	1	1	2	2	2	2	2	2
Germany	2	2	2	2	2	2	2	2	2
Hungary	2	2	2	2	2	2	2	2	2
Iceland	0	0	0	0	0	0	0	0	0
Ireland	0	0	0	0	0	0	0	0	0
Italy	1	1	1	1	2	2	2	2	2
Latvia	1	1	1	1	1	1	1	1	1
Luxembourg	0	0	0	0	0	0	0	0	0
Malta	0	0	0	0	0	0	0	0	0
Montenegro	0	0	0	0	0	0	0	0	0
Netherlands	2	2	2	2	2	2	2	2	2
Norway	0	0	0	0	0	0	0	0	0
Poland	2	2	2	2	2	2	2	2	2
Portugal	1	1	1	1	1	1	1	1	1
Romania	2	2	2	2	2	2	2	2	2
Serbia	1	1	1	1	1	1	1	1	1
Slovak Republic	0	0	0	0	0	0	0	0	0
Slovenia	0	1	1	1	1	1	1	1	1
Spain	1	1	1	1	1	1	1	1	2
Sweden	0	0	0	0	0	1	1	1	1
Switzerland	2	2	2	2	2	2	2	2	2
Ukraine	1	1	1	1	1	1	1	1	1
UK	1	1	1	1	1	1	1	1	1

Notes: The three-stage variable measures the strictness of interest deduction restrictions. It is denoted as follows: 0: no specific interest deduction restrictions; 1: a special rule or a thin capitalization rule with broad exceptions or a debt-to-equity ratio above 3; 2: thin capitalization rules without broad exception and a debt-to-equity ratio of 3 or lower or earnings stripping rules.

Table A.6 Descriptive Statistics: Panel Data Analysis

	Full Sample				IP				Non-IP			
	Obs.	Mean	Min	Max	Obs.	Mean	Min	Max	Obs.	Mean	Min	Max
EBIT	541,323	4,605.62	0.00	9,535,506	325,494	5,127.08	0.00	6,219,053	215,829	3,819.23	0.00	9,535,506
Fixed Assets	541,323	25,631.88	0.00	5.06E+07	325,494	28,875.49	0.00	5.06E+07	215,829	20,740.31	0.00	3.52E+07
Costs of Empl.	541,323	7,689.78	0.00	7,336,624	325,494	8,792.55	0.00	7,336,624	215,829	6,026.75	0.00	6,041,358
Interest Paid	375,573	1,480.30	0.00	1.94E+08	238,004	1,755.68	0.00	1.94E+08	137,569	1,003.81	0.00	6,567,206
Sales	375,573	78,082.02	0.00	1.15E+08	238,004	80,777.43	0.00	5.00E+07	137,569	73,418.77	0.00	1.15E+08
Net PPE/Assets	375,573	0.18	0.00	79.64	238,004	0.17	0.00	79.64	137,569	0.19	0.00	1.96
EBITDA/Assets	375,573	0.17	0.00	585.70	238,004	0.16	0.00	329.39	137,569	0.16	0	585.70
Intangibles	541,323	2,665.22	0.00	1.80E+07	325,494	3,722.45	0.00	1.80E+07	215,829	1,055.35	0.00	3,762,855
Intangibles/Assets	541,323	0.01	0.00	0.99	325,494	0.02	0.00	0.99	215,829	0.00	0.00	0.00
CIT	541,323	0.29	0.09	0.40	325,494	0.30	0.09	0.40	215,829	0.28	0.09	0.40
TP Doc Years	541,323	1.53	0.00	11.00	325,494	1.46	0.00	11.00	215,829	1.63	0.00	11.00
TP Doc Binary	541,323	0.49	0.00	1.00	325,494	0.49	0.00	1.00	215,829	0.51	0.00	1.00
TP Doc Years + Doc Required in Practice	541,323	2.51	0.00	12.00	325,494	2.45	0.00	12.00	215,829	2.6	0.00	12.00
TC 3-stage	541,323	1.24	0.00	2.00	325,494	1.28	0.00	2.00	215,829	1.18	0.00	2.00
TC 1/ (1+ σ)	375,573	0.18	0.00	0.50	238,004	0.21	0.00	0.50	137,569	0.16	0.00	0.50
Corruption	541,323	1.18	-1.03	2.56	325,494	1.15	-1.03	2.56	215,829	1.23	-1.03	2.56
Unemployment Rate	541,323	8.57	2.30	31.80	325,494	8.63	2.30	31.80	215,829	8.45	2.30	31.80
Inflation	541,323	2.74	-1.71	25.20	325,494	2.61	-1.71	25.20	215,829	2.94	-1.71	25.20
GDP	541,323	1.09E+12	1.81E+09	2.55E+12	325,494	1.15E+12	2.18E+09	2.55E+12	215,829	9.88E+11	1.81E+09	2.55E+12
GDP/capita	541,323	25,751.01	1421.18	70,569.24	325,494	26,021.74	1,421.18	70,569.24	215,829	25,342.54	1,421.18	70,569.24
GDP Growth Rate	541,323	1.47	-14.80	12.10	325,494	1.37	-14.80	12.10	215,829	1.63	-14.80	12.10
Growth Options	375,573	0.06	-0.99	140.86	238,004	0.06	-0.99	140.86	137,569	0.06	-0.99	23.57

Notes: The number of observations is 541,323 in the regressions with *Log(EBIT)* as a dependent variable (see section 3.6.1.1) and 375,573 in the regressions with *Log(Interest Paid)* as a dependent variable (see section 3.6.1.2). *EBIT* denotes earnings before interest and taxes. *Fixed Assets* represents total fixed assets. *Cost of Empl.* stands for the cost of employees. *Interest Paid* denotes a firm's interest payments. *Sales* stands for a company's total turnover. *Net PPE/Assets* is a ratio of a company's net property, plant, and equipment to total assets. *EBITDA/Assets* is a ratio of earnings before interest, taxes, depreciation, and amortization to total assets. *Intangibles* shows total intangible assets of a company. *Intangibles/Assets* represents a mean of the MNE's intangibles to total assets. *CIT* stands for a corporate income tax rate. *TP*-variables measure the strictness of transfer pricing regulations. *TC*-variables measure the strictness of interest deduction limitations. *Corruption* represents a corruption index. *Unemployment Rate* stands for a country's rate of unemployment. *Inflation* denotes a country's rate of inflation. *GDP* denotes a natural logarithm of a country's gross domestic product. *GDP/capita* stands for a natural logarithm of a country's GDP per-capita. *GDP Growth Rate* is a country's rate of GDP growth. *Growth Options* denotes the median annual sales growth per industry and country. IP represents a sample of IP-intensive firms as defined in section 3.5.3 and Non-IP includes a sample of all other companies.

Table A.7 Descriptive Statistics: Difference-In-Difference Estimation

Panel A. Full Sample

	Obs.	Mean	Median	Std. Dev.	Min	Max
Treatment Group						
EBIT	120	8,377.94	3,373.41	11,857.69	156.30	53,744.78
Costs of Empl.	120	15,506.77	9,793.83	20,690.72	851.26	110,785
Fixed Assets	120	55,012	11,621.67	136,975.80	78.09	704,268.70
Control Group						
EBIT	5,508	11,893.03	718.48	106,761.80	0.19	3,232,000
Costs of Empl.	5,508	16,833.22	2,011.11	73,509.92	0.33	1,769,000
Fixed Assets	5,508	39,757.99	1,007.44	265,506.80	0.00	4,920,454
All Firms						
EBIT	5,628	11,818.08	745.51	105,632.60	0.19	3,232,000
Costs of Empl.	5,628	16,804.94	2,075.49	72,784.34	0.33	1,769,000
Fixed Assets	5,628	40,083.24	1,039.74	263,423.90	0.00	4,920,454

Panel B. IP-Intensive Firms

	Obs.	Mean	Median	Std. Dev.	Min	Max
Treatment Group						
EBIT	60	10,025.57	4,050.25	13,793.34	209.69	53,744.78
Costs of Empl.	60	21,617.45	11,612.07	26,851.96	851.26	110,785
Fixed Assets	60	81,250.91	16,460.96	186,250.40	321.64	704,268.70
Control Group						
EBIT	2,976	15,668.66	1,274.36	135,135.90	0.50	3,232,000
Costs of Empl.	2,976	21,241.59	3,739.15	59,276.42	2.78	641,069
Fixed Assets	2,976	56,932.31	2,097.93	332,521.40	0.00	4,920,454
All Firms						
EBIT	3,036	15,557.14	1,337.52	133,809.60	0.50	3,232,000
Costs of Empl.	3,036	21,249.02	3,869.67	58,806.89	2.78	641,069
Fixed Assets	3,036	57,412.92	2,166.21	330,258.10	0.00	4,920,454

Notes: *EBIT* stands for earnings before interest and taxes. *Cost of Empl.* stands for the cost of employees. *Fixed Assets* represents total fixed assets. IP-intensive firms are defined in section 3.5.3

Table A.8 Robustness Tests Using Alternative Definitions of Anti-Avoidance Legislation: Log(EBIT) as a Dependent Variable

TP Measure:	TP Doc Years		TP Doc Binary		TP Doc Years + TP Doc required in practice	
TC Measure:	$1/(1+\sigma)$ $\sigma =$ TC D/E Ratio		TC 3-stage		TC 3-stage	
	IP	Non-IP	IP	Non-IP	IP	Non-IP
	I	II	III	IV	V	VI
CIT	-1.207***	0.345	-0.103	0.970***	-1.018***	0.203
	(0.291)	(0.319)	(0.250)	(0.301)	(0.285)	(0.348)
TP	0.070***	0.082***	0.048***	0.054***	0.051***	0.054***
	(0.006)	(0.007)	(0.014)	(0.016)	(0.006)	(0.008)
*CIT*TP*	0.999***	0.915***	0.677**	0.366	0.557***	0.453***
	(0.122)	(0.139)	(0.267)	(0.314)	(0.101)	(0.119)
TC	0.036	0.066	0.016*	0.068***	0.027***	0.077***
	(0.096)	(0.109)	(0.010)	(0.012)	(0.010)	(0.013)
*CIT*TC*	1.761	-1.572	0.025	-0.518***	0.177	-0.566***
	(1.184)	(1.351)	(0.146)	(0.176)	(0.161)	(0.194)
*TP*TC*	-0.188***	-0.275***	-0.031***	-0.031***	-0.023***	-0.026***
	(0.018)	(0.022)	(0.008)	(0.011)	(0.003)	(0.004)
*CIT*TP*TC*	-2.729***	-2.325***	-0.761***	-0.680***	-0.264***	-0.180***
	(0.400)	(0.472)	(0.169)	(0.201)	(0.056)	(0.068)
Log(Fixed Assets)	0.085***	0.076***	0.089***	0.074***	0.089***	0.074***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Log(Costs of Empl.)	0.414***	0.385***	0.400***	0.386***	0.399***	0.385***
	(0.009)	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)
Unemployment Rate	-0.012***	-0.010***	-0.010***	-0.010***	-0.011***	-0.012***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
Corruption	-0.016	0.053*	-0.000	0.006	-0.010	0.012
	(0.024)	(0.030)	(0.021)	(0.028)	(0.022)	(0.029)
GDP Growth Rate	0.008***	0.007***	0.007***	0.007***	0.007***	0.006***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)
Log(GDP)	-1.048***	-1.760***	0.718***	0.345	0.118	-0.315
	(0.306)	(0.367)	(0.263)	(0.311)	(0.273)	(0.322)
Log(GDP/capita)	1.097***	1.890***	-0.578**	-0.259	0.110	0.528*
	(0.288)	(0.338)	(0.238)	(0.278)	(0.260)	(0.297)
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of Companies	57,719	42,163	60,732	42,981	60,729	42,980
No. of Observations	280,267	201,728	325,494	215,827	325,417	215,757
R^2 (within)	0.094	0.085	0.092	0.082	0.092	0.082

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Robust standard errors are reported in parentheses. Units of observation are firms. The dependent variable is *Log(EBIT)*, which denotes a natural logarithm of a firm's earnings before interest and taxes. *CIT* stands for a corporate income tax rate. *TP* measures the strictness of transfer pricing regulations. *TC* measures the strictness of interest deduction restrictions. *Log(Fixed Assets)* and *Log(Cost of Empl.)* are firm-level controls and represent natural logarithms of a company's fixed assets and the cost of employees respectively. *Unemployment Rate* stands for a country's rate of unemployment. *Corruption* represents a corruption index. *GDP Growth Rate* is a country's rate of GDP growth. *Log(GDP)* denotes a natural logarithm of a country's gross domestic product. *Log(GDP/capita)* stands for a natural logarithm of a country's GDP per-capita. FE stands for fixed effects. IP represents a sample of IP-intensive firms as defined in section 3.5.3 and Non-IP includes a sample of all other companies.

Table A.9 Robustness Tests Using Alternative Definitions of Anti-Avoidance Legislation: Log(Interest Paid) as a Dependent Variable

TP Measure:	TP Doc Years		TP Doc Binary		TP Doc Years + TP Doc required in practice	
TC Measure:	$1/(1+\sigma)$ $\sigma =$ TC D/E Ratio		TC 3-stage		TC 3-stage	
	IP	Non-IP	IP	Non-IP	IP	Non-IP
	I	II	III	IV	V	VI
CIT	-0.788	3.344***	0.837	2.875***	0.371	3.177***
	(0.862)	(0.930)	(0.635)	(0.783)	(0.649)	(0.818)
TP	0.077***	0.057***	0.079***	0.012	0.022**	-0.012
	(0.012)	(0.014)	(0.026)	(0.029)	(0.011)	(0.013)
*CIT*TP*	1.636***	0.920***	3.911***	1.601**	0.910***	0.176
	(0.273)	(0.314)	(0.536)	(0.669)	(0.184)	(0.231)
TC	-0.584**	-0.579**	0.113***	0.051**	0.036*	-0.007
	(0.255)	(0.248)	(0.021)	(0.024)	(0.020)	(0.023)
*CIT*TC*	-3.291	-13.268***	-2.108***	-2.367***	-2.323***	-2.989***
	(3.247)	(3.447)	(0.366)	(0.428)	(0.373)	(0.443)
*TP*TC*	-0.265***	-0.277***	-0.095***	-0.071***	0.014***	0.017**
	(0.035)	(0.041)	(0.016)	(0.020)	(0.005)	(0.007)
*CIT*TP*TC*	-6.338***	-3.957***	-2.909***	-1.332***	-0.511***	-0.092
	(0.948)	(1.103)	(0.346)	(0.429)	(0.104)	(0.130)
Net PPE/Assets	0.172	1.469***	0.217	1.426***	0.214	1.421***
	(0.198)	(0.078)	(0.229)	(0.075)	(0.227)	(0.075)
EBITDA/Assets	-0.008	-0.001	-0.010	-0.001	-0.010	-0.001
	(0.007)	(0.002)	(0.009)	(0.002)	(0.009)	(0.002)
Log(Sales)	0.615***	0.609***	0.632***	0.600***	0.635***	0.603***
	(0.019)	(0.018)	(0.017)	(0.017)	(0.017)	(0.017)
Corruption	0.051	0.033	0.170***	0.111*	0.156***	0.148**
	(0.054)	(0.064)	(0.046)	(0.062)	(0.048)	(0.064)
Inflation	-0.004	-0.027***	0.004	-0.027***	-0.006	-0.030***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Growth Options	-0.006	-0.203***	-0.007	-0.193***	-0.005	-0.165***
	(0.006)	(0.033)	(0.007)	(0.033)	(0.006)	(0.033)
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of Companies	49,536	32,282	52,761	33,188	52,759	33,187
No. of Observations	197,496	125,963	238,004	137,569	237,995	137,558
R^2 (within)	0.062	0.069	0.061	0.064	0.062	0.064

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Robust standard errors are reported in parentheses. Units of observation are firms. The dependent variable is *Log(Interest Paid)*, which denotes a natural logarithm of a firm's interest payments. *CIT* stands for a corporate income tax rate. *TP* measures the strictness of transfer pricing regulations. *TC* measures the strictness of interest deduction limitations. *Net PPE/Assets*, *EBITDA/Assets*, and *Log(Sales)* are firm-level controls and represent a ratio of a company's net property, plant, and equipment to total assets, its ratio of earnings before interest, taxes, depreciation, and amortization to total assets, and a natural logarithm of its sales respectively. *Corruption* represents a corruption index and indicates the level of governance and political risk in a country. *Inflation* stands for a country's rate of inflation. *Growth Options* denotes the median annual sales growth per industry and country. FE stands for fixed effects. IP represents a sample of IP-intensive firms as defined in section 3.5.3 and Non-IP includes a sample of all other companies.

Table A.10 Robustness Tests Using Alternative Definitions of IP Intensity: Log(EBIT) as a Dependent Variable

	IP_2	Non-IP_2	IP_3	Non-IP_3	IP_4	Non-IP_4
	I	II	III	IV	V	VI
CIT	-0.450*	0.353	-0.525*	0.046	-0.581**	0.647**
	(0.270)	(0.285)	(0.274)	(0.298)	(0.261)	(0.298)
TP	0.050***	0.058***	0.052***	0.059***	0.054***	0.055***
	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.008)
*CIT*TP*	0.613***	0.431***	0.513***	0.528***	0.617***	0.379***
	(0.108)	(0.116)	(0.112)	(0.120)	(0.107)	(0.118)
TC	0.007	0.044***	0.011	0.044***	0.008	0.043***
	(0.010)	(0.010)	(0.010)	(0.011)	(0.009)	(0.011)
*CIT*TC*	-0.143	-0.531***	-0.044	-0.348**	-0.073	-0.655***
	(0.152)	(0.159)	(0.154)	(0.166)	(0.148)	(0.165)
*TP*TC*	-0.022***	-0.029***	-0.019***	-0.031***	-0.025***	-0.025***
	(0.003)	(0.004)	(0.004)	(0.004)	(0.003)	(0.004)
*CIT*TP*TC*	-0.275***	-0.187***	-0.248***	-0.222***	-0.298***	-0.131*
	(0.060)	(0.066)	(0.062)	(0.068)	(0.059)	(0.068)
Log(Fixed Assets)	0.090***	0.076***	0.082***	0.078***	0.084***	0.079***
	(0.004)	(0.003)	(0.004)	(0.004)	(0.003)	(0.004)
Log(Costs of Empl.)	0.399***	0.387***	0.405***	0.375***	0.401***	0.382***
	(0.009)	(0.008)	(0.010)	(0.008)	(0.008)	(0.009)
Unemployment Rate	-0.011***	-0.012***	-0.010***	-0.015***	-0.012***	-0.010***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Corruption	0.002	-0.005	-0.008	0.006	-0.014	0.022
	(0.023)	(0.027)	(0.023)	(0.028)	(0.022)	(0.028)
GDP Growth Rate	0.007***	0.006***	0.008***	0.005***	0.007***	0.006***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)
Log(GDP)	0.096	-0.288	0.292	-0.301	0.130	-0.275
	(0.287)	(0.300)	(0.298)	(0.316)	(0.279)	(0.311)
Log(GDP/capita)	0.149	0.509*	0.016	0.507*	0.130	0.543*
	(0.274)	(0.278)	(0.290)	(0.288)	(0.266)	(0.287)
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of Companies	52,985	50,728	66,842	68,459	60,389	43,324
No. of Observations	284,806	256,515	278,859	261,107	323,655	217,666
R^2 (within)	0.093	0.083	0.083	0.082	0.093	0.081

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Robust standard errors are reported in parentheses. Units of observation are firms. The dependent variable is *Log(EBIT)*, which denotes a natural logarithm of a firm's earnings before interest and taxes. *CIT* stands for a corporate income tax rate. *TP* measures the strictness of transfer pricing regulations. *TC* measures the strictness of interest deduction restrictions. *Log(Fixed Assets)* and *Log(Cost of Empl.)* are firm-level controls and represent natural logarithms of a company's fixed assets and the cost of employees respectively. *Unemployment Rate* stands for a country's rate of unemployment. *Corruption* represents a corruption index. *GDP Growth Rate* is a country's rate of GDP growth. *Log(GDP)* denotes a natural logarithm of a country's gross domestic product. *Log(GDP/capita)* stands for a natural logarithm of a country's GDP per-capita. FE stands for fixed effects. IP represents a sample of IP-intensive firms and Non-IP includes a sample of all other companies.

Table A.11 Robustness Tests Using Alternative Definitions of IP Intensity: Log(Interest Paid) as a Dependent Variable

	IP_2	Non-IP_2	IP_3	Non-IP_3	IP_4	Non-IP_4
	I	II	III	IV	V	VI
CIT	-0.140	2.971***	0.664	2.343***	-0.380	2.055**
	(0.743)	(0.726)	(0.669)	(0.782)	(0.686)	(0.831)
TP	0.018	-0.010	0.014	-0.005	0.032**	0.006
	(0.013)	(0.014)	(0.013)	(0.015)	(0.013)	(0.016)
*CIT*TP*	0.750***	0.336	0.814***	0.171	0.998***	0.661**
	(0.271)	(0.274)	(0.258)	(0.287)	(0.256)	(0.305)
TC	0.009	-0.022	0.033	-0.030	0.034	0.008
	(0.023)	(0.020)	(0.021)	(0.021)	(0.021)	(0.022)
*CIT*TC*	-1.685***	-3.107***	-2.336***	-2.308***	-1.667***	-2.674***
	(0.423)	(0.387)	(0.375)	(0.428)	(0.382)	(0.434)
*TP*TC*	0.033***	0.040***	0.037***	0.030***	0.031***	0.023**
	(0.007)	(0.008)	(0.007)	(0.008)	(0.007)	(0.009)
*CIT*TP*TC*	-0.331**	0.016	-0.324**	0.035	-0.376***	-0.113
	(0.150)	(0.153)	(0.143)	(0.160)	(0.140)	(0.165)
Net PPE/Assets	0.178	1.459***	0.195	1.517***	0.638***	0.597***
	(0.196)	(0.068)	(0.206)	(0.071)	(0.017)	(0.017)
EBITDA/Assets	-0.045*	-0.001	-0.051*	-0.001	-0.009	-0.002
	(0.027)	(0.002)	(0.028)	(0.001)	(0.008)	(0.002)
Log(Sales)	0.645***	0.602***	0.626***	0.624***	0.197	1.411***
	(0.018)	(0.016)	(0.018)	(0.016)	(0.216)	(0.071)
Corruption	0.114**	0.159***	0.060	0.213***	-0.011**	-0.034***
	(0.052)	(0.057)	(0.050)	(0.059)	(0.005)	(0.005)
Inflation	-0.009*	-0.030***	-0.019***	-0.023***	0.051	0.050
	(0.005)	(0.004)	(0.005)	(0.005)	(0.051)	(0.064)
Growth Options	-0.006	-0.141***	-0.006	-0.189***	-0.006	-0.137***
	(0.006)	(0.036)	(0.006)	(0.033)	(0.006)	(0.037)
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of Companies	46,763	39,186	56,802	52,005	52,370	33,569
No. of Observations	212,641	162,932	210,033	164,672	236,230	139,328
R^2 (within)	0.063	0.063	0.060	0.064	0.061	0.066

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Robust standard errors are reported in parentheses. Units of observation are firms. The dependent variable is *Log(Interest Paid)*, which denotes a natural logarithm of a firm's interest payments. *CIT* stands for a corporate income tax rate. *TP* measures the strictness of transfer pricing regulations. *TC* measures the strictness of interest deduction limitations. *Net PPE/Assets*, *EBITDA/Assets*, and *Log(Sales)* are firm-level controls and represent a ratio of a company's net property, plant, and equipment to total assets, its ratio of earnings before interest, taxes, depreciation, and amortization to total assets, and a natural logarithm of its sales respectively. *Corruption* represents a corruption index and indicates the level of governance and political risk in a country. *Inflation* stands for a country's rate of inflation. *Growth Options* denotes the median annual sales growth per industry and country. FE stands for fixed effects. IP represents a sample of IP-intensive firms and Non-IP includes a sample of all other companies.

Table A.12 Regression Results Using the Sample with Ultimate Owners

Dependent variable:	*Log(EBIT)*			*Log(Interest Paid)*		
	Full	IP	Non-IP	Full	IP	Non-IP
	I	II	III	IV	V	VI
CIT	-0.008	-0.426*	0.378	0.718*	0.121	2.069***
	(0.175)	(0.236)	(0.269)	(0.432)	(0.586)	(0.686)
TP	0.055***	0.051***	0.062***	0.005	0.020*	-0.013
	(0.005)	(0.006)	(0.007)	(0.009)	(0.012)	(0.014)
*CIT*TP*	0.528***	0.535***	0.515***	0.799***	1.142***	0.172
	(0.073)	(0.099)	(0.109)	(0.170)	(0.218)	(0.274)
TC	0.027***	0.009	0.044***	0.011	0.024	-0.025
	(0.006)	(0.009)	(0.010)	(0.013)	(0.018)	(0.020)
*CIT*TC*	-0.337***	-0.107	-0.534***	-2.162***	-1.979***	-2.456***
	(0.100)	(0.135)	(0.152)	(0.244)	(0.333)	(0.378)
*TP*TC*	-0.025***	-0.023***	-0.028***	0.032***	0.033***	0.031***
	(0.002)	(0.003)	(0.004)	(0.005)	(0.006)	(0.008)
*CIT*TP*TC*	-0.235***	-0.261***	-0.202***	-0.289***	-0.449***	0.031
	(0.041)	(0.055)	(0.063)	(0.095)	(0.122)	(0.153)
Log(Fixed Assets)	0.084***	0.085***	0.082***			
	(0.002)	(0.003)	(0.004)			
Log(Costs of Empl.)	0.394***	0.405***	0.378***			
	(0.006)	(0.008)	(0.008)			
Net PPE/Assets				0.355	0.230	1.371***
				(0.305)	(0.237)	(0.071)
EBITDA/Assets				-0.005*	-0.011	-0.002
				(0.003)	(0.010)	(0.002)
Log(Sales)				0.607***	0.635***	0.575***
				(0.011)	(0.016)	(0.016)
Unemployment Rate	-0.012***	-0.013***	-0.010***			
	(0.001)	(0.001)	(0.002)			
GDP Growth Rate	0.007***	0.007***	0.006***			
	(0.001)	(0.001)	(0.001)			
Log(GDP/capita)	0.185	-0.115	0.482*			
	(0.183)	(0.251)	(0.270)			
Log(GDP)	0.086	0.376	-0.139			
	(0.193)	(0.261)	(0.292)			
Corruption	0.003	-0.003	0.018	0.095***	0.080*	0.119**
	(0.016)	(0.021)	(0.027)	(0.035)	(0.044)	(0.058)
Inflation				-0.025***	-0.014***	-0.035***
				(0.003)	(0.004)	(0.005)
Growth Options				-0.012*	-0.006	-0.174***
				(0.007)	(0.006)	(0.036)
Year-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Frim FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of Companies	114,918	66,877	48,041	95,225	58,499	36,726
No. of Observations	605,489	362,482	243,007	423,342	268,919	154,423
R^2 (within)	0.089	0.095	0.082	0.059	0.062	0.062

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Robust standard errors are reported in parentheses. Units of observation are firms. *CIT* stands for a corporate income tax rate. *TP* measures the strictness of transfer pricing regulations. *TC* measures the strictness of interest deduction restrictions. *Log(Fixed Assets)* and *Log(Cost of Empl.)* are firm-level controls and represent natural logarithms of a company's fixed assets and the cost of employees respectively. *Net PPE/Assets*, *EBITDA/Assets*, and *Log(Sales)* are firm-level controls and represent a ratio of a company's net property, plant, and equipment to total assets, its ratio of earnings before interest, taxes, depreciation, and amortization to total assets, and a natural logarithm of its sales respectively. *Unemployment Rate* stands for a country's rate of unemployment. *GDP Growth Rate* is a country's rate of GDP growth. *Log(GDP/capita)* stands for a natural logarithm of a country's GDP per-capita. *Corruption* represents a corruption index. *Log(GDP)* denotes a natural logarithm of a country's gross domestic product. *Inflation* stands for a country's rate of inflation. *Growth Options* denotes the median annual sales growth per industry and country. FE stands for fixed effects. IP represents a sample of IP-intensive firms and Non-IP includes a sample of all other companies.

B Appendix to Chapter 4

Appendix B1. Theoretical Considerations: An Alternative Setting

The baseline model presented in section 4.2.2 assumes a non-deductibility of profit shifting costs. This assumption is valid if we consider shifting costs related to concealment, tax penalties, negative publicity, or economic inefficiency. However, there might also be costs related to legal and accounting services that arise from profit shifting. If we refer to Hines (1995) and assume that these costs are tax deductible at the level of a shifting subsidiary, equation 4.1 takes on the following form:

$$\Pi = (1 - \tau_s)(S(R, R^*, \varphi) - R^* - \alpha \frac{(R-r)^2}{R}) + (1 - \tau_r)\pi_r + (\tau_s - \tau_r)r \tag{B.1}$$

The first term of equation B.1 represents the after-tax profits of the subsidiary. As mentioned above, it is assumed that this affiliate is allowed to deduct shifting costs for tax purposes. The rest of the equation is analogous to equation 4.1. Hence, the second term shows the after-tax profits of the parent firm and the third term describes the after-tax royalty payments transferred from a source country S to the recipient country R. τ_s represents the statutory corporate income tax rate in a source country and τ_r denotes the statutory CIT rate in the recipient country. The first order condition of Π describing the optimal choice of royalties then reads:

$$\frac{\partial \Pi}{\partial r} = (1 - \tau_s)\frac{2\alpha\,(R - r)}{R} + (\tau_s - \tau_r) = 0 \tag{B.2}$$

which yields

$$r = R\left(1 - \frac{(\tau_r - \tau_s)}{(1 - \tau_s)2\alpha}\right) \tag{B.3}$$

As shown in equation B.3, the corporate income tax rates of the source and recipient countries appear to influence optimal royalty payments under the assumption of a tax deductibility of the expenses related to profit shifting; however, the tax terms that arise under this assumption are less straightforward to interpret than in the case of our benchmark analysis.[256] We calculate the main independent variables of interest assuming the tax deductibility of shifting costs and present the estimation results in Table B.1.

Table B.1 Results under an Alternative Assumption Regarding Shifting Costs

	Dep. Variable.: *Royalty Intensity*		Dep. Variable.: *Royalty Flows*	
	I	II	III	IV
$\tau_s/(1-\tau_s)$	1.220***	1.355**	1.174**	1.252*
	(0.432)	(0.625)	(0.538)	(0.709)
$T_{sr}/(1-\tau_s)$	-3.896***	-4.057***	-3.783***	-3.767***
	(1.365)	(1.130)	(1.286)	(1.130)
Log(R&D Exp.)		0.883***		0.882***
		(0.133)		(0.134)
Log(GDP/capita)		-1.612*		-1.768**
		(0.854)		(0.796)
Log(Population)		2.325		1.907
		(1.616)		(1.604)
Property Rights		0.035***		0.034***
		(0.012)		(0.012)
Log(Trade btw. S and R)		0.219		0.472***
		(0.177)		(0.175)
Time Fixed Effects	Yes	Yes	Yes	Yes
Country-Pair Fixed Eff.	Yes	Yes	Yes	Yes
Three-Way Cluster	✓	✓	✓	✓
Pseudo R^2	0.873	0.939	0.871	0.938
Observations	61,596	61,596	61,596	61,596

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Three-Way Cluster implies that standard errors are clustered at (and may be correlated within) base groups (source country *S*, recipient country *R*, and year) as well as every combination of the three. Pseudo R^2 represents the likelihood ratio index, also known as McFadden's R^2. Poisson pseudo-maximum likelihood model is applied in all estimations. Observational units are country-pairs. The dependent variable in columns I-II is the ratio of *Royalty Flows* in relation to *Output in S* (total value added of firms in country *S*); the ratio of royalties to output is analyzed by employing output as an exposure variable. The dependent variable in columns III-IV is *Royalty Flows*, which denotes total royalty flow from country *S* to *R*. T_{sr} is a tax rate on royalty flows from *S* to *R*. τ_s represents statutory corporate income tax rate in *S*. *Log (R&D Exp.)* is a logarithm of total R&D expenditure in *R*. *Log (GDP/capita)* measures GDP per-capita in *R*. *Log (Population)* denotes a logarithm of country *R*'s total population. *Property Rights* represents a level of intellectual property rights protection in *R*. *Log(Trade btw.S and R)* depicts a logarithm of total trade in goods between *S* and *R*.

According to Table B.1, assuming tax deductibility of shifting costs produces results that are similar to the baseline findings. For example, taxation of royalty flows appears to have a negative and statistically significant impact on the intensity and the amount of bilateral royalty flows. The tax elasticity of royalty intensity is equal to -1.7 and therefore is slightly lower in

[256] The benchmark estimations are based on evaluating the effects of τ_s and T_{sr} on the intensity of bilateral royalty flows. By contrast, this strategy leads to estimating the effects of $\tau_s/(1-\tau_s)$ and $T_{sr}/(1-\tau_s)$, which are the ratios of tax rates on royalties in relation to a source country's taxation.

absolute terms than our benchmark estimate of -2.3. However, this value is still more negative than the tax elasticity of -1.0 reported by Hines (1995), whose methodology we closely follow in Table B.1. The major difference between our baseline results and the outcomes shown in Table B.1 is a statistically significant coefficient on the source country's taxation, which turned out to be insignificant in our baseline specification (see Table 4.5). The positive effect of a source country's taxation on royalty flows is in line with our theoretical considerations presented in equations B.1-B.3.

Appendix B2. Complementary Tables

Table B.2 A List of Countries Included in the Study

Argentina	Finland	Latvia	Russian Federation
Australia	France	Lithuania	Singapore
Austria	Germany	Luxembourg	Slovakia
Belgium	Greece	Malaysia	Slovenia
Brazil	Hong Kong	Malta	South Africa
Bulgaria	Hungary	Mexico	Spain
Canada	Iceland	Morocco	Sweden
Chile	India	Netherlands	Switzerland
China	Indonesia	New Zealand	Thailand
Croatia	Iran (Islamic Republic of)	Nigeria	Turkey
Cyprus	Ireland	Norway	United Kingdom
Czech Republic	Israel	Philippines	United States
Denmark	Italy	Poland	Uruguay
Egypt	Japan	Portugal	Venezuela
Estonia	Korea (Republic of)	Romania	

Table B.3 Definitions of Variables and Data Sources

Variable	Definition	Source	Unit
Royalty Intensity	*Royalty Flows*/ *Output*	Own calculation	A ratio, %
Royalty Flows	Payments for the authorized use of intangibles, non-produced, non-financial assets, and proprietary rights (such as patents, trademarks, industrial processes, franchises) and the use, through licensing agreements, of produced originals or prototypes (such as manuscripts and films).	OECD database *Trade in Services.EBOPS*[257] and Eurostat database *International Trade in Services.bop_its6_det*[258]	Million USD, current prices
Output	Total revenues of firms measured as the value added of the corporate sector. Value added is the net output after adding up all outputs and subtracting intermediate inputs.	World Bank[259]	Million USD, current prices
τ_s and τ_r	Statutory corporate income tax rates in a source country *S* and a recipient country *R*.	*Global Corporate Tax Handbook*[260]	%
w_s	A withholding tax rate on royalty outflows in country *S*.	*Global Corporate Tax Handbook*, the IBFD Research Platform[261]	%
T_{sr}	The effective tax rate on royalty transfers from country *S* to country *R*. It incorporates all possible taxes on royalty payments in both countries (e.g. a withholding tax at source, a statutory tax on royalty income in the recipient country, and any other taxes on royalties).	Own calculation	%
$\tau_{r} - \tau_{s}$	The unweighted difference between the tax rates on royalty income in recipient country *R* and source country *S*.	Own calculation	%

[257] See OECD (2002, 2010).
[258] See Eurostat (2010).
[259] See World Bank (2016a) and World Bank (2016b).
[260] See International Bureau of Fiscal Documentation (IBFD) (1995-2012).
[261] For more information see http://www.ibfd.org/

$\tau_r - \tau_j$	The unweighted average of tax differences between the tax rate on royalty income in *R* and tax rates on royalty income in the remaining fifty-eight countries *J*.	Own calculation	%
$\tau_r - \tau_j$ *(affil.weight)*	The weighted average of tax differences between the tax rate on royalty income in *R* and tax rates on royalty income in the remaining fifty-eight countries *J*; the weight represents a number of *R*'s foreign affiliates in each country *J*.	Own calculation, micro-level data on the number of foreign affiliates is from the *Orbis* database, Bureau van Dijk.	%
$\tau_r - \tau_j$ *(assets.weight)*	The weighted average of tax differences between tax rate on royalty income in *R* and tax rates on royalty income in the remaining fifty-eight countries *J*; the weight represents the total assets of *R*'s foreign affiliates in each country *J*.	Own calculation, micro-level data on the assets of foreign affiliates is from the *Orbis* database, Bureau van Dijk.	%
$\tau_r - \tau_j$ *(FDI weight)*	The weighted average of tax differences between tax rate on royalty income in *R* and tax rates on royalty income in the remaining fifty-eight countries *J*; the weight represents country *R*'s FDI in each country *J*.	Own calculation, data on FDI is from OECD database *FDI Positions by Partner Country* [262]	%
R&D Exp.	A total amount of a country's expenditure on research and development.	OECD database *Gross Domestic Expenditure on R-D by Sector of Performance and Source of Funds*[263]	Million USD, current prices
GDP/capita	Gross domestic product per-capita.	World Bank *Development Indicators*[264]	USD, current prices
Population	Total population.	World Bank *Development Indicators*	Total
Property Rights	An index ranging from 1 to 100. It represents the level of property rights protection in a country.	Heritage Foundation[265]	An index

[262] See OECD (2014b).
[263] See OECD (2014c).
[264] See World Bank (2015).
[265] For more information see http://www.heritage.org/index/

Trade	Bilateral trade in goods.	OECD database *STAN Bilateral Trade in Goods*[266]	Thousand USD, current prices
IP_BoxAcq	A dummy variable, which is equal to one if an IP Box regime is applicable to acquired IP and to zero otherwise.	Evers et al. (2015a) and our own research	1/0
IP_Box	A dummy variable, which is equal to one if an IP Box regime is applicable to self-developed IP and to zero otherwise.	Evers et al. (2015a) and our own research	1/0
B_Index	An index. The lower the B-Index, the more attractive the tax system is for R&D investments.	Ernst and Spengel (2011), Thomson (2013), Chen and Dauchy (2015), and our own research	An index
CFC Rules	A dummy variable, which acquires the value of one if controlled foreign company rules apply between *S* and *R* and the value of zero otherwise.	Karkinsky and Riedel (2012) and our own research	1/0
TP Rules	An index which indicates on a scale from 0 to 5 the presence and strictness of transfer pricing regulations in a country.	Zinn et al. (2014) and our own research	An index

[266] See OECD (2014d).

Table B.4 Countries with IP Boxes in Place, 2012

Country	IP Box Tax Rate	Statutory Tax Rate	Type of IP allowed	
			Acquired	Existing
Belgium	6.8	33.9	N	N
China	0-12.5[1]	25	N[2]	N
Cyprus	2.5	10	Y	Y
France	16.2	34.4	Y	Y
Hungary	9.5	19	Y	Y
Liechtenstein	2.5	12.5	Y	N
Luxembourg	5.8	28.9	Y[3]	Y
Malta	0	35	Y	N
Netherlands	5	25	N	N
Spain	12	30	N	Y

Notes: [1]The exact rate depends on the income size. [2]IP developed outside of China is not allowed to be included in the IP Box. [3]In Luxembourg acquired IP is only eligible for the IP Box under certain circumstances. The time span of this variable is 1995-2012; the year 2012 was chosen in this table because it is the last year of observation in our sample. Please note that since 2012 countries such as Italy, Ireland, Portugal, and the UK have introduced IP Boxes. Statutory tax rates correspond to the corporate income tax including any surcharges (Belgium, France, and Luxembourg), local taxes (Luxembourg) and other taxes. Abbreviations: Y: Yes, N: No. Sources: Evers et al. (2015a) and our own research.

Table B.5 B-Index, 2012

Country	B-Index	Country	B-Index
Australia	0.808	Luxembourg	1.008
Austria	0.887	Mexico	1.013
Belgium	0.798	Netherlands	0.917
Canada	0.823	New Zealand	0.827
Chile	1.011	Norway	0.790
Czech Republic	0.798	Poland	1.011
Denmark	0.789	Portugal	0.498
Finland	1.009	Slovakia	1.008
France	0.944	Slovenia	0.915
Greece	0.994	Spain	0.485
Hungary	0.708	Sweden	1.013
Iceland	1.014	Switzerland	1.007
Ireland	0.944	Turkey	0.762
Italy	0.819	UK	0.915
Japan	0.864	US	0.959
Korea	0.900		

Notes: The time span of this variable is 1995-2012; the year 2012 was chosen in this table because it is the last year of observation in our sample. Sources: Ernst and Spengel (2011), Thomson (2013), Chen and Dauchy (2015), and our own calculations.

Table B.6 Countries with CFC Rules in Place, 2012

Country	Conditions, under which CFC Rules are Binding
Argentina	Countries that are not on the “Co-operative States” list
Australia	Countries that are not on the “Co-operative States” list
Brazil	Always binding
Canada	Always binding
China	Effective tax rate is < 50% of Chinese tax and a country is not on the “White List”
Denmark	Always binding
Egypt	Effective tax rate is < 75% of the Egyptian tax
Estonia	Effective tax rate is < 33% of Estonian tax and a country is not on the “White List”
Finland	Effective tax rate is < 60% of Finnish tax or a country is on the “Grey List”
France	Effective tax rate is < 50% of French tax
Germany	Effective tax rate is < 25%
Iceland	Effective tax rate is < 66% of Icelandic tax
Israel	Effective tax rate is < 15%
Italy	Effective tax rate is < 50% of Italian tax or a country is on the “Black List”
Japan	Effective tax rate is < 20%
Korea	Average effective tax rate is < 15% for most recent consecutive three years
Lithuania	Effective tax rate is < 75% of Lithuanian tax or a country is on the “Black List”
Mexico	Effective tax rate is < 75% of Mexican tax
New Zealand	Countries that are on the “Grey List”
Norway	Effective tax rate is < 66% of Norwegian tax or a country is on the “Black List”[1]
Portugal	Effective tax rate is < 60% of Portuguese tax or a country is on the “Black List”
South Africa	Effective tax rate is < 75% of South African tax
Spain	Effective tax rate is < 75% of the Spanish tax
Sweden	Effective tax rate is < 55% of Swedish tax, except a country is on the “White List”
Turkey	Effective tax rate is < 10%
UK	Effective tax rate is < 75% of British tax
Uruguay	Effective tax rate is < 12%
US	Always binding

Notes: [1]The rules do not apply if a tax treaty exists. The time span of this variable is 1995-2012; the year 2012 was chosen in this table because it is the last year of observation in our sample. Since 2006 the rules do not apply within the European Economic Area, except in special cases. CFC stands for controlled foreign company. Sources: Karkinsky and Riedel (2012) and our own research.

Table B.7 Overview of International Transfer Pricing Regulations, 2012

Country	TP Rules	Country	TP Rules	Country	TP Rules
Argentina	5	Hungary	4	Norway	4
Australia	4	Iceland	1	Philippines	2
Austria	2	India	5	Poland	4
Belgium	2	Indonesia	5	Portugal	4
Brazil	5	Iran	0	Romania	3
Bulgaria	2	Ireland	3	Russia	3
Canada	4	Israel	4	Singapore	2
Chile	1	Italy	4	Slovakia	3
China	5	Japan	4	Slovenia	4
Croatia	2	Korea	4	South Africa	3
Cyprus	0	Latvia	2	Spain	3
Czech Rep.	2	Lithuania	3	Sweden	3
Denmark	4	Luxembourg	2	Switzerland	2
Egypt	3	Malaysia	4	Thailand	2
Estonia	4	Malta	0	Turkey	4
Finland	4	Morocco	2	UK	3
France	3	Mexico	5	Uruguay	2
Germany	3	Netherlands	4	US	4
Greece	4	New Zealand	2	Venezuela	4
Hong Kong	2	Nigeria	0		

Notes: TP stands for transfer pricing. The time span of this variable is 1995-2012; the year 2012 was chosen in this table because it is the last year of observation in our sample. The index acquires the following values:
0: no transfer pricing regulations;
1: arm’s length principle was introduced in the national tax law;
2: transfer pricing documentation requirement is not introduced, but documentation is required to exist in practice;
3: documentation requirement is introduced in the national tax law, but full documentation must be provided only upon request;
4: a short disclosure of transfer pricing documentation is required;
5: a long disclosure of transfer pricing documentation is required.
Sources: Zinn et al. (2014) and our own research.

C Appendix to Chapter 5

Appendix C1. Replication of Griffith et al. (2014)

This study is based on the identification strategy applied by Griffith et al. (2014). Even though the estimation approaches are the same, the two papers slightly differ in their data samples. In order to examine these differences in more detail, we replicate the estimation of Griffith et al. (2014) as closely as possible in this part of the paper. Table C.1 presents the results of replicating Griffith et al. (2014) and gradually moving away from their sample to the one used in our paper. Similarly to the robustness checks and extended analysis, all estimations in Table C.1 employ data on non-large firms of the engineering sector as a representative sample.

Column I of Table C.1 presents the results reported by Griffith et al. (2014).[267] Column II shows the closest replication of these results that we achieve. Column III adds data from the US patent and trademark office to the sample (the study by Griffith et al. (2014) is based on data from the European patent office only). It becomes apparent from the table that the gradual alteration of the original sample does not significantly influence the key findings. The coefficient on the tax rate and its interaction with a measure of patent quality remain negative and statistically significant.

The last two columns of Table C.1 present the baseline results of our study. The major difference between column III and column IV is the period of observation. The estimation in column III uses data on patent applications between 1985 and 2005, whereas the specification in column IV employs data on patent applications between 1996 and 2012.[268] Another minor difference concerns the variable *IP Rights Protection*. Referring to Griffith et al. (2014), in the sample of 1985-2005 this control variable is based on a measure developed by Ginarte and Park (1997) and Park (2008). However, as the equivalent data is not available for a later time frame, we use statistics from the Heritage Foundation, as described in section 5.4.3, to construct this variable for our analysis. As shown in column IV, the change in the time period slightly

[267] See Griffith et al. (2014), p. 20.

[268] We use a more recent time period in our benchmark analysis because the information on trademark applications between 1985 and 1995 is not available to us.

increases (in absolute terms) the coefficient on *Tax Rate*. Column V displays the key contribution of this paper, which is the estimation of the impact of taxation on trademark location choices. The coefficient on *Tax Rate* in column V turns out to be more negative than in column IV, confirming Hypothesis 2 of this study.

Table C.1 Replication of Griffith et al. (2014)

	1985-2005	Our Replication (1985-2005)		Our Results (1996-2012)	
	Griffith et al. (2014)	Closest Replication of Griffith et al.(2014)	Column II + USPTO Data	Patents (Column IV, but different time period)	Trademarks
	I	II	III	IV	V
Tax Rate	-4.88***	-3.471***	-3.481***	-4.969***	-7.217***
	(0.24)	(0.049)	(0.049)	(0.074)	(0.114)
*Tax Rate*Quality*	-0.66**	-2.924***	-2.925***	-2.804***	-3.085***
	(0.28)	(0.059)	(0.060)	(0.113)	(0.262)
Tax Rate (Std.Dev.)	3.17***	1.766***	2.859***	4.233***	6.235***
	(0.27)	(0.138)	(0.095)	(0.102)	(0.139)
Real Activity	7.03***	8.628***	8.736***	8.362***	
	(0.09)	(0.065)	(0.065)	(0.063)	
Real Activity (Std.Dev.)	2.96***	4.420***	4.627***	4.273***	
	(0.08)	(0.050)	(0.050)	(0.049)	
High IP Rights Protection	0.19*	0.452***	0.423***	0.963***	0.176***
	(0.10)	(0.011)	(0.010)	(0.036)	(0.041)
GDP	0.43***	-0.014*	0.055***	1.128***	0.001
	(0.05)	(0.008)	(0.007)	(0.019)	(0.006)
BERD	0.09**	3.49e-05	0.004	-0.517***	0.203***
	(0.04)	(0.021)	(0.021)	(0.053)	(0.037)

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. Results are based on non-large firms of the engineering sector. The dependent variable is location choice in one of the countries shown in Table 5.1. Location-industry-firm size fixed effects are included in all estimations. *Tax Rate* stands for a host country's tax rate levied on the income from intangible assets and incorporates taxation under IP Boxes and CFC rules. *Quality* is a dummy variable that indicates intangible assets of high quality (applications filed at multiple offices). *Real Activity* is a dummy variable, which is equal to one if at least one of the intangible's inventors resides in the given country and takes on the value of zero otherwise. *High IP Rights Protection* represents an indicator of a country's level of intellectual property rights protection. *GDP* denotes a country's gross domestic product. *BERD* stands for a country's business expenditure on research and development in relation to its GDP.

In summary, there are two differences between the samples used in Griffith et al. (2014) and our study. First, we use USPTO data in addition to the EPO information employed by Griffith et al. (2014). Secondly, Griffith et al. (2014) consider the time span between 1985 and 2005, whereas we concentrate on the period between 1996 and 2012. Despite these differences between the two studies, our key findings are consistent with Griffith et al. (2014), as the analysis in Table C.1 shows.

Appendix C2. Results with Subsidiaries of US Corporations

Our benchmark analysis is based on the estimation approach of Griffith et al. (2014), and in line with the authors, we include in our sample companies with parent firms in one of these fourteen countries: Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Norway, Spain, Sweden, Switzerland, and the United Kingdom. In this section, we additionally include in our sample companies with parent firms in the Unites States and show the corresponding estimation results in Table C.2.

Table C.2 Results with Subsidiaries of US Corporations

Panel A. Patents

Industry	Electrical		Engineering		Chemical	
Size	Large	Non-Large	Large	Non-Large	Large	Non-Large
Tax Rate	-5.554***	-6.118***	-5.681***	-3.475***	-4.792***	-4.758***
	(0.054)	(0.048)	(0.063)	(0.031)	(0.099)	(0.054)
*Tax Rate*Quality*	-2.052***	-0.478***	-3.351***	-1.429***	-2.066***	0.297***
	(0.067)	(0.061)	(0.069)	(0.038)	(0.111)	(0.067)
Tax Rate (Std.Dev.)	1.584***	1.809***	3.884***	1.820***	2.182***	1.693***
	(0.071)	(0.058)	(0.065)	(0.051)	(0.129)	(0.092)
Real Activity	4.940***	6.382***	6.116***	9.872***	6.957***	8.254***
	(0.022)	(0.025)	(0.036)	(0.059)	(0.096)	(0.072)
Real Activity (Std.Dev.)	2.349***	2.835***	3.271***	5.609***	4.714***	4.535***
	(0.025)	(0.020)	(0.035)	(0.045)	(0.098)	(0.058)
High IP Rights Prot.	0.213***	0.419***	0.134***	0.153***	0.453***	0.098**
	(0.027)	(0.030)	(0.039)	(0.019)	(0.063)	(0.041)
GDP	0.471***	0.221***	-0.035***	0.266***	-0.057***	0.281***
	(0.008)	(0.005)	(0.008)	(0.004)	(0.011)	(0.007)
BERD	0.286***	0.715***	0.459***	0.139***	0.240***	0.752***
	(0.018)	(0.019)	(0.023)	(0.012)	(0.037)	(0.022)

Panel B. Trademarks

Industry	Electrical		Engineering		Chemical	
Size	Large	Non-Large	Large	Non-Large	Large	Non-Large
Tax Rate	-9.974***	-10.930***	-9.123***	-10.160***	-8.587***	-8.755***
	(0.158)	(0.072)	(0.163)	(0.079)	(0.147)	(0.078)
*Tax Rate*Quality*	-3.074***	-3.767***	0.522	-2.975***	-4.499***	-2.265***
	(0.303)	(0.132)	(0.337)	(0.179)	(0.205)	(0.170)
Tax Rate (Std.Dev.)	4.780***	-0.604*	4.098***	3.787***	3.012***	2.791***
	(0.158)	(0.318)	(0.182)	(0.084)	(0.185)	(0.104)
High IP Rights Prot.	0.039	0.196***	0.352***	-0.012	-0.234***	0.047
	(0.089)	(0.039)	(0.072)	(0.037)	(0.082)	(0.037)
GDP	0.058***	0.096***	0.042***	0.076***	0.070***	0.027***
	(0.008)	(0.004)	(0.008)	(0.004)	(0.009)	(0.004)
BERD	-0.578***	0.274***	-0.105**	0.292***	0.094*	0.159***
	(0.049)	(0.024)	(0.049)	(0.025)	(0.050)	(0.026)

Notes: ***, **, * indicates significance at the 1%, 5%, and 10% level. The samples include 3,899,752 patent applications and 1,012,287 trademark applications (the number of observations is 58,496,280 for patents and 15,184,305 for trademarks). The dependent variable is location choice in one of the countries shown in Table 5.1. Location-industry-firm size fixed effects are included in all estimations. Large stands for companies with a total number of applications above the 80th percentile in their industry; Non-Large companies are enterprises of other sizes. *Tax Rate* represents a host country's tax rate levied on the income from intangible assets and incorporates taxation under IP Boxes and CFC rules. *Quality* is a dummy variable that indicates intangible assets of high quality (applications filed at multiple offices). *Real Activity* is a binary variable, which is equal to one if at least one of the intangible's inventors resides in the given country and takes on the value of zero otherwise. *High IP Rights Prot.* represents an indicator of a country's level of intellectual property rights protection. *GDP* denotes a country's gross domestic product. *BERD* stands for a country's business expenditure on R&D in relation to its GDP.

According to Table C.2, the inclusion of firms with American parents in our sample does not influence the main findings. Hence, trademarks (see Panel B of Table C.2) show a more negative tax sensitivity than patents (see Panel A of Table C.2). This outcome is observed across all industries and firm-size categories. However, the marginal effects for patents and trademarks appear to be larger (in absolute terms) than the effects obtained in our baseline estimations (see Table 5.4) once American firms are included in the sample. This suggests that companies with US parents are even more responsive to changes in taxation than subsidiaries of European firms.[269]

[269] This result is observed across all industries and firm sizes with the exception of patent applications filed by non-large companies of the engineering sector. Here, the marginal effect decreases once US companies are added to the sample.

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