Reforming Multinational Corporate Income Taxation in the European Union

The Transition from Separate Accounting to Formula Apportionment from a Tax Competition Perspective

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Dedicated to the Ultimate Man

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Abstract

A main reason for founding the European Union was to remove internal trade obstacles and to establish a *Single Market* within its borders. Along with the increasing integration of international markets, an ever-increasing diversification of firms in tandem with the development of multinational enterprises is observable. Legislative authorities of the European Union and its member states are faced with the challenge of ensuring that their corporate tax systems keep pace with this economic transformation of companies and markets. Hence, in order to meet the requirements of an integrated European market, in 2001 the European Commission proposed a switch from Separate Accounting to Formula Apportionment as the leading corporate income taxation system in the European Union.

Basically, corporate income of multinational enterprises can be taxed according to these two different principles. At present Separate Accounting is applied at the international level, while some countries like the U.S., Canada, Germany and Switzerland use Formula Apportionment at the state or federal level.

Under the current system of Separate Accounting each subsidiary of a multinational enterprise is treated as a separate entity subject to national tax law. For this reason multinationals have to value their intra-firm trade using internal transfer prices, which should meet an external standard of comparison, so-called arm's length prices. Because of the very nature of internal trade with firm-specific tangibles and intangibles evaluating adequate transfer prices proved difficult. Consequently, Separate Accounting was identified as one reason for manipulations in favor of profit shifting for tax saving purposes.

That is why the European Commission regards the consolidation of profits including cross-border loss offset for calculating a multinational company's tax base as a more suitable approach in the economic union and advocates the Common Consolidated Corporate Tax Base (CCCTB). To allocate the consolidated tax base to the taxing countries a splitting mechanism is needed. Hence, the CCCTB proposal includes a system of Formula Apportionment. A formula apportions a share of the overall tax base depending on the multinational enterprise's geographical economic activity in the respective country. The European Commission favors a common three-factor apportionment formula containing assets, labor and sales to represent the production and consumption side.

The European Commission's proposal has initiated a continuing politico-economic discussion about the efficiency and distributional consequences of the transition to Formula Apportionment in Europe.

This doctoral thesis evaluates particular issues within this debate by presenting three theoretical articles to answer specific research questions. The articles are based on the methodological concept of a Nash tax competition model under perfect symmetry, where countries choose their corporate tax rates non-cooperatively. The non-cooperative behavior of one country may impose fiscal externalities on other countries and thereby renders the tax policy inefficient.

This dissertation focuses on the derivation, explanation and interpretation of the resulting inefficiencies under Separate Accounting and Formula Apportionment. For this reason it contributes three papers to the theoretical literature of optimal tax policies in a non-cooperative equilibrium of tax rates. The work aims to compare and discuss the alternative policy options.

The first article pertains to the public debate about the right taxation principle to apply in Europe. The article investigates the effect of fiscal equalization on the efficiency properties of corporate income tax rates chosen under the taxation principles of Separate Accounting and Formula Apportionment.
Fiscal equalization ensures efficiency if the marginal transfer just reflects the fiscal and pecuniary externalities of tax rates. In contrast to previous studies, tax base equalization (Representative Tax System) does not satisfy this condition, but combining tax revenue and private income equalization does, regardless of which taxation principle is implemented. This finding implies that it does not matter whether MNEs are taxed according to Separate Accounting or Formula Apportionment if there is equalization of national income (i.e. private income plus tax revenues). Under Formula Apportionment, tax base equalization is superior to tax revenue equalization if the wage income externality is sufficiently large.
Even though the European Union does not have an explicit equalization system, a part of the Unions's budget is financed by contributions from the member states. The implied income redistribution would indeed not be enough to ensure efficiency of corporate income taxation, since the budget is not an equalization system in the sense of our analysis. But the very existence of income redistribution in Europe might indicate that reforming the member states' contributions to the budget in a suitable way may politically be easier to achieve than replacing an implemented corporate tax system.

The second article refers to the sales factor in the proposed three-factor formula under Formula Apportionment. The incorporation of a sales factor in the formula as well as the assignment of sales at the place of origin or destination are hotly debated issues. The CCCTB Working Group suggested in 2007 the inclusion of sales following the destination principle but also mentioned that "...most member states experts that would support the inclusion of sales as a factor would prefer sales measured 'at origin' ". With

regard to the most recent proposal by the European Commission in 2011, the European Parliament advocated that the sales weight be lowered to 10%. The *Committee of the Internal Market and Consumer Protection* even called for the removal of the sales factor. In contrast, from Canada and the United States, the opposite development has been observed, namely the increasing importance of the sales factor.
Taking a two-country Nash tax competition model with a sales-only formula and market power, we investigate (i) whether the transition from Separate Accounting to Formula Apportionment mitigates tax competition and improves welfare and (ii) whether tax competition is weakest when sales are measured with the origin principle. The driving force is a negative consumption externality that hampers the positive formula externality present for both the origin and destination principle.

The third paper investigates the Commission's recommendation to implement a transition process to Formula Apportionment. During the change Formula Apportionment should be optional for multinational enterprises.
Recent empirical literature proves that profit consolidation reduces multinational enterprises' involuntary costs for complying with different tax laws, but increases discretionary compliance costs incurred by tax planning activities.
That is why the third article considers a two-country model with multinationals that are heterogeneous with respect to their involuntary compliance costs. Additionally, multinational enterprises using the Formula Apportionment system face higher discretionary compliance costs due to restricted tax base manipulation opportunities. Hence, multinational enterprises would prefer to be taxed under Formula Apportionment if and only if under Separate Accounting the involuntary compliance costs exceed the tax advantage due to better profit shifting possibilities. We show that a non-negative threshold value of involuntary compliance costs exists such that multinationals with costs above this level choose Formula Apportionment. We prove in a symmetric setting that starting from a pure Separate Accounting system with national revenue maximization, a transition from Separate Accounting to an optional Formula Apportionment increases the non-cooperative tax rates and national revenues for both countries ending up with the results of pure Formula Apportionment. This is because with identical tax rates the multinational enterprise cannot benefit from the better profit shifting opportunities under Separate Accounting but saves involuntary compliance costs. In our analysis the optional system of tax base consolidation promises an efficiency enhancement for the member countries. Hence, we deliver an additional argument in support of an international agreement on the CCCTB proposal.

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Abbreviations

BEPS	**B**ase **E**rosion and **P**rofit **S**hifting Project
CCTB	**C**ommon **C**orporate **T**ax **B**ase
CCCTB	**C**ommon **C**onsolidated **C**orporate **T**ax **B**ase
DP	**D**estination **P**rinciple
EC	**E**uropean **C**ommission
ECOFIN	**ECO**nomic and **FIN**ancial Affairs Council
EU	**E**uropean **U**nion
FA	**F**ormula **A**pportionment
FDI	**F**oreign **D**irect **I**nvestment
FOC	**F**irst **O**rder **C**ondition
ITR	**I**mplicit **T**ax **R**ate
MCPF	**M**arginal **C**ost of **P**ublic **F**unds
MNE	**M**ulti**N**ational **E**nterprise
OECD	**O**rganisation for **E**conomic **C**o-operation and **D**evelopment
OP	**O**rigin **P**rinciple
RTS	**R**epresentative **T**ax **S**ystem
SA	**S**eparate **A**ccounting
U.S.	**U**nited **S**tates

Chapter 1

Introduction

In the year 2001 the European Commission (EC) proposed the introduction of the Common Consolidated Corporate Tax Base (CCCTB) in the European Union (EU) (European Commission, 2001). The proposal of the CCCTB incorporates tax base consolidation of multinational enterprises (MNEs) as well as a formula that apportions the aggregated tax base to the respective member states. In the following we refer to the proposal as the Formula Apportionment principle. The aim of introducing Formula Apportionment is to replace the statutory principle of Separate Accounting as the leading corporate income tax system in the EU. The EC intends to adjust the European corporate tax system in order to confront the increasing integration of international markets accompanied by the intensified diversification of firms. Among other things, the legislative authorities in the EU and its member states are faced with the challenge of ensuring that their tax systems keep pace with the economic transformation of companies and markets, for instance in the manufacturing, pharmaceutical and food sectors. The increasing integration of international markets is also accelerating the flows of mobile capital as well as the volume of trade around the world (OECD, 2014). Furthermore, rapid developments in information and communication technology in the last two decades has facilitated companies' global market access without them even needing a physical presence. This trend has been accompanied by an increasing number of MNEs and an associated expansion in their activities.

For this reason, profit consolidation including cross-border loss offset for calculating the tax base of an MNE is seen as a more appropriate approach in the economic union than

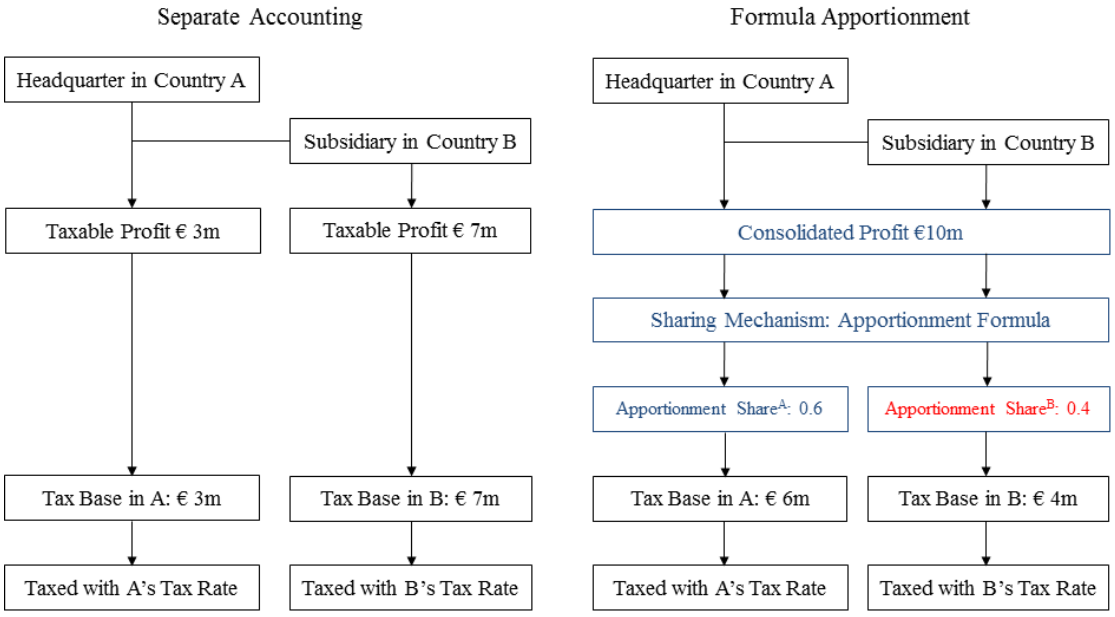
the current system of Separate Accounting with its need for transfer pricing.

The EC's proposal has initiated a continuing political and scientific discussion about the efficiency and distributional consequences of such a transition to Formula Apportionment. This dissertation aims to evaluate and elaborate three particular aspects of the debate. These are integrated in the doctoral thesis as Chapters 2, 3 and 4.

1.1 Corporate Income Taxation Principles

Basically, the corporate income of MNEs can be taxed according to two different principles: Separate Accounting and Formula Apportionment. Presently, Separate Accounting is applied for corporate income taxation at the international level, while some countries like the U.S., Canada, Germany and Switzerland use Formula Apportionment to tax companies that operate in several jurisdictions at the national or local level. The basic working mechanism of both principles on the international level is represented in Figure 1.1 and explained in more detail in the subsequent sections. We have considered two countries and one MNE with two entities.

FIGURE 1.1: Schematic Representation of Corporate Income Taxation Principles



1.1.1 Separate Accounting

Under Separate Accounting, each subsidiary of an MNE is treated as a separate entity subject to national tax law. This case is reflected on the left hand side of Figure 1.1. To derive national tax bases, MNEs have to value their intra-firm trade with internal transfer prices, which must meet an external standard of comparison, i.e. arm's length prices.[1] In particular it may be difficult to evaluate an appropriate reference price because firm-specific tangibles and intangibles are traded. Additionally, tax authorities are not able to access complete information about the nature of internal trade. As a consequence, Separate Accounting was identified as vulnerable to manipulations in favor of tax-saving-induced profit shifting. Governments have attempted to confront this development and put more effort in to detecting profit shifting strategies mainly by demanding detailed supporting documents. These activities in conjunction with an expanding number of EU members have increased administrative expenses for the countries and compliance costs for the MNEs. To moderate this trend, the EC proposed switching from Separate Accounting to Formula Apportionment to tax the corporate income of MNEs in the EU (European Commission, 2001, 2011b).

1.1.2 Formula Apportionment

Under Formula Apportionment the corporate income of all subsidiaries is consolidated and afterwards allocated to the countries in which they do business. The allocation is based on a splitting mechanism -the Apportionment Formula- that assigns tax base shares to the taxing countries depending on the MNE's geographic economic activity (Weiner, 2006). The right hand side in Figure 1.1 provides a visualization of the basic idea.

For the EU the Commission recommends a common three-factor apportionment formula containing assets, labor and sales at destination (CCCTB Working Group, 2007b) as presented in Figure 1.2 for the subsidiary in country B in Figure 1.1. Each factor gets a formula weight between zero and one so that the weights sum up to unity. To take account of the different national labor intensities the labor factor is additionally split into payroll and employee parts.

[1] For example, firms buy and sell in-house intermediate products and services or borrow and lend money at an internal interest rate.

FIGURE 1.2: European Commission's Recommended Apportionment Formula

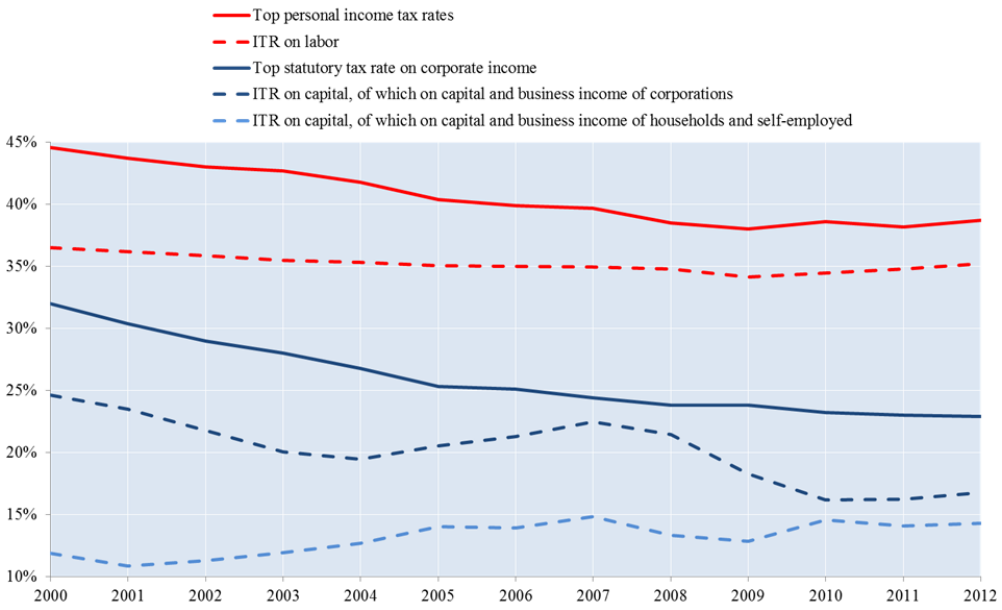
$$\text{Apportionment Share}^{B} = \sigma \frac{\text{Sales}^{B}}{\text{Sales}^{Group}} + \varphi \left[\frac{1}{2} \frac{\text{Payroll}^{B}}{\text{Payroll}^{Group}} + \frac{1}{2} \frac{\text{Number of Employees}^{B}}{\text{Number of Employees}^{Group}} \right] + \gamma \frac{\text{Assets}^{B}}{\text{Assets}^{Group}}$$

with sum of formula weights $\sigma + \varphi + \gamma = 1$

1.2 Institutional Background

Originally, the EU was founded as an economic union to remove trade obstacles among its member states. The aim was to establish a *Single Market* within its borders whilst maintaining the sovereignty of member states (European Commission, 2011b). For European corporate tax legislation this precondition implies for example that a common corporate income taxation principle would be accompanied by individual tax elements such as tax rates or tax allowances determined by national governments. Based on the described structure, the European Commission (1997) feared tax competition among member countries, and therefore losses in national tax revenues. Additionally, the EC regards shifting the tax burden from mobile capital to more immobile tax bases like labor as an unfavorable tax structure (European Commission, 1997). Figure 1.3 displays the persistent divergence of tax burden over time with the help of top statutory and implicit tax rates in the EU.

FIGURE 1.3: Comparison of EU Top Statutory Tax Rates on Labor and Corporations and Implicit Tax Rates on Labor and Capital, 2000-2012



Source for statutory tax rates: European Commission, and Eurostat, 2014, Taxation Trends in the European Union — Data for the EU Member States, Iceland and Norway, Luxembourg: Publications Office of the European Union.

Annotations for statutory tax rates: Simple averages, EU-28

Source for implicit tax rates: European Commission, and Eurostat, 2014, Products Datasets: Implicit tax rates by economic function, data download: 25/09/2015, own calculations

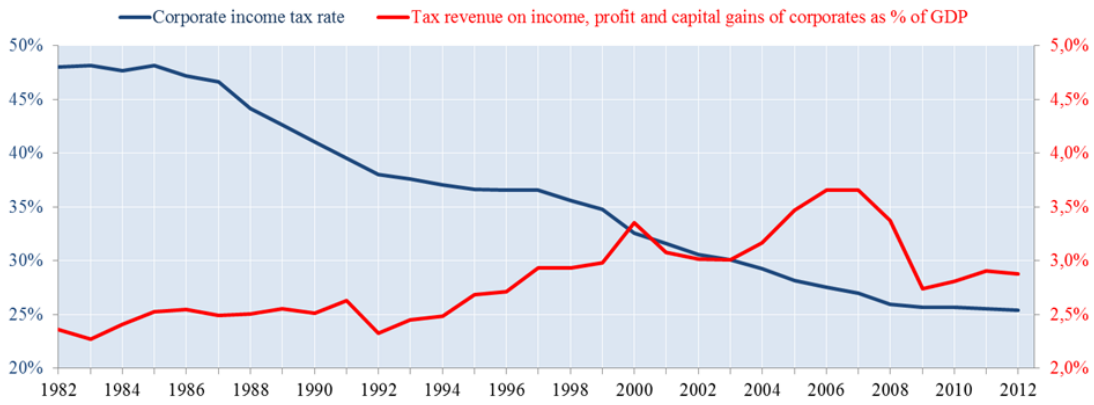
Annotations for implicit tax rates: Simple averages, data available for Belgium, Czech Republic, Denmark (2012 data from 2011), Estonia, Ireland, Spain, France, Italy, Cyprus, Latvia, Lithuania, Hungary, Netherlands, Austria, Poland, Portugal, Slovenia, Slovakia, Finland, Sweden, United Kingdom

Tax competition is seen as harmful if countries use their national tax legislation instruments aggressively to boost their tax revenues at the expense of other governments' budgets in the union. In the *Code of Conduct for Business Taxation* the European Council (1997) summarizes harmful tax measures as follows: *"... tax measures which provide for a significantly lower effective level of taxation, including zero taxation, than those levels which generally apply in the Member State in question ... . Such a level of taxation may operate by virtue of the nominal tax rate, the tax base, or any other relevant factor."*

While figure 1.4 shows that the corporate tax rates within the OECD indeed have decreased over a period of 30 years, it becomes obvious that at the same time the

corporate revenues are relatively stable and slightly increasing. This observation can be traced back to higher productivity of firms and tax-cut-cum-base-broadening policy (Haufler, 2001). Hence, the lower tax rates per se do not necessarily imply accelerated tax competition for the EU.

FIGURE 1.4: Average OECD Corporate Tax Rate and Tax Revenue, 1982-2012



Source: OECD.Stat, Dataset: Revenue Statistics - Comparative tables and Table II.1. Corporate income tax rate, Data Download: 21/09/2015

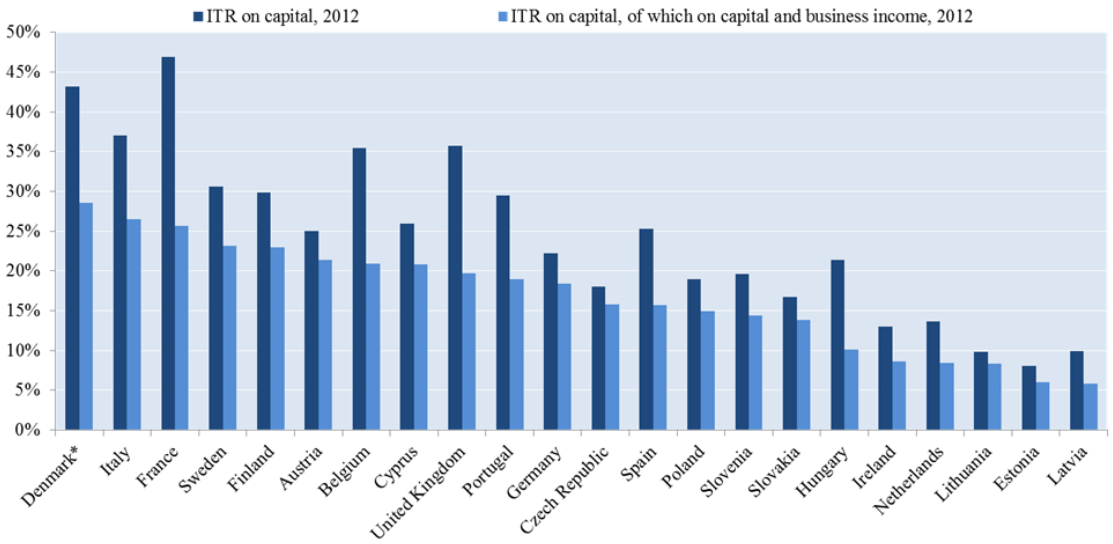
Annotations: Own calculations of OECD average tax rates, simple averages

However, an indication of the kind of tax competition described can be delivered by a direct comparison of national tax rates. The European Commission (2014) provides implicit tax rates (ITR) as a measure of the effective average tax burden on the respective tax base.[2] Figure 1.5 reveals that the ITRs on capital and on capital and business income[3] among EU member states are actually cover a wide spread. In particular small countries like the Baltic states, the Netherlands and Ireland provide low capital tax rates compared to larger economies. This hints at the fact that countries with less quantitative need for tax revenues try to attract tax base by offering a comparative tax rate advantage.

[2]The ITR relates aggregate tax revenues to the potential tax base. For a detailed description of the calculation method see European Commission (2014).

[3]Excludes taxes on capital stock.

FIGURE 1.5: Comparison of Implicit Tax Rates 2012 for Selected EU Countries



Source: European Commission, and Eurostat, 2014, Products Datasets: Implicit tax rates by economic function, data download: 25/09/2015

Annotations: *Denmark data from 2011

The first officially and widely recognized approach to adjusting the European corporate tax policy in order to deal with the increasing pressure of globalization was the EC's communication to the Council *Towards tax co-ordination in the European Union - A package to tackle harmful tax competition* (European Commission, 1997). Former attempts for more harmonization like the Neumark Report (1962), the Tempel Report (1970) or the Ruding Report (1992) came to naught due to the reluctance of the member states. Against this background it was an achievement for the EC that the ECOFIN council passed the *Code of Conduct for Business Taxation* in December 1997 based on the recommendations of the European Commission (1997). Almost simultaneously, in 1998, the OECD published the report on *Harmful Tax Competition - An Emerging Global Issue*, which had a similar message. The conclusions of the European Council (1997) meeting state:

"Recalling that a comprehensive approach to taxation policy was launched, ..., and confirmed ..., in the light of the consideration that coordinated action at the European level is needed in order to reduce continuing distortions in the single market, prevent significant losses of tax revenue and help tax structures develop in a more employment-friendly

way, ... ,
Acknowledging the positive effects of fair competition and the need to consolidate the competitiveness of the European Union and the Member States at international level, whilst noting that tax competition may also lead to tax measures with harmful effects,
Acknowledging, therefore, the need for a code of conduct for business taxation designed to curb harmful tax measures,
Emphasizing that the code of conduct is a political commitment and does not affect the Member States' rights and obligations or the respective spheres of competence of the Member States and the Community resulting from the Treaty, ..."

The first comprehensive approach to reforming the European corporate tax system was the communication *Towards an Internal Market Without Tax Obstacles* (European Commission, 2001) in 2001. In the following years the EC provided a multitude of analyses and technical reports culminating in the *Proposal for a Council Directive on a Common Consolidated Corporate Tax Base* in 2011 (European Commission, 2011b). Except for the consulting of the European Parliament in 2012 (European Parliament, 2012) further progress on a Council Directive stagnated until in June 2015 the European Commission (2015) "presented an Action Plan to fundamentally reform corporate taxation in the EU". As one "key action" it announces a "strategy to relaunch the CCCTB and a framework to ensure effective taxation where profits are generated" (Source: European Commission - press release, Brussels, 17 June 2015). Furthermore, the OECD (2013) has reinforced its efforts to tackle corporate tax avoidance on an international level, creating the Base Erosion and Profit Shifting package (BEPS) in the year 2013, which was approved by the G20 countries in 2015. The EU aims to implement the OECD measures, and therefore at the beginning of 2016 the European Commission (2016) published a new Communication with the strong statement "to put the fight against corporate tax avoidance and unfair tax competition at the heart of its political agenda" accompanied by an "ambitious reform program". The CCCTB was reacknowledged as a "holistic solution to profit shifting" and the program now contains a step-wise introduction of the CCCTB via the intermediate step of agreeing a common corporate tax base.

1.3 Own Contribution and Relation to Literature

Current empirical studies measure the economic implication of the transition to Formula Apportionment and the expected distributional effects of the reform in Europe. For all studies it holds that introducing Formula Apportionment creates winner and loser countries with respect to revenues and welfare. Oestreicher and Koch (2011) find that under the CCCTB the total tax revenue of the EU member states will be reduced by around 4.6%. However, Devereux and Loretz (2008) estimate that overall revenues will change only modestly. In contrast, in the analysis of Fuest et al. (2007) the corporate tax base shrinks significantly. A study by Roggeman et al. (2015) interlinks the national revenue implications with the voting behavior of the Members of the European Parliament. The results show that delegates from countries that stand to gain are more likely to vote in favor of the CCCTB. In connection with the requirement for unanimity in respect of tax system adjustments the authors refer to the enhanced cooperation among at least nine member states as a transitional procedure for the CCCTB. In a simulation by Bettendorf et al. (2010) a coalition of similar countries would be the most successful alternative. Despite the fact that the empirical literature gives an insight into the expected distributional effects of the reform, it is not able to take into account optimal tax policies where there is a non-cooperative equilibrium of tax rates. This function is taken over by the theoretical literature to which this dissertation aims to contribute. The models presented are symmetrical, meaning that distributional effects are automatically neglected. Our analyses rest on the efficiency approach, which, according to Devereux (2004) should be the dominant guiding principle of the international tax design, with equity should have a minor influence.

The related theoretical economic research takes up the institutional and empirical observations and translates them into a simplified Nash tax competition framework for a group of countries forming the economy. If the countries harmonize their tax policies and choose their corporate tax rates cooperatively, the outcome is the most efficient solution, which serves as the reference for the policy analysis. Under non-cooperation, individually selected tax rates may be higher or lower than that under the cooperative solution, thus rendering the policy inefficient. An alternative approach for judging the efficiency properties of a policy option is provided by the concept of fiscal externalities,

which shows how a non-cooperative, marginal change in one country's tax rate can influence the private and public income, consumption and production possibilities in other countries. Externalities can be positive or negative and consequently, non-cooperative equilibrium tax rates are inefficiently low or high.

The concerns of the EC described above regarding tax competition resulting from tax rate differentials among countries were first analyzed by Zodrow and Mieszkowski (1986) and Wilson (1986). In their seminal articles local governments compete for the mobile tax base capital by undercutting property tax rates. If tax revenues are used to provide a local public consumption good and jurisdictions maximize the utility of a representative resident, the papers prove that the public good is underprovided. The result originates from a positive capital flight externality, in that the increase in the property tax rate in one jurisdiction demands a higher return to capital and therefore, triggers the outflow of capital into the remaining regions. Because the local government does not consider this effect, the equilibrium tax rates are inefficiently low, and hence the public good is underprovided.

1.3.1 Fiscal Equalization

In his seminal paper, Wildasin (1989) discusses the implications of fiscal equalization as a policy option to mitigate the consequences of capital tax competition. More recent contributions include Büttner (2006), Dahlby and Warren (2003), Smart (2007) and Egger et al. (2010) without distinguishing different taxation principles.

In Chapter 2 this thesis investigates the effect of fiscal equalization on the efficiency properties of corporate income tax rates under Separate Accounting and Formula Apportionment. It is based on the article Liesegang and Runkel (2009).[4] We take a tax competition point of view and show that it does not matter whether MNEs are taxed according to Separate Accounting or Formula Apportionment provided the group of countries in which the MNEs operate has implemented the right fiscal equalization system.

[4]In this paper my co-author and I provide almost equal contributions. A revised version of the previous working paper will be partially published as Liesegang and Runkel (2017) in the Journal of International Tax and Public Finance, DOI 10.1007/s10797-017-9451-6. The final publication is available at `https://link.springer.com/article/10.1007/s10797-017-9451-6`.

We employ a multi-country tax competition model with fiscal equalization among countries. With the help of this model we investigate the effect of fiscal equalization on the efficiency properties of corporate tax rates chosen by symmetric countries in a non-cooperative (Nash) tax competition game. For both taxation principles we first identify the fiscal and pecuniary externalities caused by changes in tax rates. In the absence of fiscal equalization both types of externalities are external to the country's choice of tax rates in a non-cooperative setting, and thus we can show that they determine the deviation of the non-cooperative tax rates from their Pareto-efficient levels. As a benchmark result we show that under both principles, Separate Accounting and Formula Apportionment, the fiscal equalization system can be used as a Pigouvian instrument: If the marginal transfer of a country, i.e. the impact of this country's tax rate on its transfer, just reflects all externalities, then the country internalizes the external effects of its tax policy and the non-cooperative tax rates become Pareto-efficient. Against the background of this benchmark result we derive three main insights:

Firstly, under both taxation principles the so-called Representative Tax System (RTS), which basically aims at equalizing tax bases among countries, does not ensure efficiency of the non-cooperative tax rates. Under Separate Accounting the intuition is that tax base equalization ignores the pecuniary externalities as it is targeted on the public budget only. Moreover, the RTS fails to fully internalize the fiscal externalities. The reason is that a reduction in one country's tax rate reduces the worldwide tax base, since the interest rate goes up. Hence, tax base equalization takes away the increase in the tax base of the tax-reducing country, but this is not enough to compensate the other countries for their reduction in tax bases. For Formula Apportionment the story is almost the same, except for the reason why fiscal externalities are not fully internalized. For given and symmetric distribution shares of the consolidated tax base, the fall in the worldwide tax base implies that the average tax base falls to the same extent as the part of the consolidated tax base assigned to the tax-reducing country. Hence, this part of the tax-reducing country's change in tax revenues is not redistributed by tax base equalization.

Secondly, non-cooperative tax rates become efficient if tax base equalization is replaced by tax revenue equalization and augmented by private income equalization. This result also holds under both Separate Accounting and Formula Apportionment. The rationale is as follows: Tax revenue equalization actually aggravates the incomplete internalization

of fiscal externalities, since there is now a direct negative effect of a tax rate reduction in one country on this country's tax revenues and on average tax revenues. Due to averaging, the latter effect is absolutely smaller than the former. So tax revenues redistributed to the other countries fall in comparison to tax base equalization. However, equalizing the households' private income is also not perfect, since it internalizes only a part of the pecuniary externalities. A tax rate reduction in one country leads to the same reduction in capital and profit income in all countries. Hence, private income equalization balances only changes in wage income and thereby reflects only that part of the pecuniary externalities that pertains to wage income (wage income externality), but not those parts that pertain to capital and profit income (capital and profit income externalities). Interestingly, we can show that these deficiencies of tax revenue and private income equalization just offset each other, so a combined system renders non-cooperative tax rates efficient.

Thirdly, under Formula Apportionment the RTS is superior to tax revenue equalization, if the wage income externality is sufficiently large. The latter condition is satisfied, for example, if the apportionment formula uses payroll only. The net effect of tax revenue equalization is that it does not internalize the wage income externality. This externality is positive and points to inefficiently low tax rates. As argued above, the degree of internalization is lower under tax revenue equalization than under the RTS. This difference is reflected by an additional distortion under RTS that points into the other direction than the wage income externality. Hence, if the wage income externality is large enough, tax rates under the RTS are still inefficiently low, but closer to the efficient tax rates than under tax revenue equalization.

Our results have several policy implications. Perhaps most important, the second result may help to mitigate the public debate about the right taxation principle in Europe. It implies that it does not matter whether MNEs are taxed according to Separate Accounting or Formula Apportionment if there is equalization of national income. Even though the European Union does not have an explicit equalization system, a part of the EU budget is financed by contributions that are proportional to the national income of the member states, compare e.g. Fenge and Wrede (2007). We would not conclude that the implied income redistribution is already enough to ensure efficiency of corporate income taxation, since the EU budget is not an equalization system in the sense of our analysis. But the very existence of income redistribution in Europe might indicate that reforming

the member states' contributions to the budget in a suitable way may politically be easier to achieve than replacing a whole corporate tax system.

The results also have policy implications for corporate taxation and fiscal equalization in Canada and Germany. The Canadian provinces levy a corporate income tax that follows Formula Apportionment (Weiner, 2006), and use an equalization scheme that equalizes the tax bases of the provinces (Boadway, 2004, Smart, 2007). A similar institutional setting is implemented among municipalities in Germany at the local level (Büttner, 2006, Egger et al., 2010). Equalization at the state level in Germany ("Länderfinanzausgleich") represents an example of tax revenue equalization (Baretti et al., 2002, Köthenbürger, 2002). Many state taxes use a common tax rate. This would actually imply that tax revenue equalization turns in to tax base equalization. But the states are responsible for tax enforcement and so determine the effective tax rates. Hence, we really have tax revenue equalization at the state level in Germany (Stöwhase and Traxler, 2005).

Our first two main results imply that tax base equalization in Canada and Germany is not the efficient equalization system, since it is dominated by national income equalization. If comprehensive equalization of national income is viewed as politically infeasible, the Canadian and German cases may be evaluated with the help of our third result. Corporate income taxation of German municipalities uses a pure payroll apportionment formula. As our third result shows, the implemented tax base equalization is superior to the alternative of tax revenue equalization. In Canada, however, apportionment uses payroll and sales with equal weights. So it is not clear whether the RTS is still superior or whether efficiency gains can be realized by switching to tax revenue equalization.

Our analysis is also related to the literature on the relative merits of Separate Accounting and Formula Apportionment (Eggert and Schjelderup, 2003, Eichner and Runkel, 2008, 2009, Gordon and Wilson, 1986, Nielsen et al., 2003, 2010, Pethig and Wagener, 2007, Pinto, 2007, Riedel and Runkel, 2007, Sørensen, 2004, Wellisch, 2004). But in contrast to our analysis, none of these papers take into account fiscal equalization. Without distinguishing different taxation principles, several studies discuss the implications of fiscal equalization for capital tax competition. Our analysis is closest to DePater and Myers (1994), Köthenbürger (2002), and Bucovetsky and Smart (2006). Under the conditions of our analysis, i.e. symmetric countries and fixed capital supply, these authors show that the RTS ensures efficiency of non-cooperative tax rates. The difference to our

results is due to the different modeling of corporate taxation. While we consider a tax on corporate income, defined as the difference between sales and deductible factor costs, previous studies assume a unit (wealth) tax on capital. Hence, in their framework there is no interest effect on the worldwide tax base, which is one of the driving forces behind our results. Moreover, with symmetric countries and fixed capital supply, pecuniary externalities sum up to zero in previous studies, whereas a non-zero sum of pecuniary externalities is another driving force of our results.

1.3.2 Formula Design

In the recommended common three-factor apportionment formula (Figure 1.2) the measuring of the sales factor is the subject of much controversy. The main question is whether sales should be measured at destination or at origin. The destination principle implies that sales are taken into account at the place where they are ultimately delivered or consumed. According to the origin principle, in contrast, sales are taken into account at the place where they are produced. The CCCTB Working Group (2007b) suggested the inclusion of sales following the destination principle. In contrast, "...most member states' experts that would support the inclusion of sales as a factor would prefer sales measured 'at origin' " (CCCTB Working Group, 2007b). Moreover, related to the question of destination versus origin principle, there is also a discussion about the formula weight on sales. Actually, each factor should be equally weighted (CCCTB Working Group, 2007b). However, with regard to the most recent proposal from the (European Commission, 2011b) for a council directive on this topic the European Parliament advocated amending the input factor weightings for assets and labor to 45% each and lowering the sales weight to 10%. The *Committee of the Internal Market and Consumer Protection* even called for the removal of the sales factor (European Parliament, 2012). The main argument is that with the destination principle it would be easy for MNEs to move the ultimate delivery to a non-CCCTB country and the power of the tax policies in source countries would be reduced.

Motivated by this controversial discussion on the sales factor, in Chapter 3 (Liesegang, 2016) we take a tax competition perspective and ask under which principle detrimental competition in tax rates is stronger, considering that tax rates are also controlled by member states under Formula Apportionment. To focus on the question of destination

versus origin principle, in our model a sales-only formula is used. In each of two identical countries an MNE operates one manufacturing subsidiary that produces a diversified commodity representing a brand. The goods are delivered to the local market and to the foreign retail subsidiaries. Internal transfer prices are charged for the export of the goods. Each subsidiary has monopoly power on its output market and cross-border shopping is omitted.

We derive the Nash equilibrium in tax rates of this tax competition game between countries. The analysis delivers two central findings. Firstly, we prove that the Formula Apportionment system with a sales-only formula mitigates tax competition compared to Separate Accounting. Secondly, our paper shows that, from a welfare perspective, using Formula Apportionment with an origin-based sales factor dominates a sales factor relying on the destination principle. Hence, our paper argues for implementing Formula Apportionment with a sales factor measured at origin.

The reason for the first result can be found in the direct profit shifting opportunities under Separate Accounting. The overall effect of a tax increase in one country on foreign welfare is positive using Separate Accounting or Formula Apportionment, but the sum of externalities under Separate Accounting is always greater than that of Formula Apportionment irrespective of the definition of the sales factor.

The key feature of the second result is that the negative consumption externality of the origin principle counteracts the positive formula externality whereas under destination principle the consumption and formula externality have the same sign. So the sum of externalities is positive for both considered alternatives under Formula Apportionment, but it is always greater for the destination principle in comparison to the origin principle.

We identify the transfer price under Separate Accounting as well as under Formula Apportionment as a tax saving device. Under Separate Accounting an MNE responds to a tax increase in one country by reducing the transfer price for the exported goods and increasing the transfer price for the goods that are imported to that country. This means that paper profits are lowered in the tax-increasing country, which is reflected in a positive profit shifting externality. In comparison to the direct under- or over-invoicing of internal trade under Separate Accounting, under Formula Apportionment the MNE has limited profit manipulation opportunities because it may influence the tax base allocation only indirectly via the formula.

A tax increase in one country triggers the MNE to downsize the apportionment share in this country to save taxes. This is done by manipulating transfer prices and, thus, revenues and the apportionment formula. The mechanism for lowering revenues in the tax-increasing country differs between the origin and the destination principle. Under the origin principle, the MNE's head office increases the transfer price in the tax-increasing country in order to scale down production. The transfer price in the country where the tax rate remains constant is lowered to stimulate production there. Because under the destination principle the place of consumption is relevant for the apportionment share, the transfer price in the tax-increasing country is lowered to expand the demand in the country, where the goods are delivered and revenues are imputed. Conversely, imports to the tax-increasing country are curbed by a higher transfer price for these imports. Overall, the quantitative effects on the sales share are identical for both principles and constitute the same positive formula externality, which is lower than the profit shifting externality under Separate Accounting. The resulting profit income externality is negative and coincides for both principles under Formula Apportionment with Separate Accounting.

If we consider the effect of a tax rate increase on foreign consumption possibilities it is only relevant how the supply in this country is affected by the tax increase. When the origin principle is used, the transfer price for the good that is exported from the tax-increasing country rises. Therefore, the supply of this good in the foreign market decreases and the consumption possibilities are cut. Hence, the consumption externality under the origin principle is negative. In contrast, under Separate Accounting and the destination principle the consumption externality is positive because the transfer price for the exported good is lowered, as a consequence of which foreign supply increases. But the restricted usage of the transfer price under Formula Apportionment with the destination principle mitigates the repercussions on private consumption possibilities and therefore, the consumption externality compared to Separate Accounting.

Our results complement the findings of Eichner and Runkel (2008), who also provide a foundation for implementing a sales factor at origin. They show that a formula containing sales at origin can mitigate the positive externalities caused by the assets and labor factors. Eichner and Runkel (2008) use a model with decreasing returns to scale, wherein a fixed production factor hampers the formula manipulation possibilities of the

MNE and therefore a sales factor mitigates the corresponding positive formula externality. In contrast to our analysis, however, their model does not allow an analysis of the destination principle. Hence, they derive an argument why sales (with the origin principle) are better than capital or labor, but they cannot show that sales with the origin principle are better than sales with the destination principle. This is the main contribution in our analysis.

Our analysis is also related to Kind et al. (2005) and Schjelderup and Sørgard (1997). They compare corporate tax competition under Separate Accounting and Formula Apportionment in the presence of MNEs and transfer pricing. Because they assume oligopolistic markets, the transfer price has a tax saving and strategic function. They use a two-country model where a commodity is exported at trade costs. Kind et al. (2005) also show that the higher the level of economic integration the more preferable is Formula Apportionment to Separate Accounting. But again, the focus is only on the sales factor at destination, and therefore they cannot obtain our results.

Gordon and Wilson (1986) demonstrate for the U.S. that Formula Apportionment influences the incentives of companies for horizontal integration and the relocation of production. Because in their model Formula Apportionment is politically instable, governments try to substitute Formula Apportionment by direct taxes on the formula factors. A politically significant argument for the sales factor is provided by Anand and Sansing (2000). They prove theoretically and empirically for the U.S. federal states that the weight of the sales factor becomes a policy instrument in a non-cooperative equilibrium if countries are able to alter the formula unilaterally. They show that in a Nash equilibrium only importing states increase their weight for sales. Exporters prefer to give greater weight to the input factors. In contrast to our analysis, however, they only focus on a sales factor according to the destination principle, and thus cannot obtain our results.

Pinto (2007) analyzes the efficiency characteristics of Formula Apportionment with a capital share and a production share that is equivalent to sales at origin in a tax competition framework. He shows that regional governments would always opt for a formula including only the production share to extend the public good provision. In contrast to our paper, this paper does not include a comparison of the destination and the origin principle.

1.3.3 Compliance Costs

With the introduction of a CCCTB in Europe, the European Commission (2011b) also assumes that the MNEs' compliance costs would be reduced because the CCCTB would replace the current corporate tax system of SA, where MNEs must deal with 28 different corporate tax systems within the EU (European Commission, 2001). Slemrod and Blumenthal (1996) or Shaw et al. (2010) classify compliance costs as involuntary and discretionary compliance costs. Involuntary compliance costs must be expended to comply with tax legislation and are unavoidable. This is in contrast to discretionary compliance costs which are incurred voluntarily to reduce the tax liability. Compliance costs in general waste valuable social resources (Shaw et al., 2010). The European Commission (2011a) refers to them as deadweight costs.

For the European Commission (2011b) the specific tax planning and reporting of transfer prices for internal transactions and intangible firm-specific services to the tax authorities under SA appear to be very costly. That is why a major issue in the proposal by the Commission concerns governmental administration costs and compliance costs for multinational firms.

Furthermore, authors such as Mintz (2004) and Devereux (2004) consider the reduction of compliance costs for businesses and administration costs for tax authorities under FA to be the most striking factor in favor of the CCCTB. The reason is that MNEs are no longer forced to deal with several national tax systems. This view is supported by an expert study by Deloitte (2009) which estimates that the CCCTB will decrease compliance costs to approximately 1/3 of the current system.

Mintz (2004) stresses that were FA to be introduced, "... governments would need to feel that the benefits outweigh costs". That is why he recommends the EU-wide compulsory CCCTB as the long-term objective and the optional system as a more practicable transition method. A politically convenient way of implementing an FA system would be to allow its existence in parallel to SA using a common corporate tax rate. The Commission is pursuing this strategic approach. Making the FA system optional is one key element of the CCCTB proposal. This means that companies would be allowed to choose whether to stay in the SA system or move to FA taxation. This ability to choose a tax regime is controversial, since prima facie it appears counterproductive: Only those firms that would reduce their taxes under the CCCTB would opt for the new system.

Intuitively, one would expect corporate tax competition to accelerate with governments never benefiting from the introduction of the CCCTB. However, this argument disregards the above-mentioned saving of compliance costs: To opt for FA may be profitable even with an increased tax bill, since MNEs have lower compliance costs and with it higher after-tax profits. If so, national tax revenues will increase and tax competition be mitigated. The aim of the paper is to prove this hypothesis within a theoretical setting.

We develop a model with two countries each of which hosts a continuum of heterogeneous MNEs. An MNE operates headquarters and a subsidiary in the home country and a subsidiary in the host country. Subsidiaries earn exogenous before-tax profits. Each country imposes a corporate income tax which is based on either SA or FA. Complying with tax legislation causes costs to the MNE at head office-level. As a key feature of our model we "distinguish between involuntary costs, which must be expended to comply with the law, and discretionary costs, which are incurred in an effort to reduce tax liability" (Slemrod and Blumenthal, 1996). Within our framework MNEs are heterogeneous in the sense that they differ in their involuntary compliance costs. But whereas the reduction of involuntary cost makes the tax system more efficient, decreasing discretionary cost makes harmful tax planning more profitable. Starting from this line of thought we will show in this paper that the EC's aim to cut involuntary compliance costs with the optional introduction of FA (European Commission, 2011b) could enhance efficiency.

An MNE faces the following trade-off when deciding whether it wants to be taxed according to SA or FA: The consolidation of profits reduces the complexity of complying with the tax legislation but hampers the tax-induced profit shifting possibilities. For example under SA the MNE shifts paper profits whereas under FA it has to reallocate real formula inputs like labor or sales, or adjust the firm's structure to capture tax savings. Therefore, opting for FA decreases involuntary costs (in the model they are set to zero) but increases discretionary costs for the MNE. We firstly derive the threshold value of involuntary compliance costs, which subdivides the MNEs into two groups. Firms below the threshold stay in the existing system, whilst MNEs above it would prefer FA. Afterwards we prove that starting from a pure SA system with national revenue maximization, its coexistence with FA increases tax rates and therefore mitigates tax competition. In our symmetric setting SA is even completely substituted by FA.

Our model setup is closely related to the paper by Büttner et al. (2011). They analyze the

implications of introducing FA for the group structure of MNEs. They model the MNE's decision to include a subsidiary in its group (FA taxation) or not (SA taxation). In this decision the MNE faces a trade-off between better profit shifting opportunities under SA and saved non-consolidation costs under FA. It turns out that with a higher tax rate differential or low non-consolidation costs it becomes more beneficial not to consolidate the tax bases. However, in contrast to our paper, Büttner et al. (2011) elucidate the defining of the MNE's group and consolidation as a strategic planning tool for the firm's structure. In contrast, our focus lies on the relationship between involuntary compliance costs and tax saving opportunities, which renders the coexistence of SA and FA more efficient compared to the present European system of pure SA.

There are studies by Keen and Mintz (2004) and Dharmapala et al. (2011) which also aim to derive an optimal threshold level within an optimal taxation environment. Keen and Mintz (2004) analyze the optimal threshold level of turnover at which firms must register for value-added tax. Firms differ in their taxable sales. The trade-off for a revenue-maximizing government from an increased threshold consists in a loss of tax revenues against saved administrative and compliance costs. Dharmapala et al. (2011) consider the optimal taxation of firms when the government faces tax collection costs. Firm heterogeneity is attributed to taxable output. In their model countries use a fixed per-firm fee and a linear tax on output. They find that if a firm's output falls below a certain cutoff level, it renders taxation of this firm inefficient. To internalize social administrative costs a positive fee is derived as optimal. In our paper we explicitly model two types of tax compliance costs incurred by an MNE under SA and FA. We show that if consolidation reduces involuntary costs related to tax legislation, the introduction of FA enhances efficiency.

Further support for our results comes from the implications of a water's edge, which could be interpreted as a geographical rather than an administrative coexistence of SA and FA. Riedel and Runkel (2007) analyze the transition from SA to FA using a three country model. The frontier between the FA union and the third country constitutes the water's edge. Similarly to our results, their short-run analysis with fixed tax rates proves that the overall amount of profit shifted to the tax haven decreases. In the long-run analysis, the water's edge regulation enhances welfare in comparison with SA for a wide range of cases. These results are in line with the empirical findings of Bettendorf et al. (2009).

In recent years several authors such as Eichner and Runkel (2008), Mintz (2004), Mintz and Weiner (2003), Nielsen et al. (2003, 2010), Sørensen (2004) and Fuest (2008) have focused on the relative merits of SA and FA. Despite different approaches they came to the conclusion that FA would create new distortions as long as tax rate differentials within the EU persist. Because the European Commission (2011b) rejects the harmonization of national corporate tax rates, the introduction of FA does not necessarily mitigate tax competition. In contrast to our paper, however, none of these studies investigates the trade-off between voluntary and discretionary compliance costs under SA and FA.

Our analysis proves that with the introduction of an optional FA system the non-cooperative tax rates, and with them tax revenues, increase in each country. Hence, we find that the optional system of tax base consolidation promises an efficiency enhancement for the EU.

The remainder of the thesis is structured as follows. Chapter 2 evaluates the consequences of supplementing the two alternatives discussed for the European corporate taxation system with a fiscal equalization scheme. In Chapter 3 the implications of using a sales factor in the apportionment formula, which can be based either on the destination or the origin principle, are analyzed. In Chapter 4 optional Formula Apportionment is evaluated in the presence of involuntary and discretionary compliance costs for MNEs. Chapter 5 concludes the findings and considers future prospects.

Chapter 2

Corporate Income Taxation of Multinationals and Fiscal Equalization[1]

Parts of the previous version has been submitted to the Journal of Public Economic Theory.

2.1 Introduction

Corporate income of multinational enterprises (MNEs) can basically be taxed according to two different principles. The principle of Separate Accounting (SA) states that corporate income of each subsidiary of an MNE is taxed separately in accordance with the host country's tax code. Under the principle of Formula Apportionment (FA), in contrast, corporate income of all subsidiaries is first consolidated and then assigned to the taxing countries according to a formula that usually contains the MNE's capital, payroll and sales shares in the respective countries. SA is applied in corporate income taxation at the international level, while some countries like the US, Canada, Germany and Switzerland use FA in taxing firms that operate in several jurisdictions at the national

[1]This chapter is based on Liesegang and Runkel (2009). In this paper my co-author and I provide almost equal contributions. A revised version of the previous working paper will be partially published as Liesegang and Runkel (2017) in the Journal of International Tax and Public Finance, DOI 10.1007/s10797-017-9451-6. The final publication is available at `https://link.springer.com/article/10.1007/s10797-017-9451-6`.

level. Recently, the European Commission (CCCTB Working Group, 2007a,b, European Commission, 2001, 2011a,b, European Parliament, 2012) proposed replacing SA with FA within the borders of the European Union. This proposal has led to a heated debate among politicians and researchers on the relative merits of the two taxation principles.

This paper shows that, from a tax competition point of view, it does not matter whether MNEs are taxed according to SA or FA, provided the group of countries in which the MNEs operate has implemented the right fiscal equalization system. We employ a multi-country tax competition model with fiscal equalization among countries. In this model, each country hosts a subsidiary of a representative MNE that produces an output with mobile capital and immobile labor. Wage rates and the interest rate are endogenously determined on local labor markets and the capital market. Corporate income of the MNE is taxed according to SA or FA. The MNE may reduce tax payments by shifting profits between countries. Each country is populated by a representative household that earns factor income from inelastically supplying capital and labor and profit income from owning a share of the MNE. The household's utility is determined by the consumption of a private good and a public good. The public good is provided by the local government which finances its expenditures by the revenues from the corporate tax. In addition, countries receive or pay transfers within a fiscal equalization system. The transfers depend on the corporate tax rates chosen by the countries.

With the help of this model we investigate the effect of fiscal equalization on the efficiency properties of corporate tax rates chosen by symmetric countries in a non-cooperative (Nash) tax competition game. For both taxation principles we first identify the fiscal and pecuniary externalities caused by changes in tax rates. Fiscal externalities show how the tax rate of one country influences tax revenues in the other countries. Pecuniary externalities describe the effect of one country's tax rate on private income (capital, wage and profit income) in the other countries. In the absence of fiscal equalization, both types of externalities are external to the country's choice of tax rates in a non-cooperative setting and, thus, we can show that they determine the deviation of the non-cooperative tax rates from their Pareto-efficient (cooperative) levels. As a benchmark result we then show that under both SA and FA the fiscal equalization system can be used as a Pigouvian instrument: if the marginal transfer of a country, that is the impact of this country's tax rate on its transfer, just reflects all externalities, then the

country internalizes the external effects of its tax policy and the non-cooperative tax rates become Pareto-efficient.

Against the background of this benchmark result, we derive three main insights by investigating which type of equalization system satisfies the Pigouvian internalization requirement. The first main result is that under both taxation principles the so-called Representative Tax System (RTS), which basically aims at equalizing tax bases among countries, does not ensure efficiency of the non-cooperative tax rates. Under SA the intuition is that tax base equalization ignores the pecuniary externalities as it is targeted on the public budget only. Moreover, the RTS fails to fully internalize the fiscal externalities. The reason is that a reduction in one country's tax rate reduces the worldwide tax base, since the interest rate goes up. Hence, tax base equalization takes away the increase in the tax base of the tax-reducing country, but this is not enough to compensate the other countries for their reduction in tax bases. Under FA, the story is almost the same except for the reason why fiscal externalities are not fully internalized. For given and symmetric distribution shares of the consolidated tax base, the fall in the worldwide tax base implies that the average tax base falls to the same extent as the part of the consolidated tax base assigned to the tax-reducing country. Hence, this part of the tax-reducing country's change in tax revenues is not redistributed by tax base equalization.

Our second main result shows that non-cooperative tax rates become efficient if tax base equalization is replaced by tax revenue equalization and augmented by private income equalization. This result, too, holds under both SA and FA. The rationale is as follows. Tax revenue equalization actually aggravates the incomplete internalization of fiscal externalities, since there is now a direct negative effect of a tax rate reduction in one country on this country's tax revenues and on average tax revenues. Due to averaging, the latter effect is absolutely smaller than the former, so tax revenues redistributed to the other countries fall in comparison to tax base equalization. However, equalizing the households' private income is also not perfect, since it internalizes only a part of the pecuniary externalities. A tax rate reduction in one country leads to the same reduction in capital and profit income in all countries. Hence, private income equalization balances only changes in wage income and thereby reflects only that part of the pecuniary externalities that pertains to wage income (wage income externality), but not those parts that

pertain to capital and profit income (capital and profit income externalities). Interestingly, we can show that these deficiencies of tax revenue and private income equalization just offset each other, so a combined system renders non-cooperative tax rates efficient.

The third main result is that under FA the RTS is superior to tax revenue equalization, if the wage income externality is sufficiently large. The latter condition is satisfied, for example, if the apportionment formula uses payroll only. The net effect of tax revenue equalization is that it does not internalize the wage income externality. This externality is positive and points to inefficiently low tax rates. As argued above, the degree of internalization is lower under tax revenue equalization than under the RTS. This difference is reflected by an additional distortion under RTS that points into the other direction than the wage income externality. Hence, if the wage income externality is large enough, tax rates under the RTS are still inefficiently low, but closer to the efficient tax rates than under tax revenue equalization.

Our results have several policy implications. Perhaps most important, the second result may help to mitigate the public debate about the right taxation principle in Europe. It implies that it does not matter whether MNEs are taxed according to SA or FA if there is equalization of national income (i.e. private income plus tax revenues). Even though the European Union does not have an explicit equalization system, a part of the EU budget is financed by contributions that are proportional to the national income of the member states (Fenge and Wrede, 2007). We would not conclude that the implied income redistribution is already enough to ensure efficiency of corporate income taxation, since the EU budget is not an equalization system in the sense of our analysis. But the very existence of income redistribution in Europe might indicate that reforming the member states' contributions to the budget in a suitable way may politically be easier to achieve than replacing a whole corporate tax system. With the same caution, a similar argument can be made with respect to corporate income taxation by means of FA in US states. In the US there is no equalization system either, but it is well known that federal taxes and transfers redistribute national income across states (Bayoumi and Masson, 1995, Mélitz and Zumer, 2002).

The results also have policy implications for corporate taxation and fiscal equalization in Canada and Germany. The Canadian provinces levy a corporate income tax that follows FA (Weiner, 2006), and there is an equalization scheme that equalizes tax bases of the

provinces (Boadway, 2004, Smart, 2007). A similar institutional setting is implemented among municipalities in Germany at the local level (Büttner, 2006, Egger et al., 2010).

Our first two main results imply that tax base equalization in Canada and Germany is not the efficient equalization system, since it is dominated by national income equalization. If comprehensive equalization of national income is viewed as politically infeasible, then the Canadian and German cases may be evaluated with the help of our third result. Corporate income taxation of German municipalities uses a pure payroll apportionment formula. Hence, our third result shows that the implemented tax base equalization is superior to the alternative of tax revenue equalization. In Canada, however, apportionment uses payroll and sales with equal weights, so we will show that it is not clear whether the RTS is still superior or whether efficiency gains can be realized by switching to tax revenue equalization.[2]

Our analysis is related to the literature on the relative merits of SA and FA (Eggert and Schjelderup, 2003, Eichner and Runkel, 2008, 2009, Gordon and Wilson, 1986, Nielsen et al., 2003, 2010, Pethig and Wagener, 2007, Pinto, 2007, Riedel and Runkel, 2007, Sørensen, 2004, Wellisch, 2004). However, in contrast to our analysis, none of these papers take into account fiscal equalization.[3] Without distinguishing different taxation principles, several studies discuss the implications of fiscal equalization for capital tax competition. The seminal paper is Wildasin (1989). More recent contributions include Büttner (2006), Dahlby and Warren (2003), Smart (2007) and Egger et al. (2010).[4] Our analysis is closest to DePater and Myers (1994), Köthenbürger (2002), and Bucovetsky and Smart (2006). Under the conditions of our analysis, i.e. symmetric countries and fixed capital supply, these authors show that the RTS ensures efficiency of non-cooperative tax rates.[5] The difference to our results is due to the different modeling of

[2]Equalization at the state level in Germany ("Länderfinanzausgleich") represents an example for tax revenue equalization (Baretti et al., 2002, Köthenbürger, 2002). Many state taxes use a common tax rate. This would actually imply that tax revenue equalization turns into tax base equalization. But the states are responsible for tax enforcement and so determine the effective tax rates. Hence, we really have tax revenue equalization at the state level in Germany (Stöwhase and Traxler, 2005).

[3]There is a paper by Traxler and Reutter (2008) on FA and fiscal equalization. But they model FA as a means of redistributing tax revenues and compare the resulting effects on the countries' tax enforcement policy with those of fiscal equalization. In contrast to our paper, they do not address the question of how fiscal equalization can be used to internalize externalities of corporate tax rates under FA and SA.

[4]There is also a body of literature discussing incentive effects of fiscal equalization in the presence of labor mobility, in contrast to capital mobility. A survey is given in Boadway (2004).

[5]For the case of asymmetric countries and/or an endogenous capital supply (savings), these studies also come to the conclusion that a pure RTS does not ensure efficiency.

corporate taxation. While we consider a tax on corporate income, defined as the difference between sales and deductible factor costs, previous studies assume a unit (wealth) tax on capital. Hence, in their framework there is no interest effect on the worldwide tax base, which is one of the driving forces behind our results.[6] Moreover, with symmetric countries and fixed capital supply, pecuniary externalities sum up to zero in previous studies, whereas a non-zero sum of pecuniary externalities is another driving force of our results.

The paper is organized as follows. Section 2 describes the basic framework. In Section 3 and Section 4 we examine tax competition and fiscal equalization under SA and FA, respectively. Section 5 concludes.

2.2 Basic Framework

Consider an economy consisting of $n \geq 2$ identical countries. There is a large number of MNEs with subsidiaries in each country. We suppose all MNEs are identical and, without loss of generality, focus on the representative MNE. In country i the MNE produces a (numeraire) good with the help of k_i units of the mobile input capital and ℓ_i units of the immobile input labor. The production function reads $F(k_i, \ell_i)$. It exhibits positive and decreasing marginal returns with respect to the two inputs, i.e. $F_k > 0$, $F_{kk} < 0$, $F_\ell > 0$ and $F_{\ell\ell} < 0$. Furthermore, the cross derivative of the production function satisfies $F_{k\ell} = F_{\ell k} > 0$, so increasing the quantity of one input raises the marginal return to the other input. The production function is homogeneous of degree $m \in]0, 1[$, i.e. $F(\lambda k_i, \lambda \ell_i) = \lambda^m F(k_i, \ell_i)$ for all $\lambda > 0$. Assuming $m \in]0, 1[$ means that we have decreasing returns to scale. Hence, there is a fixed third production factor such as land or entrepreneurial services that gives rise to positive economic rents.[7]

The MNE may shift profits between its subsidiaries by, for example, manipulating transfer prices of intermediate goods and services or by reallocating overhead costs (Devereux, 2006). In an abstract way, profit shifting can be modeled by introducing the variable s_i.

[6] In an extension, Smart (1998) discusses a (pure) profit tax. However, in his approach the tax rate is always 100% and he does not explicitly account for capital mobility and different taxation principles. More important, and related to this, in his model the worldwide (and average) profit tax base is determined exogenously, so he too does not obtain the results derived by our analysis.

[7] This is a typical assumption in the above-mentioned literature on SA versus FA. All our main results also hold for the case of constant returns to scale ($m = 1$), with slight changes in the notation of our analysis.

If $s_i < 0$, the MNE shifts profits from the subsidiary in country i to the subsidiaries in the other countries. For $s_i > 0$, profits are shifted to the subsidiary in country i. Profit shifting has to satisfy $\sum_{j=1}^{n} s_j = 0$. This condition ensures that profit shifting does not influence the MNE's overall profits. Profit shifting is not free of cost to the MNE since, for example, the MNE has to pay tax consultants or may face the risk of being detected and penalized when its profit shifting strategy violates tax law. We assume that the concealment costs of the subsidiary in country i are represented by $C(s_i)$. This function is supposed to satisfy $C(0) = 0$, $\operatorname{sgn}\{C'(s_i)\} = \operatorname{sgn}\{s_i\}$ and $C''(s_i) > 0$ for all s_i. That means that concealment costs are U-shaped with a minimum at the point where the MNE does not shift profits. Note that our modeling implicitly assumes that profit shifting between two subsidiaries is associated with concealment costs in both subsidiaries. Though we think that this is a realistic assumption, since each country has its own tax rules that the MNE has to satisfy, all our results would qualitatively remain true when we assume concealment costs to accrue only once.

In most tax systems, labor costs are fully deductible from the corporate tax base, while capital costs are only partially deductible. For example, debt financing costs usually reduce the tax base, while equity financing costs cannot be deducted. We therefore assume that the MNE is allowed to deduct the share $\rho \in [0, 1[$ of capital costs from the tax base. The deductibility parameter ρ is the same for all countries and determined exogenously. This is a realistic assumption for many FA systems, like the one in Germany and Canada or the proposed system in Europe, since these systems use a common tax base definition.[8] Denoting the wage rate in country i by w_i and the world interest rate by r, the MNE's tax base in country i reads

$$\phi_i = F(k_i, \ell_i) - \rho r k_i - w_i \ell_i + s_i. \tag{2.1}$$

The tax base of the MNE equals revenues reduced by the partially deductible capital costs and the fully deductible labor costs and adjusted by profit shifting.

Each country is populated by a representative household who owns a fixed capital endowment $\overline{k}$ and a fixed labor endowment $\overline{\ell}$. The household earns income from inelastically supplying these factor endowments on the world capital market and the local labor market, respectively. Moreover, the household in country i owns a share $\theta_i = 1/n$ of the

[8] An exception is FA in the US where each state uses its own tax base definition. But even in this system the definitions are not that different, compare e.g.Weiner (2006).

MNE, and thus receives the share $1/n$ of the MNE's after-tax profits π as profit income. The household uses its total income to buy the numeraire good. Denoting by c_i the quantity consumed, the budget constraint of the household in country i reads

$$c_i = r\overline{k} + w_i\overline{\ell} + \theta_i\pi. \tag{2.2}$$

In addition to the numeraire good, the household consumes the quantity g_i of a (local) public good provided by the local government. The utility of the household in country i is represented by the quasi-concave utility function $U(c_i, g_i)$.

The equilibrium on the world capital market requires that the MNE's aggregate capital demand has to be equal to the households' aggregate capital supply, i.e.

$$\sum_{j=1}^{n} k_j = n\overline{k}. \tag{2.3}$$

The local labor market in country i is in equilibrium if the MNE's labor demand in this country equals the household's labor supply. Formally, we obtain

$$\ell_i = \overline{\ell}. \tag{2.4}$$

Capital demand k_i and labor demand ℓ_i *inter alia* depend on the factor prices r and w_i according the MNE's profit-maximization that we consider in detail below. Hence, the factor prices r and w_i are endogenously determined by the equations (2.3) and (2.4).

2.3 Separate Accounting

Behavior of the MNE. Under SA, the MNE's profits are subject to taxation in the country where they are declared. Denoting country j's statutory tax rate by t_j, after-tax profits of the MNE under SA can be written as

$$\pi = \sum_{j=1}^{n}(1-t_j)\phi_j - (1-\rho)r\sum_{j=1}^{n} k_j - \sum_{j=1}^{n} C(s_j). \tag{2.5}$$

The MNE maximizes its after-tax profits with respect to capital demand, labor demand and profit shifting, taking as given the tax rates and the factor prices. In solving its maximization problem, the MNE takes into account the profit shifting constraint

$\sum_{j=1}^{n} s_j = 0$. Denoting the Lagrange multiplier associated with this constraint by μ, the first-order conditions of profit maximization are

$$(1 - t_i)[F_k(k_i, \ell_i) - \rho r] - (1 - \rho)r = 0, \tag{2.6}$$

$$F_\ell(k_i, \ell_i) - w_i = 0, \tag{2.7}$$

$$1 - t_i - C'(s_i) + \mu = 0, \tag{2.8}$$

with $i \in \{1, \ldots, n\}$. Due to (2.6), capital is invested in country i up to the point where the after-tax marginal returns equal marginal costs, taking into account deductibility of capital costs. Equation (2.7) shows that the same is true with respect to labor input, except for replacing the after-tax marginal returns by the before-tax marginal returns since payroll is fully tax deductible. Finally, profits are shifted up to the point where the marginal benefits from saving taxes equal the marginal concealment costs, as shown in (2.8). This condition together with $\sum_{j=1}^{n} s_j = 0$ implies that the MNE shifts profits from countries with above average tax rates to countries with below average tax rates.

The first-order conditions (2.6)–(2.8) together with the market clearing conditions (2.3) and (2.4) determine capital input, labor input, wage rates and the interest rate in the equilibrium of the factor markets. For later purposes, we have to identify the comparative static effects of tax rate changes on the equilibrium values. We follow previous studies on SA versus FA and focus on the case of full symmetry where countries impose the same tax rate $t_i = t$ for all $i \in \{1, \ldots, n\}$.[9] With identical tax rates in all countries we obtain $k_i = \overline{k}$, $\ell_i = \overline{\ell}$, $w_i = w$, $s_i = 0$ and $\phi_i = \phi$ for all $i \in \{1, \ldots, n\}$. Totally differentiating (2.6)–(2.8) and then applying the symmetry assumption, the appendix

[9] It may be argued that this is a restrictive assumption when discussing the implications of fiscal equalization. But the basic *incentive* effects of equalization can also be investigated under symmetry. Moreover, equalization with asymmetric countries has already been studied by DePater and Myers (1994), Köthenbürger (2002), and Bucovetsky and Smart (2006). Hence, assuming symmetry helps to work out the effects that the modeling of corporate taxation has for the incentive effects of equalization.

proves

$$\frac{\partial r}{\partial t_i} = -\frac{F_k - \rho r}{n(1 - t\rho)} < 0, \tag{2.9}$$

$$\frac{\partial k_i}{\partial t_i} = -(n-1)\frac{\partial k_j}{\partial t_i} = \frac{n-1}{n}\frac{F_k - \rho r}{(1-t)F_{kk}} < 0, \tag{2.10}$$

$$\frac{\partial w_i}{\partial t_i} = -(n-1)\frac{\partial w_j}{\partial t_i} = \frac{n-1}{n}\frac{(F_k - \rho r)F_{k\ell}}{(1-t)F_{kk}} < 0, \tag{2.11}$$

$$\frac{\partial s_i}{\partial t_i} = -(n-1)\frac{\partial s_j}{\partial t_i} = -\frac{n-1}{n}\frac{1}{C''} < 0, \tag{2.12}$$

with $i, j \in \{1, \ldots, n\}$ and $i \neq j$. Reducing the tax rate in country i lowers capital costs in this country. Hence, the MNE reallocates capital away from all other countries to country i, as shown in equation (2.10). According to (2.9), the reallocation of capital comes along with an increase in the interest rate. Because of the complementarity of capital and labor ($F_{k\ell} > 0$), an increase (decline) in capital input increases (lowers) the marginal returns to labor. Thus, the MNE has an incentive to raise labor demand in country i and decrease labor demand in all other countries. Since labor input is fixed due to the labor market equilibrium condition (2.4), these changes in labor demand are transformed into corresponding changes in the wage rates, as shown in (2.11). Finally, equation (2.12) states that the fall in country i's tax rate induces the MNE to shift more profits from the other countries to country i.

Tax competition. Having investigated the behavior of the MNE, we can now turn to tax competition among the countries. The public budget constraint of country i contains public good consumption g_i on the expenditure side and the receipts from corporate taxation $t_i\phi_i$ on the revenue side. In addition, we introduce a fiscal equalization system that influences the public budget constraint. More specifically, country i's budget constraint contains the expression $T^i(\mathbf{t})$ where $\mathbf{t} := (t_1, \ldots, t_n)$ is the vector of corporate tax rates of all countries. If $T^i(\mathbf{t})$ is positive, it represents a transfer that country i receives. For negative values of $T^i(\mathbf{t})$, country i has to pay a contribution. We assume $\sum_{j=1}^{n} T^j(\mathbf{t}) = 0$, so resources collected from one country are fully redistributed to other countries. Taking into account the equalization system, country i's budget constraint reads

$$g_i = t_i\phi_i + T^i(\mathbf{t}). \tag{2.13}$$

Country i sets its tax rate t_i in order to maximize the utility of its representative household, $U(c_i, g_i)$, subject to the private and public budget constraints (2.2) and (2.13). Moreover, it takes into account the effect of its tax rate on the factor market equilibrium captured by (2.9)–(2.12), but it takes as given the tax policy of all other countries. Hence, we have a non-cooperative tax competition game among the n countries. The Nash equilibrium of this game is determined by $\partial U(c_i, g_i)/\partial t_i = 0$ for all $i \in \{1, \ldots, n\}$.

As already mentioned above, we focus on a symmetric equilibrium with $t_i = t$, $k_i = \overline{k}$, $\ell_i = \overline{\ell}$, $w_i = w$, $s_i = 0$ and $\phi_i = \phi$ for all $i \in \{1, \ldots, n\}$. Using (2.9)–(2.12), it is straightforward to show that in the symmetric equilibrium the condition $\partial U(c_i, g_i)/\partial t_i = 0$ can be rewritten as

$$\frac{U_g}{U_c} = \frac{\phi - n\rho t\overline{k}\dfrac{\partial r}{\partial t_i} + (n-1)(\mathrm{CE} + \mathrm{WE} + \mathrm{PE})}{\phi - n\rho t\overline{k}\dfrac{\partial r}{\partial t_i} - (n-1)(\mathrm{TE} + \mathrm{SE}) + T^i_{t_i}}, \tag{2.14}$$

with

$$\mathrm{CE} = \overline{k}\frac{\partial r}{\partial t_i} < 0,\ \mathrm{WE} = \overline{\ell}\frac{\partial w_j}{\partial t_i} > 0,\ \mathrm{PE} = \frac{1}{n}\frac{\partial \pi}{\partial t_i} = \frac{1}{n}\left[-\phi - n(1-\rho t)\overline{k}\frac{\partial r}{\partial t_i}\right] < 0, \tag{2.15}$$

$$\mathrm{TE} = t\left[(F_k - \rho r)\frac{\partial k_j}{\partial t_i} - \rho\overline{k}\frac{\partial r}{\partial t_i} - \overline{\ell}\frac{\partial w_j}{\partial t_i}\right] \gtreqless 0, \quad \mathrm{SE} = t\frac{\partial s_j}{\partial t_i} > 0, \tag{2.16}$$

for $i \neq j$. The expressions in (2.15) are the pecuniary externalities caused by corporate income taxation. They represent the effect of country i's tax rate on private income in country j. A decrease in country i's tax rate raises capital and profit income in country j (negative capital and profit income externalities CE and PE)[10] and lowers wage income in country j (positive wage income externality WE). Equation (2.16) contains the fiscal externalities, i.e. the effect of country i's tax rate on country j's tax revenues. A decrease in country i's tax rate changes the tax base net of profit shifting in country j (positive or negative tax base externality TE) and reduces the tax base in country j via a fall in profit shifting (positive profit shifting externality SE). In the absence of fiscal equalization, the pecuniary and fiscal externalities determine the deviation of the equilibrium tax rates from their Pareto-efficient (cooperative) level. Formally, this can be seen by setting all externalities and $T^i_{t_i}$ equal to zero in (2.14). We then obtain $U_g/U_c = 1$ which is

[10] The sign of PE follows from using (2.7), (2.9) and the Euler Theorem $mF = kF_k + \ell F_\ell$ in the definition of PE in (2.15), so we obtain $\mathrm{PE} = -(1-m)F/n < 0$.

the Samuelson rule for the Pareto-efficient supply of the local public good.[11] It can be shown that the sign of the sum of all externalities is indeterminate. Hence, it is not clear whether tax competition leads to inefficient undertaxtion (sum of externalities is positive) or inefficient overtaxation (sum of externalities is negative). In any case, the sum of externalities is zero only by chance and, thus, it can be expected that without fiscal equalization tax competition leads to inefficient tax rates.

Fiscal equalization. This inefficiency result holds in the absence of fiscal equalization. However, from (2.14) it becomes obvious that the equilibrium condition of the tax competition game coincides with the Samuelson rule if and only if

$$T^i_{t_i} = (n-1)(\mathrm{CE} + \mathrm{WE} + \mathrm{PE} + \mathrm{TE} + \mathrm{SE}). \tag{2.17}$$

Hence, the fiscal equalization system can be used as a Pigouvian instrument to correct for the inefficiency caused by the non-cooperative tax policy. If the marginal transfer of country i reflects all externalities caused by country i's tax rate, then country i internalizes the effects of its tax policy on all other countries. As a consequence, the tax policy in the non-cooperative tax competition game is identical to the Pareto-efficient (cooperative) tax policy characterized by the Samuelson rule.

This is qualitatively the same insight as the previous literature obtained in the standard tax competition model with a unit tax on capital (Bucovetsky and Smart, 2006, DePater and Myers, 1994, Köthenbürger, 2002). An important difference is, however, that the nature of externalities in our framework is different from that in previous studies. This raises the question of which type of equalization system satisfies (2.17) and, thus, ensures that the non-cooperative tax policy becomes Pareto-efficient. One candidate considered in the previous literature is the so-called Representative Tax System (RTS) that aims at equalizing the difference in a region's tax base relative to that of a representative tax system. Under the RTS the transfer of country i reads

$$T^{iB}(\mathbf{t}) = \bar{t}(\bar{\phi} - \phi_i), \tag{2.18}$$

[11] The appendix shows that the Samuelson rule really characterizes the Pareto-efficient (cooperative) solution in our model.

where $\bar{\phi} = \sum_{j=1}^{n} \phi_j/n$ is the average tax base and $\bar{t} = \sum_{j=1}^{n} t_j\phi_j / \sum_{j=1}^{n} \phi_j$ is the representative tax rate, i.e. the tax rate that yields the same tax revenues when applied to the world tax base as the sum of regional tax revenues. The RTS is a central element in the fiscal equalization system in Canada (Boadway, 2004, Smart, 2007), and also equalization at the local level in Germany aims at equalizing tax bases (Büttner, 2006, Egger et al., 2010). To illustrate the basic working of the RTS, it is useful to consider a symmetric situation with identical tax bases. If country i tries to improve its tax base by reducing its tax rate and if this reduction in the tax rate leaves unaltered the average tax base, then the fiscal equalization system fully redistributes the increase in country i's tax revenues back to the other countries. Hence, the net effect is zero and country i looses the incentive to lower its tax rate.

Exactly for that reason, the RTS renders the non-cooperative tax policy in the standard tax competition framework with symmetric countries and a fixed capital supply efficient (Bucovetsky and Smart, 2006, Köthenbürger, 2002).[12] In contrast, in our framework the RTS is not able to restore efficiency. Differentiating (2.18) with respect to t_i, taking into account (2.1), (2.10)–(2.12) and (2.16) and applying symmetry yields

$$T_{t_i}^{iB} = -\rho t\bar{k}\frac{\partial r}{\partial t_i} - t\frac{\partial \phi_i}{\partial t_i} = (n-1)(\mathrm{TE}+\mathrm{SE}) + (n-1)\rho t\bar{k}\frac{\partial r}{\partial t_i}. \tag{2.19}$$

Comparing (2.19) with (2.17) immediately proves

Proposition 2.1. *Suppose the non-cooperative tax competition game under SA attains a symmetric Nash equilibrium. Then, implementing a fiscal equalization system of the RTS type* $[T^i(\mathbf{t}) = T^{iB}(\mathbf{t})$ *for* $i = 1, \ldots, n]$ *does not ensure Pareto-efficiency of the non-cooperative tax rates.*

The intuition of this result can best be explained with the help of (2.19). This equation shows that the RTS does not internalize the pecuniary externalities CE, WE and PE. The reason is obvious, since the RTS aims at equalizing the countries' tax bases, not their private income. But even if we ignore this deficiency, (2.19) reveals a further reason for the failure of the RTS. Tax base equalization does not fully internalize the fiscal externalities TE and SE. To understand this, suppose we start in a fully symmetric

[12] Formally, in this type of model the RTS reads $T^{iB}(\mathbf{t}) = \bar{t}(\sum_{j=1}^{n} k_j/n - k_i)$. From $\sum_{j=1}^{n} \partial k_j/\partial t_i = 0$ follows $T_{t_i}^{iB} = -t(\partial k_i/\partial t_i) = (n-1)t(\partial k_j/\partial t_i)$. The latter expression reflects the fiscal externality. As the pecuniary externalities sum up to zero, the RTS renders the non-cooperative tax policy efficient.

situation where all countries have the same tax base. If country i now tries to improve its tax base by reducing its tax rate, the transfer system redistributes the corresponding increase in country i's tax revenues back to the other countries, see the expression $-t(\partial\phi_i/\partial t_i)$ in (2.19). In contrast to the standard tax competition model, however, the worldwide tax base $\sum_{j=1}^{n}\phi_j$ falls, since the interest rate and thereby capital costs go up in response to the tax rate decrease in country i.[13] As a consequence, the average tax base $\bar{\phi}$ falls and, thus, the redistribution system takes away from country i more than the additional tax revenues. This effect is represented by the expression $-\rho t\bar{k}(\partial r/\partial t_i)$ in (2.19). But even the increased transfer of country i is not enough to compensate the other countries for their loss in tax revenues, since averaging implies that the fall in the average tax base is smaller than the fall in the worldwide tax base. In sum, the RTS internalizes only a part of the fiscal externalities as shown in (2.19).

At this point a remark on the countries' impact on the interest rate is in order. As argued above, the RTS fails to fully internalize fiscal externalities because a decline in country i's tax rate influences the interest rate. One might therefore conjecture that this failure of the RTS vanishes when countries are small so that their impact on the interest rate is negligible. But this is not true. Formally, the case of small countries is reflected by our model if the number of countries is large. If we let n converge to infinity, equation (2.9) shows that country i's impact on the interest rate really tends to zero. However, the failure of the RTS to fully internalize fiscal externalities still remains as shown by using $n \to \infty$ in (2.19). Intuitively, the reason is that a decline in country i's tax rate still lowers the worldwide tax base. For large n, country i's impact on the interest rate and on the tax base of a single other country is small. But the aggregate number of countries is large and, thus, the sum of tax bases of the other countries still decreases. Hence, Proposition 2.1 and its interpretation also hold for the case of small countries. The same will be true for all results derived below.

The failure of the RTS stated in Proposition 2.1 raises the question of how to modify the fiscal equalization system in order to ensure that the non-cooperative tax policy becomes efficient. We discuss two modifications. As the RTS fails to fully internalize the fiscal externalities, we take a look at tax revenue equalization represented by

$$T^{iR}(\mathbf{t}) = \overline{t\phi} - t_i\phi_i, \tag{2.20}$$

[13] Formally, using equations (2.10)–(2.12) we obtain $\sum_{j=1}^{n}(\partial\phi_j/\partial t_i) = -n\rho\bar{k}(\partial r/\partial t_i) > 0$.

where $\overline{t\phi} = \sum_{j=1}^{n} t_j \phi_j / n$ equals average tax revenues. Since the RTS ignores pecuniary externalities, we additionally consider private income equalization given by

$$T^{iP}(\mathbf{t}) = \bar{c} - c_i, \tag{2.21}$$

where $\bar{c} = \sum_{j=1}^{n} c_j / n$ represents average private income. Note that according to (2.2), private income in country i equals private consumption c_i.

Differentiating equation (2.20) with respect to t_i and taking into account (2.1), (2.10)–(2.12) and (2.16) yields

$$T_{t_i}^{iR} = -\rho t \bar{k} \frac{\partial r}{\partial t_i} - t \frac{\partial \phi_i}{\partial t_i} - \phi \frac{n-1}{n} = (n-1)(\mathrm{TE} + \mathrm{SE}) + \frac{n-1}{n} \left(-\phi + n \rho t \bar{k} \frac{\partial r}{\partial t_i} \right) \tag{2.22}$$

Comparing (2.22) with (2.19) shows that tax revenue equalization triggers the same effects as the RTS and is thereby characterized by the same deficiencies as the RTS. But there is now an additional effect reflected by the expression $-\phi(n-1)/n$ in (2.22). To understand this additional effect note that under tax revenue equalization the reduction in country i's tax rate has a direct negative impact on country i's tax revenues and on average tax revenues. Because of averaging, the loss in country i's tax revenues is larger in absolute terms than the loss in average tax revenues. Hence, the direct effect further reduces the net transfer of country i to the other countries and aggravates this deficiency of the RTS. In terms of externalities, tax revenue equalization decreases the part of fiscal externalities that is internalized, compared to the RTS.

Similarly, from (2.1), (2.2), (2.10)–(2.12), (2.16) and (2.21) we obtain

$$\begin{aligned} T_{t_i}^{iP} &= \bar{k} \frac{\partial r}{\partial t_i} + \frac{1}{n} \frac{\partial \pi}{\partial t_i} - \frac{\partial c_i}{\partial t_i} = -\bar{\ell} \frac{\partial w_i}{\partial t_i} \\ &= (n-1)\mathrm{WE} = (n-1)(\mathrm{CE} + \mathrm{WE} + \mathrm{PE}) - \frac{n-1}{n} \left(-\phi + n \rho t \bar{k} \frac{\partial r}{\partial t_i} \right). \end{aligned} \tag{2.23}$$

If country i reduces its tax rate, its private income is raised by an increase in capital, wage and profit income. This increase in private income is reflected by the term $\partial c_i / \partial t_i$ in the first line of (2.23). However, the increase via capital and profit income is fully compensated by an equal increase in average private income reflected by the terms $\bar{k}(\partial r / \partial t_i)$ and $(\partial \pi / \partial t_i)/n$ in the first line of (2.23). What remains is the effect via country i's wage income that the income equalization system redistributes to the

other countries and that is enough to compensate the other countries for the decline in their wage income. But the other countries also benefit from an increase in capital and profit income and the income equalization system does not compensate for these changes. In terms of externalities this means that private income equalization internalizes the positive wage income externality but not the negative capital and profit income externalities, as shown in the second line of (2.23).

To sum up, implementing tax revenue equalization or private income equalization separately does not remove the deficiencies of the RTS. Private income equalization internalizes only a part of the pecuniary externalities and tax revenue equalization even worsens the internalization of fiscal externalities. An open question is, however, whether combinations of the different equalization systems render the non-cooperative tax policy Pareto-efficient. Combining private income equalization with tax revenue equalization and the RTS, respectively, yields

$$T^{iP}_{t_i} + T^{iR}_{t_i} = (n-1)(\mathrm{CE} + \mathrm{WE} + \mathrm{PE} + \mathrm{TE} + \mathrm{SE}), \tag{2.24}$$

$$T^{iP}_{t_i} + T^{iB}_{t_i} = (n-1)(\mathrm{CE} + \mathrm{WE} + \mathrm{PE} + \mathrm{TE} + \mathrm{SE}) + \phi\frac{n-1}{n}. \tag{2.25}$$

Comparing with (2.17) immediately proves

Proposition 2.2. *Suppose the non-cooperative tax competition game under SA attains a symmetric Nash equilibrium. Then,*
(i) implementing private income equalization and tax revenue equalization $[T^i(\mathbf{t}) = T^{iP}(\mathbf{t}) + T^{iR}(\mathbf{t})$ *for all* $i = 1, \ldots, n]$ *renders the non-cooperative tax rates efficient,*
(ii) implementing private income equalization and the RTS $[T^i(\mathbf{t}) = T^{iP}(\mathbf{t}) + T^{iB}(\mathbf{t})$ *for all* $i = 1, \ldots, n]$ *leads to inefficiently high equilibrium tax rates.*

The problem of income equalization is that it does not internalize the capital and profit income externalities. Interestingly, these externalities just equal the part of the fiscal externalities that is not internalized by tax revenue equalization.[14] Hence, the deficiency of one of these equalization systems offsets the deficiency of the other system and combining both systems renders the equilibrium tax rates Pareto-efficient, as stated in Proposition 2.2 (i). Under the RTS, in contrast, the deficiency regarding the internalization of fiscal externalities is not as severe as under tax revenue equalization. Hence,

[14] Formally, the term $(n-1)[-\phi + n\rho t\bar{k}(\partial r/\partial t_i)]/n$ in equations (2.22) and (2.23) is equal to $(n-1)(\mathrm{CE} + \mathrm{PE})$. This is straightforward to show by using equation (2.15).

combining RTS with the private income equalization redistributes too many resources between the countries and thereby prompts the countries to raise the corporate tax rates above their efficient levels, as proven by Proposition 2.2 (ii).

2.4 Formula Apportionment

Behavior of the MNE. Under FA the tax bases of the MNE's subsidiaries are consolidated. This gives the consolidated tax base $\sum_{j=1}^{n} \phi_j$ which is apportioned to the countries according to a certain formula. We consider the general case in which the formula contains all three apportionment factors usually employed in practice, that are the MNE's capital, sales and payroll shares. Denoting the weights attached to these factors by γ, σ and φ with $(\gamma, \sigma, \varphi) \in [0,1]^3$ and $\gamma + \sigma + \varphi = 1$, the share of the consolidated tax base apportioned to country i can be written as

$$A^i(k_i, k_{-i}, \ell_i, \ell_{-i}, w_i, w_{-i}) = \gamma \frac{k_i}{\sum_{j=1}^{n} k_j} + \sigma \frac{F(k_i, \ell_i)}{\sum_{j=1}^{n} F(k_j, \ell_j)} + \varphi \frac{w_i \ell_i}{\sum_{j=1}^{n} w_j \ell_j}, \tag{2.26}$$

where $x_{-i} := (x_1, ..., x_{i-1}, x_{i+1}, ..., x_n)$ for $x \in \{k, \ell, w\}$. The MNE's tax liability in country i is $t_i A^i(\cdot) \sum_{j=1}^{n} \phi_j$ and its after-tax profits read

$$\pi = (1-\tau) \sum_{j=1}^{n} \phi_j - (1-\rho) r \sum_{j=1}^{n} k_j - \sum_{j=1}^{n} C(s_j), \tag{2.27}$$

where

$$\tau = \sum_{j=1}^{n} t_j A^j = t_i + \sum_{j \neq i}^{n} (t_j - t_i) A^j \tag{2.28}$$

is the MNE's effective tax rate equal to the weighted average of all national tax rates.

The MNE maximizes after-tax profits (2.27). Since tax bases are consolidated, it is not possible to lower the tax liability by shifting profits. For this reason the optimal amount of profit shifting is zero in all countries, i.e. $s_i = 0$ for all $i = 1, \ldots, n$. The first-order conditions with respect to capital and labor input are given by

$$\sum_{j=1}^{n} \phi_j \cdot \sum_{j \neq i}^{n} (t_i - t_j) A^j_{k_i} + (1-\tau)[F_k(k_i, \ell_i) - \rho r] - (1-\rho) r = 0, \tag{2.29}$$

$$\sum_{j=1}^{n} \phi_j \cdot \sum_{j \neq i}^{n} (t_i - t_j) A^j_{\ell_i} + (1-\tau)[F_\ell(k_i, \ell_i) - w_i] = 0, \tag{2.30}$$

for $i = 1, \ldots, n$. As under SA, these conditions contain the after-tax marginal returns to the input factors and the factor costs. But due to consolidation and apportionment the after-tax marginal returns are now computed not with the help of the national tax rates, but with the help of the effective tax rate τ. Moreover, (2.29) and (2.30) are characterized by additional terms containing the derivatives of the apportionment formula. These terms reflect the MNE's formula manipulation incentive, i.e. the incentive to increase investment and labor demand in low-tax countries in order to increase the share of the consolidated tax base assigned to these countries.

To derive the comparative static effects of tax rate changes, we again focus on a symmetric situation with $t_i = t$, $k_i = \bar{k}$, $\ell_i = \bar{\ell}$, $w_i = w$ and $\phi_i = \phi$ for all $i = 1, \ldots, n$. Moreover, symmetry implies $A^i = 1/n$ and

$$A^i_{k_i} = -(n-1)A^j_{k_i} = \frac{n-1}{n^2}\left(\frac{\gamma}{\bar{k}} + \frac{\sigma F_k}{F}\right), \tag{2.31}$$

$$A^i_{\ell_i} = -(n-1)A^j_{\ell_i} = \frac{n-1}{n^2}\left(\frac{\varphi}{\bar{\ell}} + \frac{\sigma F_\ell}{F}\right), \tag{2.32}$$

$$A^i_{w_i} = -(n-1)A^j_{w_i} = \frac{n-1}{n^2}\frac{\varphi}{w}. \tag{2.33}$$

Using these expressions, the Appendix proves

$$\frac{\partial r}{\partial t_i} = -\frac{F_k - \rho r}{n(1-t\rho)} < 0, \tag{2.34}$$

$$\frac{\partial k_i}{\partial t_i} = -(n-1)\frac{\partial k_j}{\partial t_i} = \frac{(n-1)\phi}{n(1-t)F_{kk}}\left(\frac{\gamma}{\bar{k}} + \frac{\sigma F_k}{F}\right) < 0, \tag{2.35}$$

$$\frac{dw_i}{dt_i} = -(n-1)\frac{\partial w_j}{\partial t_i} = \frac{(n-1)\phi}{n(1-t)F_{kk}}\left(\frac{\gamma F_{k\ell}}{\bar{k}} + \frac{\sigma(F_k F_{k\ell} - F_\ell F_{kk})}{F} - \frac{\varphi F_{kk}}{\bar{\ell}}\right) < 0, \tag{2.36}$$

for $i, j = 1, \ldots, n$ and $i \neq j$. These results are qualitatively the same as under SA, but the intuition is different. Under SA the MNE reallocates factor inputs to the tax-reducing country because this raises the tax base in this country and lowers the tax bases in the other countries. Due to tax base consolidation, this incentive is not present under FA. However, the tax rate reduction in country i now induces the MNE to raise investment in country i and to lower investment in all other countries since, by doing so, the MNE increases the share of the consolidated tax base assigned to country i. The same is true with respect to labor demand and, because labor supply in each country is fixed, with respect to wage rates. Formally, this intuition is confirmed by the fact that

the effects in (2.35) and (2.36) are non-zero only if one of the formula weights γ, σ or φ is positive.

Tax Competition. Under FA, tax revenues of country i read $t_i A^i(\cdot)\sum_{j=1}^n \phi_j$. Adding the transfer $T^i(\mathbf{t})$ of the fiscal equalization system, the public budget constraint of country i can be written as

$$g_i = t_i A^i(k_i, k_{-i}, \ell_i, \ell_{-i}, w_i, w_{-i}) \sum_{j=1}^n \phi_j + T^i(\mathbf{t}). \tag{2.37}$$

The government of country i chooses its tax rate t_i in order to maximize its resident's utility $U(c_i, g_i)$ subject to the private and public budget constraints (2.2) and (2.37). With the help of (2.1), (2.27), (2.28) and (2.31)–(2.36), it is straightforward to show that the Nash equilibrium of the resulting tax competition game is characterized by

$$\frac{U_g}{U_c} = \frac{\phi - n\rho t\bar{k}\dfrac{\partial r}{\partial t_i} + (n-1)(\mathrm{CE} + \mathrm{WE} + \mathrm{PE})}{\phi - n\rho t\bar{k}\dfrac{\partial r}{\partial t_i} - (n-1)(\mathrm{TE} + \mathrm{FE}) + T^i_{t_i}}. \tag{2.38}$$

with

$$\mathrm{CE} = \bar{k}\frac{\partial r}{\partial t_i} < 0,\ \mathrm{WE} = \bar{\ell}\frac{\partial w_j}{\partial t_i} > 0,\ \mathrm{PE} = \frac{1}{n}\frac{\partial \pi}{\partial t_i} = \frac{1}{n}\left[-\phi - n(1-\rho t)\bar{k}\frac{\partial r}{\partial t_i}\right] < 0, \tag{2.39}$$

$$\mathrm{TE} = \frac{t}{n}\sum_{j=1}^n \frac{\partial \phi_j}{\partial t_i} = -\rho t\bar{k}\frac{\partial r}{\partial t_i} > 0, \tag{2.40}$$

$$\mathrm{FE} = tn\phi\frac{\partial A^j}{\partial t_i} = t\phi\left[\left(\frac{\gamma}{\bar{k}} + \frac{\sigma F_k}{F}\right)\frac{\partial k_j}{\partial t_i} + \frac{\varphi}{w}\frac{\partial w_j}{\partial t_i}\right] > 0. \tag{2.41}$$

According to (2.38), the deviation of the non-cooperative tax policy from the Pareto-efficient solution is again determined by the pecuniary and fiscal externalities. The pecuniary externalities in (2.39) are basically the same as under SA. The only difference is that the wage income externality WE is now influenced by the formula, as can be seen by using (2.36) in WE. The fiscal externalities under FA are represented by (2.40) and (2.41). In contrast to SA, the tax base externality TE is now unambiguously positive since it reflects the effect on the consolidated tax base, so changes in capital and wage rates cancel out and only the change via the interest rate remains. Moreover, the profit

shifting externality is replaced by the formula externality FE, since under FA the MNE shifts profits by manipulating apportionment shares instead of paper profits.

Fiscal Equalization. From (2.38) we see that the Nash equilibrium of the tax competition game under FA is efficient if and only if

$$T^i_{t_i} = (n-1)(\mathrm{CE} + \mathrm{WE} + \mathrm{PE} + \mathrm{TE} + \mathrm{FE}). \tag{2.42}$$

As under SA, the transfer system under FA plays a Pigouvian role. In order to render tax rates efficient, the marginal transfer of country i has to internalize the externalities caused by this country's tax rate.

We start again by investigating whether the RTS satisfies this condition. Under FA the relevant tax base of country i is given by $\phi^c_i = A^i \sum_{j=1}^n \phi_j$. The average tax base is the same as under SA since $\sum_{j=1}^n A^i = 1$ implies $\bar{\phi} = \sum_{j=1}^n \phi^c_j/n = \sum_{j=1}^n \phi_j/n$. The representative tax rate reads $\bar{t} = \sum_{j=1}^n t_j\phi^c_j / \sum_{j=1}^n \phi^c_j$. Under the RTS, the transfer of country i equals

$$T^{iB}(\mathbf{t}) = \bar{t}(\bar{\phi} - \phi^c_i). \tag{2.43}$$

From (2.1), (2.35), (2.36), (2.40), (2.41), (2.43) and $\partial A^i/\partial t_i = -(n-1)(\partial A^j/\partial t_i)$ follows

$$T^{iB}_{t_i} = -\rho t\bar{k}\frac{\partial r}{\partial t_i} - t\frac{\partial \phi^c_i}{\partial t_i} = (n-1)\mathrm{FE} = (n-1)(\mathrm{FE} + \mathrm{TE}) + (n-1)\rho t\bar{k}\frac{\partial r}{\partial t_i}. \tag{2.44}$$

Comparing (2.44) with (2.42) immediately proves

Proposition 2.3. *Suppose the non-cooperative tax competition game under FA attains a symmetric Nash equilibrium. Then, implementing a fiscal equalization system of the RTS type* $[T^i(\mathbf{t}) = T^{iB}(\mathbf{t})$ *for* $i = 1, \ldots, n]$ *does not ensure Pareto-efficiency of the non-cooperative tax rates.*

The RTS ignores the pecuniary externalities and fails to fully internalize the fiscal externalities. This is the same reasoning as for the failure of the RTS under SA, but the story for the partial internalization of the fiscal externalities is now different. Suppose country i reduces its tax rate and, by doing so, changes its tax revenues. This change is represented by $-t(\partial\phi^c_i/\partial t_i)$ in the first part of (2.44), and it is caused by a reduction

in the consolidated tax base and an increase in the share of the consolidated tax base assigned to country i. In the RTS, the former effect is neutralized by an equal fall in the average tax base, which is reflected by $-\rho t\bar{k}(\partial r/\partial t_i)$ in the first part of (2.44). What remains is the increase in country i's share of the consolidated tax base. This increase is fully redistributed to the other countries, so the other countries are compensated for the decline in their shares of the consolidated tax base. But the other countries also suffer from the reduction in the consolidated tax base for which the RTS does not compensate. Hence, the transfer taken from country i is too low, i.e. the RTS reflects the formula externality, but not the tax base externality.

As an alternative equalization system we again consider tax revenue equalization and private income equalization. Average tax revenues can be written as $\overline{t\phi^c} = \sum_{j=1}^{n} t_j\phi_j^c/n$. Country i's transfer under tax revenue equalization therefore reads

$$T^{iR}(\mathbf{t}) = \overline{t\phi^c} - t_i\phi_i^c. \tag{2.45}$$

Differentiating (2.45) in the same way as (2.43) gives

$$T_{t_i}^{iR} = -\rho t\bar{k}\frac{\partial r}{\partial t_i} - t\frac{\partial \phi_i^c}{\partial t_i} - \phi\frac{n-1}{n} = (n-1)(\mathrm{FE}+\mathrm{TE}) + \frac{n-1}{n}\left(-\phi + n\rho t\bar{k}\frac{\partial r}{\partial t_i}\right) \tag{2.46}$$

Compared to the RTS, under tax revenue equalization a tax rate decrease in country i additionally has a direct negative effect on average tax revenues and on the tax revenues of country i. This effect is represented by the term $-\phi(n-1)/n$ in (2.46). It is the reason why the internalization of the fiscal externalities under tax revenue equalization is less complete than under the RTS, as becomes obvious by comparing (2.44) and (2.46).

Private income is defined in the same way as under SA, so the transfer paid or received by country i under private income equalization is expressed in the same way as in (2.21). Moreover, the definitions of the private income externalities under FA and SA are also the same, as can be seen from comparing equation (2.15) with equation (2.39). Hence, the analysis of private income equalization under FA is qualitatively the same as under SA. That means, analogous to (2.23), we can show that private income equalization internalizes the wage income externality WE, but fails to correct for the capital and profit income externalities CE and PE, respectively.

Combining the different types of equalization systems, we obtain

$$T_{t_i}^{iP} + T_{t_i}^{iR} = (n-1)(\mathrm{CE} + \mathrm{WE} + \mathrm{PE} + \mathrm{TE} + \mathrm{FE}), \tag{2.47}$$

$$T_{t_i}^{iP} + T_{t_i}^{iB} = (n-1)(\mathrm{CE} + \mathrm{WE} + \mathrm{PE} + \mathrm{TE} + \mathrm{FE}) + \phi\frac{n-1}{n}. \tag{2.48}$$

Comparing with (2.42) proves

Proposition 2.4. *Suppose the non-cooperative tax competition game under FA attains a symmetric Nash equilibrium. Then,*
(i) implementing private income equalization and tax revenue equalization $[T^i(\mathbf{t}) = T^{iP}(\mathbf{t}) + T^{iR}(\mathbf{t})$ *for all* $i = 1, \ldots, n]$ *renders the non-cooperative tax rates efficient,*
(ii) implementing private income equalization and the RTS $[T^i(\mathbf{t}) = T^{iP}(\mathbf{t}) + T^{iB}(\mathbf{t})$ *for all* $i = 1, \ldots, n]$ *leads to inefficiently high equilibrium tax rates.*

Private income equalization ignores the capital and profit income externalities. These externalities are also the reason why tax revenue equalization does not fully internalize the fiscal externalities. Hence, the drawbacks of both equalization systems just offset each other and a combined private income and tax revenue equalization system ensures an efficient corporate tax policy under FA, as stated by Proposition 2.4 (i). The degree of internalization of the fiscal externalities is larger under the RTS than under tax revenue equalization. Combining the RTS with private income equalization therefore implies too much internalization, so the non-cooperative tax rates are inefficiently high, as shown by Proposition 2.4 (ii).

Comparing Proposition 2.4 with Proposition 2.2, we see that a combination of private income and tax revenue equalization ensures efficiency, regardless of whether corporate income taxation follows SA or FA. As already discussed in the Introduction, this result may help to mitigate the discussion on the right taxation principle in the European Union. To see this, we have to take into account that the combination of private income and tax revenue equalization is the same as national income equalization and that there is already some redistribution of national income in Europe via the EU budget. Of course, the EU budget does not represent an equalization system as modeled in our formal analysis. But with some caution we may at least argue that the existing income redistribution provides a good basis for implementing an equalization system that *inter alia* accounts for externalities caused by corporate income taxation in Europe. Perhaps

a reform of income redistribution is even easier to implement than a reform of the corporate tax system, since the former does not directly affect firms and households. In the same sense we may argue that income redistribution in the US contributes to internalization of externalities arising from corporate income taxation at the state level.

If national income equalization is not feasible, for example due to political reasons, the question arises of whether the RTS or tax revenue equalization performs better in terms of efficiency. This question is of particular importance under FA since in Canada and Germany we observe the combination of FA taxation and tax base equalization. Rewriting (2.44) and (2.46) to

$$T_{t_i}^{iB} = (n-1)(\mathrm{FE}+\mathrm{TE}+\mathrm{CE}+\mathrm{PE}) + \phi\frac{n-1}{n}, \tag{2.49}$$

$$T_{t_i}^{iR} = (n-1)(\mathrm{FE}+\mathrm{TE}+\mathrm{CE}+\mathrm{PE}), \tag{2.50}$$

and inserting into (2.38), it immediately follows

Proposition 2.5. *Suppose the non-cooperative tax competition game under FA attains a symmetric Nash equilibrium. Then, implementing an RTS* $[T^i(\mathbf{t}) = T^{iB}(\mathbf{t})$ *for all* $i = 1, \ldots, n]$ *is superior to implementing tax revenue equalization* $[T^i(\mathbf{t}) = T^{iR}(\mathbf{t})$ *for all* $i = 1, \ldots, n]$*, if* $\mathrm{WE} > \phi/n$.

Proposition 2.5 identifies $\mathrm{WE} > \phi/n$ as a sufficient condition for the superiority of the RTS over tax revenue equalization under FA. As can be seen from (2.49) and (2.50), neither the RTS nor tax revenue equalization internalizes the wage income externality represented by $(n-1)\mathrm{WE}$. This externality is positive and points to inefficiently low tax rates in the equilibrium of the tax competition game. But the RTS is characterized by a further distortion. It fails to exactly internalize the other externalities. This failure is reflected by the expression $\phi(n-1)/n > 0$ in (2.49) and points to too much internalization and too high equilibrium tax rates. Hence, it goes in the other direction than the missing wage income externality. If $\mathrm{WE} > \phi/n$, the wage income externality is the more severe distortion and the countries end up with inefficient undertaxation under both equalization systems. However the tax rates under the RTS are then closer to their efficient levels than with tax revenue equalization.

Whether the condition $\mathrm{WE} > \phi/n$ is satisfied depends *inter alia* on the shape of the apportionment formula. Under a pure payroll formula we have $\gamma = \sigma = 0$ and $\varphi = 1$.

Inserting into (2.36) and (2.39) implies WE $> \phi/n$ if and only if $1/(1-t) > 1$. The latter condition is always satisfied since $t < 1$. Hence, with a pure payroll formula the wage income externality is sufficiently large and, in terms of efficiency, the RTS always outperforms tax revenue equalization. This insight supports the institutional setting at the local level in Germany where FA taxation of corporate income employs a pure payroll formula. Hence, the implemented tax base equalization is really more efficient than the alternative of tax revenue equalization

The implications for the Canadian case are less clear-cut. Corporate income taxation at the province level in Canada employs the FA principle with a formula that uses payroll and sales with equal weights. For $\gamma = 0$ and $\sigma = \varphi = 1/2$ the condition WE $> \phi/n$ may or may not be satisfied. To illustrate, consider the special case of a Cobb-Douglas production function $F(k_i, \ell_i) = k_i^{\alpha}\ell_i^{\beta}$ with $\alpha, \beta \in]0, 1[$. Inserting into (2.36) and (2.39) implies WE $> \phi/n$ if and only if $1 + \beta - \alpha > 2(1-t)(1-\alpha)$. Whether this latter condition is satisfied or not depends on the properties of the production function and the equilibrium tax rate. The growth literature often supposes constant returns to scale with $\alpha = 0.3$ and $\beta = 0.7$ (e.g. Ortigueira and Santos (1997) and Steger (2005)). The above condition is then equivalent to $1.4 > 1.4(1-t)$, and thus always satisfied according to $t < 1$. However, if we assume a fixed production factor (like land or natural resources) with a production share of $1 - \alpha - \beta = 0.2$ (e.g. Nordhaus et al. (1992)) and keep the assumption of $\alpha = 0.3$, then the above condition becomes $t > 14.29\%$. As the corporate income tax rates of Canadian provinces currently lie between 10% and 16%,[15] it is no longer clear whether the condition WE $> \phi/n$ is satisfied and the RTS is superior to tax revenue equalization. This problem becomes the more severe the lower the production share of labor represented by β.

2.5 Conclusion

This paper addresses the question of whether pecuniary and fiscal externalities arising in tax competition among countries can be internalized by fiscal equalization. The main innovation of the analysis is that it explicitly models a corporate income tax and distinguishes different taxation principles, whereas previous studies interpreted corporate taxation as a unit (wealth) tax on capital. In contrast to the previous literature, we

[15] See http://www.kpmg.ca/en/services/tax/taxrates.html.

can show that, with symmetric countries and an exogenously given capital supply, tax base equalization is not suitable for rendering non-cooperative tax rates Pareto-efficient. The reason is that tax base equalization does not internalize the pecuniary externalities, which in our framework are usually different from zero, and only partially internalizes the fiscal externalities since a tax rate reduction in one country lowers the worldwide tax base. Tax revenue equalization aggravates the latter problem, but combined with private income equalization it just internalizes all externalities and ensures efficient tax rates. These results hold for both taxation principles. If private income equalization is not feasible under FA, then tax base equalization may be superior to tax revenue equalization depending on the apportionment formula used.

2.A Proof of equations (2.9)–(2.12).

Totally differentiating (2.6), taking into account (2.4) and then applying the symmetry assumption yields

$$(1-t)F_{kk}\mathrm{d}k_i - (F_k - \rho r)\mathrm{d}t_i - (1-\rho t)\mathrm{d}r = 0. \tag{2.51}$$

From (2.3) we obtain $\sum_{i=1}^{n} \mathrm{d}k_i = 0$. Hence, summing (2.51) over all countries gives

$$-(F_k - \rho r)\sum_{i=1}^{n} \mathrm{d}t_i - n(1-\rho t)\mathrm{d}r = 0. \tag{2.52}$$

To identify the comparative static effects of tax rates changes, we have to set all but one $\mathrm{d}t_i$ equal to zero. This immediately proves (2.9). Using (2.9) in (2.51) and using $\sum_{i=1}^{n} \mathrm{d}k_i$ yields (2.10). From (2.7) and $\ell_i = \bar{\ell}$, we obtain $\mathrm{d}w_i = F_{k\ell}\mathrm{d}k_i$. Using (2.10) in this relation proves (2.11). Finally, differentiating (2.8) yields

$$-\mathrm{d}t_i - C''\mathrm{d}s_i + \mathrm{d}\mu = 0. \tag{2.53}$$

Summing (2.53) over all countries and setting all but one $\mathrm{d}t_i$ equal to zero implies $\mathrm{d}\mu = \mathrm{d}t_i/n$ since $\sum_{i=1}^{n} s_i = 0$ yields $\sum_{i=1}^{n} \mathrm{d}s_i = 0$. Using the expression for $\mathrm{d}\mu$ in (2.53) and taking into account $\sum_{i=1}^{n} \mathrm{d}s_i = 0$ proves (2.12). ■

2.B Pareto-efficient (cooperative) solution.

We derive the Pareto-efficient (cooperative) solution only for the tax regime of SA. Since there are no regime specific costs in our model, it follows from Coasean economics that the Pareto-efficient solution under FA is exactly the same.

To characterize the cooperative solution, consider a social planner (e.g. a supranational government) that maximizes the countries' joint welfare given by

$$\sum_{j=1}^{n} U(c_j, g_j) = \sum_{j=1}^{n} U(r\bar{k} + w_j\bar{\ell} + \pi/n, t_j\phi_j), \tag{2.54}$$

where ϕ_j, π, r, k_j and w_j depend on the tax rates according to (2.1), (2.5) and (2.9)–(2.12). Maximizing (2.54) with respect to t_i and applying the symmetry property yields

the first-order condition

$$U_c\left(n\bar{k}\frac{\partial r}{\partial t_i}+\bar{\ell}\sum_{j=1}^{n}\frac{\partial w_j}{\partial t_i}+\frac{\mathrm{d}\pi}{\mathrm{d}t_i}\right)+U_g\left(\phi+t\sum_{j=1}^{n}\frac{\partial \phi_j}{\partial t_i}\right)=0. \tag{2.55}$$

From (2.1), (2.5) and (2.9)–(2.12) we obtain $\sum_{j=1}^{n}\partial w_j/\partial t_i=0$, $\partial\pi/\partial t_i=-\phi-n(1-\rho t)\bar{k}(\partial r/\partial t_i)$ and $\sum_{j=1}^{n}\partial\phi_j/\partial t_i=-n\rho\bar{k}(\partial r/\partial t_i)$. Inserting into (2.55) gives

$$U_c\left(-\phi+n\rho t\bar{k}\frac{\partial r}{\partial t_i}\right)+U_g\left(\phi-n\rho t\bar{k}\frac{\partial r}{\partial t_i}\right)=0, \tag{2.56}$$

and, thus, the Samuelson rule $U_g/U_c=1$. ■

2.C Proof of equations (2.34)–(2.36).

Totally differentiating (2.29) and (2.30), taking into account $\mathrm{d}\ell_i=0$ from (2.4) and applying the symmetry property yields

$$n\phi\sum_{j\neq i}^{n}(\mathrm{d}t_i-\mathrm{d}t_j)A^j_{k_i}+(1-t)F_{kk}\mathrm{d}k_i-(F_k-\rho r)\mathrm{d}\tau-(1-t\rho)\mathrm{d}r=0, \tag{2.57}$$

$$n\phi\sum_{j\neq i}^{n}(\mathrm{d}t_i-\mathrm{d}t_j)A^j_{\ell_i}+(1-t)F_{k\ell}\mathrm{d}k_i-(1-t)\mathrm{d}w_i=0. \tag{2.58}$$

Equation (2.28) and the symmetry assumption implies $\mathrm{d}\tau=\sum_{j=1}^{n}\mathrm{d}t_j/n$. Inserting into (2.57) and solving for k_i gives

$$\mathrm{d}k_i=\frac{1}{(1-t)F_{kk}}\left\{\frac{F_k-\rho r}{n}\sum_{j=1}^{n}\mathrm{d}t_j-n\phi A^j_{k_i}\left[(n-1)\mathrm{d}t_i-\sum_{j\neq i}^{n}\mathrm{d}t_j\right]+(1-t\rho)\mathrm{d}r\right\} \tag{2.59}$$

If we sum up (2.59) over all $i=1,\ldots,n$ and take into account $\sum_{i=1}^{n}\mathrm{d}k_i=0$ from (2.3) as well as $\sum_{i=1}^{n}[(n-1)\mathrm{d}t_i-\sum_{j\neq i}^{n}\mathrm{d}t_j]=0$, equation (2.59) simplifies to

$$\mathrm{d}r=-\frac{F_k-\rho r}{n(1-t\rho)}\sum_{j}\mathrm{d}t_j. \tag{2.60}$$

Equation (2.34) follows from (2.60), if we set one $\mathrm{d}t_j \neq 0$ and all others equal to zero. Inserting (2.60) back into (2.59) implies

$$\frac{\partial k_i}{\partial t_i} = -(n-1)\frac{\partial k_i}{\partial t_j} = -\frac{n(n-1)\phi A^j_{k_i}}{(1-t)F_{kk}}. \tag{2.61}$$

Using (2.31) proves (2.35). Finally, from (2.58) we obtain

$$\mathrm{d}w_i = F_{k\ell}\mathrm{d}k_i + \frac{n\phi}{1-t}\sum_{j\neq i}(\mathrm{d}t_i - \mathrm{d}t_j)A^j_{\ell_i}, \tag{2.62}$$

and, thus,

$$\frac{\partial w_i}{\partial t_i} = F_{k\ell}\frac{\partial k_i}{\partial t_i} + \frac{n(n-1)\phi}{1-t}A^j_{\ell_i}, \qquad \frac{\partial w_i}{\partial t_j} = F_{k\ell}\frac{\partial k_i}{\partial t_j} - \frac{n\phi}{1-t}A^j_{\ell_i}. \tag{2.63}$$

Using (2.61) and (2.32) proves (2.36). ■

Chapter 3

Measuring Sales in the Apportionment Formula: Origin vs. Destination Principle[1]

3.1 Introduction

The European Union (EU) was founded to remove trade obstacles among its member states and to establish a *Single Market* within its borders (European Commission, 2011b). Along with the increasing integration of international markets, an ever-increasing diversification of firms in tandem with the development of multinational enterprises (MNEs) is observable. Among other things, the legislative authorities in the EU and its member states are faced with the challenge of ensuring that their corporate tax systems keep pace with the economic transformation of companies and markets, for instance in the manufacturing, pharmaceutical and food sectors.

Under the current system of international profit taxation, Separate Accounting (SA), each subsidiary is treated as a separate entity which is subject to national tax law. For this reason the subsidiaries have to value their intra-firm trade with internal transfer prices, which must meet an external standard of comparison, i.e. arm's length prices.[2]

[1]This chapter is based on Liesegang (2016). After resubmitting, the paper has the status of "Under Review" in the Journal of Public Economics.

[2]For example, firms buy and sell in-house intermediate products and services or borrow and lend money at an internal interest rate.

Because tax authorities never have complete information about the nature of internal trade, and because firm-specific tangibles and intangibles are traded, it is difficult to evaluate an appropriate reference price. As a consequence, SA was identified as one reason for manipulations in favor of profit shifting for tax saving purposes. For this reason, governments put more effort in to detecting profit shifting strategies mainly by demanding detailed supporting documents. These activities, in conjunction with an expanding number of EU members, increased administrative expenses for both the states and the MNEs.

Thus, in 2001 the European Commission (EC) proposed switching from SA to Formula Apportionment (FA) as the leading corporate income tax system in the EU (European Commission, 2001, 2011b). One key element of this approach is to consolidate the profits of a corporate group to a Common Consolidated Corporate Tax Base (CCCTB), thus rendering transfer pricing unprofitable. The consolidated tax base is apportioned to the member states with a splitting mechanism - the formula (Weiner, 2006). The EC recommends a common three-factor apportionment formula containing assets, labor and sales at destination.

The sales factor in the apportionment formula is subject of controversy. The main question is whether sales should be measured at destination or at origin. The destination principle implies that sales are taken into account at the place where they are ultimately delivered or consumed. According to the origin principle sales are taken into account at the place where they are produced. The CCCTB Working Group (2007b) suggested the inclusion of sales following the destination principle. In contrast, "...most member states' experts that would support the inclusion of sales as a factor would prefer sales measured 'at origin' " (CCCTB Working Group, 2007b). Moreover, related to the question of destination versus origin principle, there is also a discussion about how large the formula weight on sales should be. Actually, each factor should be equally weighted (CCCTB Working Group, 2007b). However, with regard to the most recent proposal from the EC for a council directive on this topic (European Commission, 2011b) the European Parliament (2012) advocated amending the input factor weightings for assets and labor to 45% each and lowering the sales weight to 10%. The *Committee of the Internal Market and Consumer Protection* even called for the removal of the sales factor. The main argument is that with the destination principle it would be easy for MNEs to

move the ultimate delivery to a non-CCCTB country and the power of the tax policies in source countries would be reduced.

Motivated by this controversial discussion on the sales factor this paper aims to answer the question. In doing so, we take a tax competition perspective, i.e. we ask under which principle detrimental competition in tax rates is stronger, considering that tax rates are also controlled by member states under FA.[3] To focus on the issue of destination versus origin principle, in our model a sales-only formula is used, i.e. the weights for assets and labor are set to zero. In each of two identical countries an MNE operates one manufacturing subsidiary that produces a diversified commodity representing a brand. The goods are delivered to the local market and to the foreign retail subsidiaries. Internal transfer prices are charged for the export of the goods. Each subsidiary has monopoly power on its output market and cross-border shopping is omitted. Exports can be over- or underinvoiced to shift profits at positive concealment costs. The MNE sets production and profit shifting such that after-tax profits are maximized. Taking this behavior into account, the governments of the countries non-cooperatively set their tax rates under SA and FA with either a destination- or origin-based sales apportionment factor. We derive the Nash equilibrium of this tax competition game between the countries.

Our analysis delivers two central findings. Firstly, we prove that the FA system with a sales-only formula mitigates tax competition compared to SA.[4] Secondly, our paper shows that, from a welfare perspective, using FA with an origin-based sales factor dominates a sales factor relying on the destination principle. Hence, our paper argues for implementing FA with a sales factor measured at origin.

The overall effect of a tax increase in one country on foreign welfare is positive irrespective of using SA or FA. We derive that the sum of externalities under SA is always greater than that of FA for both definitions of the sales factor. The reason for the first result can be found in the direct profit shifting opportunities under SA.

The sum of externalities is positive for both considered alternatives under FA. The key feature of the second result is that the negative consumption externality of the origin

[3]With reference to the EC proposal, all countries have approved the tax base definition and formula. Decisions about the tax rate remain at member state level, allowing "... a certain degree of tax competition to be maintained ..." (European Commission (2011b), p. 4).

[4]For an alternative approach of this comparison see Nielsen et al. (2010).

principle counteracts the positive formula externality whereas under the destination principle the consumption and formula externality have the same sign.

We identify the transfer price under SA as well as under FA as a tax saving device. Under SA an MNE responds to a tax increase in one country by reducing the transfer price for the exported goods and increasing the transfer price for the goods that are imported to that country. This means that paper profits are lowered in the tax-increasing country, which is reflected in a positive profit shifting externality.

In comparison to the direct under- or overinvoicing of internal trade under SA, under FA the MNE has limited profit manipulation opportunities because it may influence the tax base allocation only indirectly via the formula. A tax increase in one country triggers the MNE to downsize the apportionment share in this country to save taxes. This is done by manipulating transfer prices and, thus, revenues and the apportionment formula. The mechanism to lower revenues in the tax-increasing country differs between the origin and the destination principle. Under the origin principle, the MNE's head office increases the transfer price in the tax-increasing country in order to scale down production, and lowers it in the country where the tax rate remains constant to stimulate production there. Because, under the destination principle, the place of consumption is relevant for the apportionment share, the transfer price in the tax-increasing country is lowered to expand the demand in the country where the goods are delivered and revenues are imputed. Conversely, imports to the tax-increasing country are curbed by a higher transfer price for these imports. Overall the quantitative effects on the sales share are identical for both principles and constitute the same positive formula externality, which is lower than the profit shifting externality under SA. The resulting profit income externality is negative and coincides for both principles under FA with SA.

If we consider the effect of a tax rate increase on foreign consumption possibilities it is relevant how the supply in this country is affected by the tax increase. When the origin principle is used, the transfer price for the good that is exported from the tax-increasing country rises. Therefore, the supply of this good in the foreign market decreases and the consumption possibilities are cut. Hence, the consumption externality under the origin principle is negative. In contrast, under SA and FA with the destination principle the consumption externality is positive because the transfer price for the exported good is

lowered, and therefore foreign supply increases. However, the restricted usage of the transfer price under FA also mitigates the repercussions on the private consumption possibilities, and therefore the consumption externality of the destination principle is lower than for SA.

Our results complement the findings of Eichner and Runkel (2008), who also provide a foundation for implementing a sales factor at origin. They show that a formula containing sales at origin can mitigate the positive externalities caused by the assets and labor factors. Eichner and Runkel (2008) use a model with decreasing returns to scale, wherein a fixed production factor hampers the formula manipulation possibilities of the MNE, and therefore a sales factor mitigates the corresponding positive formula externality. In contrast to our analysis, however, their model does not allow an analysis of the destination principle. Hence, they derive an argument why sales (with the origin principle) are better than capital or labor, but they cannot show that sales with the origin principle are better than sales with the destination principle. This is the main contribution in our analysis.

Our analysis is also related to Kind et al. (2005) and Schjelderup and Sørgard (1997). They compare corporate tax competition under SA and FA in the presence of MNEs and transfer pricing. Because they assume oligopolistic markets, the transfer price has a tax saving and strategic function. They use a two-country model where a commodity is exported at trade costs. Kind et al. (2005) show that the higher the level of economic integration the more preferable is FA to SA. But again, the focus is only on the sales factor at destination, and therefore they cannot obtain our results.

A politically significant argument for the sales factor is provided by Anand and Sansing (2000). They prove theoretically and empirically for the U.S. federal states that the weight of the sales factor becomes a policy instrument in a non-cooperative equilibrium if countries are able to alter the formula unilaterally. In contrast to our analysis they only focus on a sales factor according to the destination principle, and thus cannot obtain our results. In line with our findings, however, they show that in a Nash equilibrium only importing states increase their weight for sales to receive a larger apportionment share of the tax base, whereas exporting states prefer greater weight to be given to the input factors.

Pinto (2007) analyzes efficiency characteristics of FA with a capital and a production, i.e. sales at origin, share in tax competition framework. He shows that regional governments would always opt for a formula including only the production share to extend the public good provision. Moreover, this paper does not include a comparison of the destination and origin principles.

The paper is organized as follows. Section 2 describes the basic framework. In Section 3 profit maximization of the MNE and corporate tax competition under SA are analyzed. Section 4 presents the outcomes using FA with either the origin or the destination principle. In Section 5 the results for the different tax regimes are compared and discussed. Section 6 concludes.

3.2 The Model

3.2.1 Basic Structure and Multinational Enterprise

The basic structure of the model goes back to Lockwood (1993) and Lockwood (2001). We consider an economy consisting of two identical countries which are indexed by $i, j = 1, 2$. In each country, there lives a representative household who is endowed with one unit of time. This time endowment can be spent on leisure ℓ^i or on work remunerated with the wage rate w^i. Labor is internationally perfectly mobile, so that the wage rates in both countries are equalized. We normalize this common wage rate to one, i.e. $w^i = w^j = w = 1$.

A representative multinational group produces two international brands, also denoted by the indices i and j. Due to cost advantages, the MNE operates a local subsidiary in country i, where only brand i is manufactured (Horst, 1971).[5] Brand i is directly sold in country i and delivered to a retail subsidiary in country j, which sells brand i in country j. The variables q_i^i and q_i^j denote the quantities of brand i produced in country i and sold in country i and j, respectively.[6] For the production of one unit output the producer needs one unit of the input labor. Hence, the linear production costs for the

[5]The production side of the model is in the spirit of Horst (1971), who shows that with increasing marginal costs the affiliate with a cost advantage becomes an exporter. Neither transport nor import tariffs can change the direction of trade in his model. In the present paper we abstract from additional cost and assume the producing subsidiary may produce the brand at lower marginal cost.

[6]Throughout the paper the subscript indicates the country where the good is produced and superscripts indicate the country where the good is consumed.

producing affiliate i read $K_i = q_i^i + q_i^j$. Final goods from country i are exported to the foreign retail subsidiary in country j at the internal transfer price g_i which has not to be equal to the true marginal (labor) cost $w = 1$. The transfer price is chosen centrally by the headquarters and is therefore exogenous from the perspective of the subsidiaries.

The producing subsidiary in country i sells q_i^i units of the good at the price $p(q_i^i)$; revenues are therefore $R(q_i^i) = p(q_i^i)q_i^i$. The importing subsidiary located in country j supplies the quantity q_i^j at price $p(q_i^j)$ and earns revenues $R(q_i^j) = p(q_i^j)q_i^j$. To make sure that the symmetric equilibrium is unique, we follow Gresik (2010) and assume strictly concave revenue functions with the following properties: $R(0) = 0$, $R'(0) > 0$, $R'(\cdot) > 0$ and $R''(\cdot) < 0$. Because of producing differentiated goods and market segmentation each retailer may behave as a monopolist in its national market.[7] Pre-tax profits for the entities selling brand i in country i and country j read, respectively,

$$\begin{aligned} \Pi_i^i &= R(q_i^i) + g_i q_i^j - (q_i^i + q_i^j) \\ \Pi_i^j &= R(q_i^j) - g_i q_i^j. \end{aligned} \qquad i = 1, 2,\ i \neq j \tag{3.1}$$

The subsidiary which produces and sells brand i in country i earns revenues $R(q_i^i)$ from selling brand i goods to consumers in country i and from exporting quantity q_i^j to its related retailer in country j at the transfer price g_i. The production costs are denoted by $q_i^i + q_i^j$. The retail subsidiary in country j has to pay the import of brand i and earns revenues $R(q_i^j)$ by selling the goods in the local market. Irrespective of the mode of taxation headquarters choose the transfer price; so the subsidiaries take the transfer price as given. Each subsidiary maximizes its before-tax profits in (3.1) by setting quantities. The first-order conditions of profit maximization for the subsidiaries are

$$R'(q_i^i) = 1 \text{ and } R'(q_i^j) = g_i\ , \qquad i = 1, 2,\ i \neq j. \tag{3.2}$$

According to (3.2) sales in the home market, q_i^i, do not depend on the transfer price; the marginal revenue equals the marginal production costs. The foreign subsidiary in country j, in contrast, equalizes marginal revenues and the transfer price. From this follows that the volume of trade depends on g_i.

[7] Schjelderup and Sørgard (1997) and Nielsen et al. (2003) prove that under oligopolistic competition it exists the strategic advantage to decentralizing alongside the tax saving incentive. We abstract from quantity competition in oligopoly markets, but nevertheless apply decentralized decision-making to isolate the tax saving incentive under FA induced by transfer pricing.

Starting from the first order conditions (3.2), the output adjustments for a transfer price change ($dg_i \neq 0$) are

$$\frac{dq_i^i}{dg_i} = 0 \quad \text{and} \quad \frac{dq_i^j}{dg_i} = \frac{1}{R''(q_i^j)} < 0 \ , \qquad i = 1, 2, \ i \neq j. \tag{3.3}$$

When the transfer price is increased, importing subsidiaries demand less output to keep up with the higher marginal costs, whereas the output decision for the local market is not affected.

The total after-tax profit of the multinational equals the before-tax profits of all subsidiaries less concealment costs, C_i and C_j, and tax payments, T^i and T^j. Concealment costs arise if the transfer price deviates from marginal cost of the traded good, i.e. if $g_i \neq 1$. They are represented by a quadratic concealment cost function:[8]

$$C_i = cq_i^j(g_i - 1)^2 \qquad i = 1, 2, \ i \neq j, \tag{3.4}$$

where $c > 0$ is a given constant. Headquarters determine the transfer prices g_i and g_j to maximize the MNE's after-tax profits

$$\pi = \Pi_i^i + \Pi_i^j + \Pi_j^j + \Pi_j^i - C_i - C_j - T^i - T^j.$$

Tax payments T^i and T^j and, thus, the solution to profit maximization depends on the tax regime under consideration and will therefore be discussed below.

3.2.2 Household and Government

The household in country i consumes the local and imported goods, q_i^i and q_j^i, leisure, ℓ^i, and a public good, G^i, provided by the local government out of corporate tax revenues T^i. As with the private good, each unit of the public good is produced with one unit of labor. The public budget constraint therefore reads $G^i = T^i$. The preferences of the household in country i are represented by the additively separable utility function

$$U(q_i^i, q_j^i, \ell^i, G^i) = \frac{\sigma}{\sigma - 1}\left[(q_i^i)^{\frac{\sigma-1}{\sigma}} + (q_j^i)^{\frac{\sigma-1}{\sigma}}\right] + \ell^i + \lambda G^i \quad \sigma, \lambda > 1.$$

[8] A convex concealment cost function is a common assumption in the tax competition literature with transfer pricing, compare e. g. Nielsen et al. (2010), Eichner and Runkel (2008), Kind et al. (2005). It represents either fines connected with detecting the misreporting by a tax authority or administrative expenses to justify the choice.

The properties of these quasi-linear preferences are very useful for focusing on the effects of corporate taxation in our model. Because the utility function is separable in both private goods, the cross price effects are zero. Additionally $\sigma > 1$ provides monopoly power for the subsidiaries by constituting the mark-up over marginal cost. The mark-up will be the lower, the closer σ is to unity, because in this case the products tend to be perfect substitutes. The marginal utility of income is also assumed to be constant and equal to one. To reflect the value of governmental public good provision, the quantity of the public good is weighted with the marginal cost of public funds (MCPF) denoted by the parameter $\lambda > 1$.

To finance private consumption, the household generates wage income from labor supply and profit income π^i from MNE ownership. We assume that the MNE is equally owned by the inhabitants of both countries, so that each household receives one half of MNE's after-tax profit, i.e. $\pi^i = 0.5\pi$. Therefore, the private budget constraint reads $1+0.5\pi = p_i^i q_i^i + p_j^i q_j^i + \ell^i$.

Given this budget constraint, utility maximization with respect to private consumption and leisure gives the inverse market demands $p_i^i = p_i^i(q_i^i) = (q_i^i)^{-1/\sigma}$ and $p_j^i = p_j^i(q_j^i) = (q_j^i)^{-1/\sigma}$. Substituting these demand functions into the budget constraint, solving for leisure and afterwards plugging the resulting expression into the utility function, we end up with a utility function that depends only on the quantity of private consumption, the public good and profit income:

$$W(q_i^i, q_j^i, \pi^i, G^i) = \frac{1}{\sigma - 1}\left[(q_i^i)^{\frac{\sigma-1}{\sigma}} + (q_j^i)^{\frac{\sigma-1}{\sigma}}\right] + 1 + \pi^i + \lambda G^i \quad \sigma, \lambda > 1. \tag{3.5}$$

Because the household is representative, this function also describes the welfare function in country i.

The government of country i aims to maximize domestic welfare W^i, disregarding the impact of its policy on country j's welfare. Hence, we consider a Nash tax competition game in tax rates between two countries. For the purpose of this paper we identify policy externalities, because they reflect the extent of detrimental tax competition among countries. The equilibrium tax rate of country i is inefficiently high (low) if the sum of external effects on country j is negative (positive). In deriving the externalities we focus on the symmetric Nash equilibrium of tax competition. For each tax regime - SA, FA with an origin-based sales factor and FA with a destination-based sales factor - the game

has three stages: At stage 1, governments choose their tax rates non-cooperatively and simultaneously to maximize welfare. The second stage shows the transfer price choices of the MNE's headquarters given the equilibrium tax rates chosen at stage 1. Finally, at the third stage the subsidiaries set their quantities, for given transfer prices chosen at stage 2. The game is solved by backward induction.

3.3 Separate Accounting

3.3.1 MNE Profit Maximization

Under SA, subsidiaries are taxed separately according to the tax law of their host country. Hence, subsidiaries' tax bases are identical with the before-tax profits described in equation (3.1). Their profit-maximizing production decisions at the third stage of the game are characterized by (3.2). At stage 2, the MNE's after-tax profit, π^{SA}, equals the before-tax profits less tax liabilities and concealment costs. We obtain:

$$\begin{aligned}\pi^{SA} =&(1-t^i)(\Pi_i^j+\Pi_j^i)-C_i+(1-t^j)(\Pi_j^j+\Pi_i^j)-C_j\\ =&(1-t^i)\left[R(q_i^i)+g_iq_i^j-(q_i^i+q_i^j)+R(q_j^i)-g_jq_j^i\right]-cq_i^j(g_i-1)^2\\ &+(1-t^j)\left[R(q_j^j)+g_jq_j^i-(q_j^j+q_j^i)+R(q_i^j)-g_iq_i^j\right]-cq_j^i(g_j-1)^2.\end{aligned} \tag{3.6}$$

After-tax profit maximization by headquarters with respect to g_i and g_j yields the first-order conditions

$$\frac{\partial\pi^{SA}}{\partial g_i}=(1-t^i)\left[q_i^j+(g_i-1)\frac{\partial q_i^j}{\partial g_i}\right]-(1-t^j)q_i^j-c\left[2(g_i-1)q_i^j+(g_i-1)^2\frac{\partial q_i^j}{\partial g_i}\right]=0 \tag{3.7a}$$

$$\frac{\partial\pi^{SA}}{\partial g_j}=(1-t^j)\left[q_j^i+(g_j-1)\frac{\partial q_j^i}{\partial g_j}\right]-(1-t^i)q_j^i-c\left[2(g_j-1)q_j^i+(g_j-1)^2\frac{\partial q_j^i}{\partial g_j}\right]=0 \tag{3.7b}$$

where we have used $R'(q_i^j)=g_i$ and $R'(q_j^i)=g_j$ according to before-tax profit maximization for the subsidiaries. After-tax profit maximization with respect to the transfer prices shows that a change in g_i or g_j affects the value of internal trade and triggers quantity adjustments following this price change. Below we consider only symmetric situations with $t^i=t^j=t^S$. From the first-order conditions (3.7a) for g_i and (3.7b) for g_j we then obtain the optimal transfer prices $g_i^S=g_j^S=1$. Thus, profit maximization for the subsidiaries in equation (3.2) implies $R'(q_i^i)=R'(q_i^j)=R'(q_j^j)=R'(q_j^i)=1$, respectively. From this it follows that the quantities and revenues are equalized, too:

$q_i^i = q_i^j = q_j^j = q_j^i = q^S$ and $R(q_i^i) = R(q_i^j) = R(q_j^j) = R(q_j^i) = R(q^S)$. Given the inverse demand functions, appendix 3.A proves that explicit solutions can be derived as

$$q^S = \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma} \quad \text{and} \quad R(q^S) = \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma - 1}.$$

Note that with symmetry this implication holds for the three considered taxation principles.

For later purposes we need to know the impact of tax rates on transfer prices. Including the subsidiaries' reaction derived in equation (3.3) and using the symmetry assumption, appendix 3.A proves

$$\frac{dg_i^S}{dt^i} = -\frac{dg_j^S}{dt^i} = -\frac{1}{(1 - t^S)\sigma + 2c} < 0. \tag{3.8}$$

A tax increase in country i raises the taxation on the revenues of the exporting and importing subsidiaries located in i marginally by q^S. To avoid higher tax liabilities, the headquarters aim to lower the tax bases in country i. For this reason, the transfer price for the exported good, g_i, is decreased. This reaction reduces the value of exports but also stimulates internal demand for exports from i. The transfer price for the imported good, g_j, is increased. So the costs for the importing subsidiary rise. Additionally, a the higher transfer price lessens demand for imports to country i. Equation (3.8) also reveals that the quantitative effect goes up for a smaller σ, lower equilibrium tax rates and concealment costs.

3.3.2 Tax Competition and Externalities

If countries compete for tax revenues in a Nash manner each country chooses the national corporate tax rate non-cooperatively to maximize national welfare. Hence, the government of country i chooses the tax rate t^i to maximize the welfare W^i taking country j's tax rate t^j as given. Analytically this is done by solving the first-order condition $\partial W^i / \partial t^i = 0$. To obtain equilibrium in tax rates (t^{iS}, t^{jS}) we solve the first-order conditions for both countries simultaneously. By assuming symmetry the equilibrium tax rates are identical and simplify to $t^{iS} = t^{jS} = t^S$. Because we are aiming to compare the different taxation principles, we are interested in the efficiency of the equilibrium tax rate t^S. For this reason we determine at the symmetric equilibrium the externalities

imposed by country i on country j's welfare, i.e. $\partial W^j/\partial t^i$. To keep track of the different effects we disaggregate the overall welfare effect into sub-externalities which can be traced back to the components of the welfare function in equation (3.5). For this purpose we derive a consumption externality, a (profit) income externality and a public consumption externality which originates under SA from a profit shifting externality.

Combining equations (3.3) and (3.8) shows that a unilateral tax rate increase in country i triggers extended sales of brand i in country j. As a consequence the consumer price for good i in country j falls and consumption there increases. This constitutes a positive consumption externality (CE).[9] The consumption externality is obtained by differentiating the utility from private consumption in country j of equation (3.5) with respect to the tax rate in country i and using equations (3.3) and (3.8) with symmetry as the starting point:

$$CE^S = \frac{1}{\sigma}(q^S)^{-\frac{1}{\sigma}}\frac{\partial q_i^j}{\partial g_i}\frac{\partial g_i^S}{\partial t^i} = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\frac{1}{(1-t^S)\sigma+2c} > 0. \tag{3.9}$$

The second sub-externality stems from the effect of country i's tax rate on the public consumption G^j in country j which is refinanced by tax revenues. Under SA they arise from taxing the before-tax profits of subsidiaries domiciled in this country. Formally, we obtain:

$$G^j = T^j = t^j\left[R(q_j^j) + g_j q_j^i - (q_j^j + q_j^i) + R(q_i^j) - g_i q_i^j\right]. \tag{3.10}$$

Country i's tax policy may influence foreign tax revenues, if sales or costs linked to tax bases in j are changed. A tax rate increase in country i induces a transfer price increase for exports from country j to country i and a transfer price decrease for the imports from country i to country j. Both adjustments improve the tax base in country j and thereby induce a positive profit shifting externality (PE). To derive the PE we differentiate the public budget constraint in equation (3.10) with respect to the tax rate t_i using equations (3.2), (3.3), (3.8) and the symmetry assumption. It yields

$$PE = \frac{\partial T^j}{\partial t^i} = t^S\left(q^S\frac{\partial g_j^S}{\partial t^i} - q^S\frac{\partial g_i^S}{\partial t^i}\right) = 2t^S\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^S)\sigma+2c} > 0. \tag{3.11}$$

Finally, country i's tax rate affects welfare in country j via changes in household j's

[9] The consumption externality is also shown in Lockwood (2001) and Mintz and Tulkens (1986). Both papers discuss a two-country model with commodity taxation at origin or destination.

profit income $\pi^j = 0.5\pi^{SA}$, i.e. half of the changes in MNE's after-tax profit influence the income of the household in country j. Differentiating π^{SA} from (3.6), using the envelope theorem, the symmetry properties ($g_i^S = g_j^S = 1$, q^S and $R(q^S)$) and the first-order conditions for subsidiaries' profit maximum in equation (3.2) we obtain the income externality (IE)

$$IE = 0.5\,\frac{\partial \pi^{SA}}{\partial t^i} = -[R(q^S) - q^S] = -\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1} < 0 \tag{3.12}$$

The effect on welfare in country j results from the sum of the derived sub-externalities. It is shown in appendix 3.A that the overall effect is positive

$$\begin{aligned}\frac{\partial W^{jS}}{\partial t^i} &= CE^S + \lambda\, PE + IE \\ &= \left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\left[\frac{1}{(1-t^S)\sigma + 2c}\left(\frac{\sigma}{\sigma-1} + 2\lambda t^S\right) - \frac{1}{\sigma-1}\right] > 0.\end{aligned} \tag{3.13}$$

Hence, the equilibrium tax rates under SA are inefficiently low.

3.4 Formula Apportionment

3.4.1 MNE Profit Maximization

Under FA, the companies of the multinational group are tax liable as a business unit. Tax bases are consolidated first and apportioned subsequently based on the MNE's economic activity in the taxing country. To focus on the influence of sales, only revenues enter the formula in our model.[10] All before-tax profits given in equation (3.1) are consolidated to a single corporate tax base $\Pi = \Pi_i^i + \Pi_i^j + \Pi_j^j + \Pi_j^i$. Since the terms $g_i q_i^j$ and $g_j q_j^i$ cancel out by consolidation, there is no longer a direct profit shifting incentive for the MNE. However, as will be seen below, the MNE uses transfer prices to indirectly manipulate the apportionment shares.

The apportionment shares A^i and A^j, with $A^i = 1 - A^j$, allocate a fraction of the consolidated tax base to the taxing countries. We distinguish whether the revenues are apportioned at the place of origin, i.e. $A^i = O^i$, or at the place of destination, i.e. $A^i = D^i$.

[10] As Kind et al. (2005) hint there is no qualitative difference to using sales or revenues.

When a sales factor is calculated with the origin principle, only the location of production is relevant. Because the MNE produces solely one brand in one country, the fraction of the consolidated tax base allocated to country i equals the revenues from producing brand i as a proportion of overall revenues. Therefore, the apportionment factor for country i, O^i, reads

$$O^i = \frac{R(q_i^i) + R(q_i^j)}{R(q_i^i) + R(q_i^j) + R(q_j^j) + R(q_j^i)}. \tag{3.14}$$

Under the destination principle it is decisive where the brands are delivered. Revenues that accrue from consumption of brand i and brand j in country i, define the apportionment share, D^i, of the consolidated tax base allocated to country i:

$$D^i = \frac{R(q_i^i) + R(q_j^i)}{R(q_i^i) + R(q_i^j) + R(q_j^j) + R(q_j^i)}. \tag{3.15}$$

The allocated tax base is taxed with the national tax rate.[11] The relevant corporate tax rate for the MNE is now represented by the effective tax rate τ. It equals the average corporate tax rate where the weights are represented by the shares of the consolidated tax base allocated to the countries, i.e.

$$\tau = t^i A^i + t^j A^j = (t^i - t^j)A^i + t^j, \qquad A = O, D. \tag{3.16}$$

The after-tax profit of the MNE under FA thus reads

$$\begin{aligned} \pi^{FA} =& (1-\tau)\Pi - C_i - C_j \\ =& (1-\tau)\left[R(q_i^i) + R(q_i^j) - (q_i^i + q_i^j) + R(q_j^j) + R(q_j^i) - (q_j^j + q_j^i)\right] \\ & - cq_i^j(g_i - 1)^2 - cq_j^i(g_j - 1)^2. \end{aligned} \tag{3.17}$$

[11] We follow the EC's proposal and assume that the tax base definition and the formula is the same for both countries. The countries compete only in corporate tax rates.

After-tax profit maximization with respect to the transfer prices g_i and g_j yields the first-order conditions:

$$\begin{aligned}\frac{\partial \pi^{FA}}{\partial g_i} =& -(t^i - t^j)\frac{\partial A^i}{\partial g_i}\Pi + (1-\tau)\left[R'(q_i^j) - 1\right]\frac{\partial q_i^j}{\partial g_i} \\ & - c\left[2(g_i - 1)q_i^j + (g_i - 1)^2\frac{\partial q_i^j}{\partial g_i}\right] = 0\end{aligned} \tag{3.18a}$$

$$\begin{aligned}\frac{\partial \pi^{FA}}{\partial g_j} =& -(t^i - t^j)\frac{\partial A^i}{\partial g_j}\Pi + (1-\tau)\left[R'(q_j^i) - 1\right]\frac{\partial q_j^i}{\partial g_j} \\ & - c\left[2(g_j - 1)q_j^i + (g_j - 1)^2\frac{\partial q_j^i}{\partial g_j}\right] = 0,\end{aligned} \tag{3.18b}$$

Equations (3.18a) and (3.18b) reveal that the transfer prices are still relevant for the headquarters. A change in transfer prices leads to adjustments of internal demand for traded goods and thereby sold quantities. Additionally they influence the apportionment factors.

In the following we evaluate the effects at the symmetric equilibrium of tax rates $t^{iA} = t^{jA} = t^A$. We use the subsidiaries' first-order conditions $R'(q_i^j) = g_i$ and $R'(q_j^i) = g_j$ in order to rewrite (3.18a) and (3.18b) as

$$\begin{aligned}\frac{\partial \pi^{FA}}{\partial g_i} =& (1-t^A)(g_i - 1)\frac{\partial q_i^j}{\partial g_i} - c\left[2(g_i - 1)q_i^j + (g_i - 1)^2\frac{\partial q_i^j}{\partial g_i}\right] = 0 \\ \frac{\partial \pi^{FA}}{\partial g_j} =& (1-t^A)(g_j - 1)\frac{\partial q_j^i}{\partial g_j} - c\left[2(g_j - 1)q_j^i + (g_j - 1)^2\frac{\partial q_j^i}{\partial g_j}\right] = 0\end{aligned}$$

The solution to this set of equations is $g_i^A = g_j^A = 1$. From the subsidiaries' first-order conditions $R'(q_i^i) = R'(q_i^j) = R'(q_j^j) = R'(q_j^i) = 1$ we then obtain $q_i^i = q_i^j = q_j^j = q_j^i = q^A$ where

$$q^A = \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma} \quad \text{and} \quad R(q^A) = \left(\frac{\sigma - 1}{\sigma}\right)^{\sigma - 1}.$$

The transfer price decisions influence the apportionment share and the produced quantities which are delivered to the foreign subsidiaries. Hence, we need to know the effects of tax rate changes on transfer prices. As appendix 3.D shows, a unilateral tax rate change in country i affects the transfer price choices for both countries according to

$$\frac{dg_i^A}{dt^i} = \frac{4[R(q^A) - q^A]}{\frac{1-t^A}{R''(q^A)} - 2cq^A}\frac{\partial A^i}{\partial g_i} \quad \text{and} \quad \frac{dg_j^A}{dt^i} = \frac{4[R(q^A) - q^A]}{\frac{1-t^A}{R''(q^A)} - 2cq^A}\frac{\partial A^i}{\partial g_j}. \tag{3.20}$$

Equation (3.20) reveals that under FA a tax rate increase in one country triggers the MNE to adjust the formula share and thereby the effective tax rate that is relevant for the after-tax profit. We will refer to this behavior as the formula manipulation incentive. In general the basic formula manipulation incentive can be described as follows: If country i increases its tax rate t^i, the headquarters aim to shift its allocated tax base from country i to country j by reducing A^i and increasing A^j, which is equivalent in the two-country case, since $A^j = 1 - A^i$. This is done by using the transfer price to adapt sales and revenues and thereby the apportionment share to the (new) tax environment.

Considering the apportionment shares for country i in equations 3.14 and 3.15, there are two ways to increase these shares. The first is to increase the revenues that define the numerator for the respective principle. The second one is to decrease revenues in the denominator that are not part of the numerator. Note that with constant marginal production costs the revenues from the non-traded quantities are constant. Hence, effectively, the MNE adjusts the revenues from traded quantities to save taxes.

The impact of the transfer prices g_i and g_j on the apportionment share determines the magnitude and sign of equation (3.20). This impact, in turn, depends on whether the origin or the destination principle is used. In the following, we will discuss these two cases separately.

3.4.1.1 Origin Principle

To derive the influence of transfer price changes for the apportionment share calculated with the origin principle, equation (3.14) is differentiated with respect to the transfer prices g_i and g_j

$$\begin{aligned}
\frac{\partial O^i}{\partial g_i} &= \frac{[R(q_j^j) + R(q_j^i)]R'(q_i^j)}{\Big[R(q_i^i) + R(q_i^j) + R(q_j^j) + R(q_j^i)\Big]^2}\frac{\partial q_i^j}{\partial g_i} < 0 \\
\frac{\partial O^i}{\partial g_j} &= -\frac{[R(q_i^i) + R(q_i^j)]R'(q_j^i)}{\Big[R(q_i^i) + R(q_i^j) + R(q_j^j) + R(q_j^i)\Big]^2}\frac{\partial q_j^i}{\partial g_j} > 0
\end{aligned} \tag{3.21}$$

The intuition of the result in equation (3.21) from the perspective of country i is as follows: When the export price g_i is increased, the foreign retail entity faces higher costs, which will be passed over to consumers via a consumer price increase. The demand abroad for brand i falls ($(dq_i^j/dg_i < 0$ in (3.3)) and so do total revenues from producing

this brand. Because these revenues determine the apportionment share for country i this share declines as well. In contrast, an increased import price g_j for the brand produced in country j reduces the demand in country i, and therefore the production ($dq_j^i/dg_j < 0$) and revenues in the foreign country. The revenues allocated to country i remain constant ($dq_i^i/dg_i = 0$, $dq_i^j/dg_j = 0$) and so the relative share of revenues for country i increases.

For a tax rate change in country i the reactions of transfer prices follow from combining equations (3.20) and (3.21) and applying symmetry. Appendix 3.D proves

$$\frac{dg_i^O}{dt^i} = -\frac{dg_j^O}{dt^i} = \frac{0.5}{(1-t^O)\sigma + 2c} > 0 \tag{3.22}$$

Hence, when the tax rate of country i increases, the MNE is incentivized to increase the export price g_i in order to lower the revenues and thereby the apportionment share from production in country i. On the other hand, the import price g_j is decreased to earn higher revenues in country i which are assigned to country j and thereby the apportionment share for country i is lowered.

3.4.1.2 Destination Principle

Under the destination principle, differentiating equation (3.15) with respect to the transfer prices g_i and g_j yields

$$\begin{aligned}
\frac{\partial D^i}{\partial g_i} &= -\frac{[R(q_i^i) + R(q_j^i)]R'(q_i^j)}{\left[R(q_i^i) + R(q_i^j) + R(q_j^j) + R(q_j^i)\right]^2}\frac{\partial q_i^j}{\partial g_i} > 0 \\
\frac{\partial D^i}{\partial g_j} &= \frac{\left[R(q_j^j) + R(q_j^i)\right] R'(q_j^i)}{\left[R(q_i^i) + R(q_i^j) + R(q_j^j) + R(q_j^i)\right]^2}\frac{\partial q_j^i}{\partial g_j} < 0
\end{aligned} \tag{3.23}$$

From the viewpoint of country i an increase in the export price g_i reduces foreign demand for brand i due to the higher consumer prices. But under the destination principle these lowered foreign revenues determine the apportionment share of country j whereas the revenues from consumption in country i do not change. This means that an increased export price increases the relative volume of revenues dedicated to country i and with that the allocation share assigned to country i. If the import price g_j increases, the price for the imported good in country i has to increase too. Hence, the consumption and

thereby the revenues of the imported good in country i decrease. Under the destination principle these revenues determine the apportionment share in country i which is then lowered.

Based on equation (3.20) in combination with (3.23) and symmetry, the effect on the transfer prices using the destination principle is proved in appendix 3.D and yields

$$\frac{dg_i^D}{dt^i} = -\frac{dg_j^D}{dt^i} = -\frac{0.5}{(1-t^D)\sigma + 2c} < 0. \tag{3.24}$$

A tax increase in country i affects the transfer price decisions twofold. Firstly, it leads to a decreased export price g_i. This stimulates the demand for the exported quantity q_i^j and the revenues allocated to country j increase. Revenues which are assigned to country i remain constant, and thus are apportioned a relatively lower weighting. So, the tax base share allocated to country i is reduced. Secondly, the apportionment share for country i declines because the headquarters increase the import price g_j for the brand j sold by the foreign retail subsidiary in country i to curtail the demand and thereby revenues assigned to country i.

Overall, we have seen that irrespective of the taxation principle used, the head office is able to realign transfer prices to downsize the MNE's apportionment factor in the tax-increasing country. In other words, MNEs use internal transfer pricing for formula manipulation to maximize after-tax profits. Comparing the effects of a tax rate increase in one country on the transfer prices for the origin principle and the destination principle in equations (3.22) and (3.24) diametrically opposed reactions are observable. For the household in the tax-increasing country, these reactions result in widened consumption possibilities under the origin principle, whereas under the destination principle they are cut.

3.4.2 Tax Competition and Externalities

As described for SA we consider a Nash tax competition game in tax rates. Under FA the tax rate t^i is chosen non-cooperatively to maximize national welfare W^{iA}. We will differentiate between the origin principle, $A = O$, and the use of the destination principle, $A = D$. Hence, the first-order condition reads $\partial W^{iA}/\partial t^i = 0$. Equilibrium tax rates (t^{iA}, t^{jA}) are derived by solving the first-order conditions for both countries

simultaneously. With symmetry the equilibrium tax rates coincide and yield $t^{iA} = t^{jA} = t^A$. In the following sections we analyze how the measurement of sales in the apportionment formula affects the degree of inefficiency of the equilibrium tax rate t^A and thereby of tax competition under FA. Therefore, we apply the concept of externalities imposed by country i's tax policy on the welfare of country j, i.e. $\partial W^{jA}/\partial t^i$. Again the welfare effect is split into the three sub-externalities: a consumption externality, a (profit) income externality and a public consumption externality triggered under FA by the formula externality.

If country i increases its national tax rate, the MNE reacts with a re-optimization of transfer prices to lower the apportionment share in the tax-increasing country. For the origin principle (destination principle) we have seen in equation (3.22) (equation (3.24)) that the export price g_i increases (decreases) and the import price g_j decreases (increases). Hence, the subsidiaries are directed to curb (improve) their sales in country j and to improve (curb) them in country i. However, only the adjustment of quantities exported to country j, q_i^j, leads to a change in foreign consumption. Differentiating the utility from private consumption of country j in equation (3.5) with respect to the tax rate of country i and applying (3.2), (3.22) or (3.24) and symmetry results in the consumption externality (CE). For the origin principle and destination principle, respectively, it yields

$$CE^O = -CE^D = \frac{1}{\sigma}(q^A)^{-\frac{1}{\sigma}}\frac{\partial q_i^j}{\partial g_i}\frac{\partial g_i^A}{\partial t^i} = -\left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}\frac{0.5}{(1-t^A)\sigma+2c} < 0. \tag{3.25}$$

Using the origin principle, a tax increase in country i triggers the MNE to reduce production in country i for the market in country j. Hence, the consumption possibilities of brand i in country j are cut and the prices increase. This is reflected in the negative consumption externality, $CE^O < 0$, in equation (3.25). For the destination principle the transfer price for brand i traded to country j is reduced and thereby the supply in country j increases with a tax increase in country i. For consumers in country j this implies a lower price for the imported good and extended consumption possibilities such that $CE^D > 0$, as shown in equation (3.25).

Under FA, country i and country j obtain the shares A^i and A^j respectively of the consolidated tax base for tax purposes. Tax revenues attached to country j read

$$G^j = T^j = t^j A^j \left[R(q_i^i) + R(q_i^j) + R(q_j^j) + R(q_j^i) - (q_i^i + q_i^j + q_j^j + q_j^i) \right]. \tag{3.26}$$

The effect of a tax rate change in country i on the tax revenues in country j is derived by differentiating equation (3.26) with respect to t^i and afterwards using the symmetry property ($t^{iA} = t^{jA} = t^A$, $g_i^A = g_j^A = 1$, q^A and $R(q^A)$). With symmetry tax revenue changes arise solely from country j's manipulated formula share. They are represented by the following formula externality (FE)

$$FE^A = \frac{\partial T^j}{\partial t^i} = t^A \cdot 4 \left[R(q^A) - q^A \right] \left(\frac{\partial A^j}{\partial g_j} \frac{\partial g_j}{\partial t^i} + \frac{\partial A^j}{\partial g_i} \frac{\partial g_i}{\partial t^i} \right), \qquad A = O, D.$$

With $R(q^A) - q^A = (1/\sigma)((\sigma - 1)/\sigma)^{\sigma - 1}$ and equations (3.35) and (3.22) or (3.36) and (3.24) for the origin principle and the destination principle respectively, the formula externality yields

$$FE^A = t^A \left(\frac{\sigma}{\sigma - 1} \right)^{-\sigma} \frac{0.5}{(1 - t^A)\sigma + 2c} > 0, \qquad A = O, D. \tag{3.27}$$

Equation (3.27) reveals that the formula externality is positive and has the same structure for both tax methods. The reason is that a tax increase in country i induces the MNE - irrespective of the taxation principle - to manipulate the apportionment share of the consolidated tax base in favor of country j's tax revenues. For the origin principle this is done by increasing the transfer price g_i to reduce revenues attributed to country i and by lowering the transfer price g_j to stimulate revenues from production in country j. If the destination principle is in law, the transfer price g_i is reduced to increase sales in country j and g_j is raised in order to earn lower revenues from consumption in country i.

With symmetry the effect from a tax increase in country i on the profit income of the household in country j coincides with the income externality derived in equation (3.12). Accordingly, the sum of externalities accounts for the overall change in welfare in country j caused by a tax increase in country i. It yields

$$\frac{\partial W^{jA}}{\partial t^i} = CE^A + \lambda FE^A + IE, \qquad A = O, D.$$

To determine the sign of the specific sum of externalities we use the expressions of sub-externalities derived for the origin principle and destination principle in equations (3.25), (3.27) and (3.12). As appendix 3.E proves, it yields a positive welfare effect for the origin principle

$$\frac{\partial W^{jO}}{\partial t^i} = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} \left[\frac{1}{(1-t^O)\sigma+2c}\left(-\frac{1}{2}\frac{\sigma}{\sigma-1}+\frac{1}{2}\lambda t^O\right)-\frac{1}{\sigma-1}\right] > 0. \tag{3.28}$$

We restrict our results to inner solutions. That is why we only consider cases where the equilibrium tax rates are less than 100%, i.e. $t^O < 1$. As equation (3.39) in appendix 3.E shows, this condition is fulfilled if $c < [\lambda(\sigma-1)-\sigma]/[4(2\lambda-1)]$.

Applying the destination principle we prove in appendix 3.E that the sum of externalities is positive and reads

$$\frac{\partial W^{jD}}{\partial t^i} = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} \left[\frac{1}{(1-t^D)\sigma+2c}\left(\frac{1}{2}\frac{\sigma}{\sigma-1}+\frac{1}{2}\lambda t^D\right)-\frac{1}{\sigma-1}\right] > 0. \tag{3.29}$$

As equations (3.28) and (3.29) reveal, a tax rate increase in country i results in strictly positive spillovers on the welfare in country j for both the origin as well as for the destination principle. Hence, feasible equilibrium tax rates are inefficiently low.

3.5 Comparison of Results

We summarize our previous results regarding the sign of the welfare effect of a tax rate change in country i on country j for the three considered taxation principles in

Proposition 3.1. *In a non-cooperative Nash equilibrium of corporate tax rates a tax increase in country i has a positive effect the welfare in country j positively irrespective of the mode of taxation. The equilibrium non-cooperative tax rates under SA, under FA with the origin principle, and FA with the destination principle are inefficiently low.*

In the following we compare the size of the sum of externalities derived in equations (3.13), (3.28) and (3.29) to account for the extent of inefficiencies. For the purpose of a direct comparison of the three tax principles we consider the externalities for given tax rates, i.e. for $t^S = t^D = t^O = t$. Then we end up with

$$\frac{\partial W^{jS}}{\partial t^i} > \frac{\partial W^{jD}}{\partial t^i} > \frac{\partial W^{jO}}{\partial t^i} > 0.$$

Therefore, the order of the non-cooperative equilibrium tax rates yields $t^O > t^D > t^S$.

Comparing SA with FA using the destination principle we see that both methods end up with a positive consumption externality. The consumption externalities are positive because consumption possibilities in the foreign countries are increased. For a given tax rate the consumption externality of SA is twice as much as that of FA. Under SA MNEs use their transfer pricing policy to shift profits to the low tax country, thus inducing the profit shifting externality. Introducing FA with the destination principle causes a formula externality since it triggers the MNE to manipulate the apportionment factor via internal trade shifting. Comparing the profit shifting externality in equation (3.11) and formula externality in equation (3.27) it becomes obvious that the effect from formula manipulation is only a quarter of profit shifting. The private income externality is identical and negative for both taxation methods. Because of reduced consumption distortions and hampered profit shifting opportunities the overall externalities for FA with the destination principle are lower than they are for SA.

If we consider solely FA but compare the destination principle and the origin principle, one key element can be observed: For the consumption possibilities in a country, where sales are expanded and where they are cut is decisive. When sales are measured at destination, the imports to the tax-increasing country will be restricted and the exports to the foreign country are stimulated. The reason is that lower domestic and higher foreign demand reduces the relative sales share in the tax-increasing country. In contrast, using the origin principle induces the MNE to lower the exports to the foreign country and to increase the imports to the tax-increasing country and thereby it reduces the tax base share allocated to the tax-increasing country. However, only the adjustment of production for the foreign market affects foreign consumption relevant to the consumption externality. Hence, the consumption externalities have the same absolute value, but are positive for the destination principle and negative using the origin principle. As explained above, the MNE exploits bilateral trade to reduce the apportionment share in the tax-increasing country because it may use exports and imports as substitutes to save taxes. Therefore, the formula externality and the spillovers on tax revenues are positive and coincide for given tax rates. This formula effect can also be found in Eichner and Runkel (2008) for the origin principle and in Kind et al. (2005) for the destination principle. The negative private income externality is again the same for both principles. In aggregation the external effects on foreign welfare are positive for both principles and

therefore the equilibrium tax rates are inefficiently low. However, due to the negative consumption externality under the origin principle the inefficiency is mitigated compared to the destination principle.

In contrast to previous such as Kind et al. (2005), Nielsen et al. (2010) or Sørensen (2004), in the model presented, the comparison between SA and FA with only sales in the formula is clear-cut and results in

Proposition 3.2. *Compared to SA, FA with a sales-only formula mitigates corporate tax competition. If sales in the formula are measured with the origin principle tax competition is weaker than if sales are measured with the destination principle.*

3.6 Summary and Conclusions

The current international corporate tax system of SA is vulnerable to profit shifting for tax saving purposes because intra-firm trade has to be valued with internal transfer prices. This is the main reason why in 2001 the European Commission proposed switching from SA to FA, with the recommended apportionment formula containing assets, labor and sales. A controversial question is whether sales should be measured at destination or at origin. To focus on this issue we use a two-country model with a sales-only formula. We analyze and compare the efficiency of corporate tax rates in a symmetric Nash tax equilibrium under SA, FA with the origin principle, and FA with the destination principle. It is shown that tax competition is weakest using the origin principle and strongest for SA. The efficiency outcome of the destination principle lies inbetween. For SA we derive the expected positive profit shifting, a positive consumption and a negative income externality. Contrary to the initial intention, under FA an MNE will also manipulate transfer prices, and in so doing, revenues, and finally the apportionment formula. This also leads to a negative income externality. With the origin-based sales factor a tax increase in one country triggers the MNE to increase export prices and lower import prices in this country, whereas under the destination principle, import prices are increased and export prices decreased. This leads in both cases to an identical positive formula externality. For our result it is decisive that the diametrical setting of transfer prices triggers a negative consumption externality for the origin principle and a positive one under the destination principle. Therefore, under the origin principle the

consumption externality counteracts the positive formula externality whereas under the destination principle, the consumption externality reinforces it. Hence, the paper argues for implementing FA with a sales factor measured at origin and proves that FA with only sales in the formula is more efficient than SA.

It was stressed at the beginning that the strategic effect of transfer pricing under oligopolistic competition presented in Kind et al. (2005) and Schjelderup and Sørgard (1997) has been left out intentionally. By implementing Cournot competition for the exported good in our model the strategic incentive should lead to a reduction in export prices. Intuitively, the positive consumption externalities under FA with the destination principle, and under SA should be aggravated and mitigated using the origin principle.

In the political debate, the European Parliament fears that introducing FA will result in a turning away from the source principle. The amendments of the European Parliament and the *Committee of the Internal Market and Consumer Protection* call for a scaling down or simply omission of the sales factor (European Parliament, 2012). The experiences in Canada and the United States have produced the opposite development, namely an increased importance of the sales factor based on the destination principle. Considering the composition of the EU, simply turning away from sales as one factor does not seem to be a politically smart choice. Our results confirm that the sales factor is a meaningful tool in the apportionment formula and that FA with a sales factor mitigates tax competition compared to SA. In addition, this paper delivers an argument for implementing sales at the place of origin and thereby supplies a reasonable compromise in the political discussion in Europe and also a middle course of retaining the sales factor.

3.A Comparative Statics of Transfer Pricing under Separate Accounting

Totally differentiating the first-order condition (3.7a) and then applying symmetry (i.e. $t^i = t^j = t^S$, $g_i^S = g_j^S = 1$, $q_i^i = q_i^j = q_j^j = q_j^i = q^S$, $R(q_i^j) = R(q_j^i) = 1$ gives

$$-dt^i q^S + dt^j q^S + dg_i \left[(1 - t^S) \frac{\partial q_i^j}{\partial g_i} - 2cq^S \right] = 0. \tag{3.30}$$

From (3.7a) we know $dq_i^j / dg_i = 1/R''(q^S)$. Inserting into (3.30) and setting either $dt^i \neq 0$ and $dt^j = 0$ or $dt^i = 0$ and $dt^j \neq 0$ gives

$$\frac{dg_i^S}{dt^i} = -\frac{dg_j^S}{dt^i} = \frac{q^S}{\frac{(1-t^S)}{R''(q^S)} - 2cq^S}. \tag{3.31}$$

From $R(q_i^j) = p(q_i^j) q_i^j$ and $p(q_i^j) = (q_i^j)^{-\frac{1}{\sigma}}$ we obtain $R(q_i^j) = (q_i^j)^{\frac{\sigma-1}{\sigma}}$ and, thus, $R'(q_i^j) = \frac{\sigma-1}{\sigma}(q_i^j)^{-\frac{1}{\sigma}}$, $R''(q_i^j) = -\frac{\sigma-1}{\sigma^2}(q_i^j)^{-\frac{1+\sigma}{\sigma}}$. Moreover, profit maximization of subsidiaries in the symmetry case yields

$$R'(q^S) = \left(\frac{\sigma - 1}{\sigma} \right) (q^S)^{-\frac{1}{\sigma}} = 1 \;\Leftrightarrow\; q^S = \left(\frac{\sigma - 1}{\sigma} \right)^{\sigma}$$

Inserting q^S and $R''(q^S)$ into (3.31) proves (3.8).

3.B Sign of Welfare Externality under Separate Accounting

We calculate the first-order condition of welfare maximization in country i by applying the welfare function defined in equation (3.5). We use the equations (3.6) for the profit income and (3.10) for the public good financing in combination with the symmetry assumption, i.e. $g_i^S = g_j^S = 1$, q^S and $R(q^S)$. We differentiate the welfare function for

country i with respect to the tax rate in country i, t^i. We obtain

$$\begin{aligned}\frac{\partial W^{iS}}{\partial t^i} &= 2\lambda\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1} - \left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1} \\ &- \left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\frac{1}{(1-t^S)\sigma+2c} - 2\lambda t^S\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^S)\sigma+2c} = 0 \\ &= -\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^S)\sigma+2c}\left(\frac{\sigma}{\sigma-1}+2\lambda t^S\right) + (2\lambda-1)\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1} = 0 \\ &= \left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^S)\sigma+2c}\left(\frac{\sigma}{\sigma-1}+2\lambda t^S\right) - (2\lambda-1)\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1} = 0.\end{aligned} \tag{3.32}$$

To prove equation (3.13) we rewrite the sum of the subexternalities summarized in equation (3.13) as

$$\frac{\partial W^{jS}}{\partial t^i} = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^S)\sigma+2c}\left(\frac{\sigma}{\sigma-1}+2\lambda t^S\right) - \left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1} > 0. \tag{3.33}$$

The minuends in equation (3.32) and (3.33) are identical and positive. To derive the sign of equation (3.33), we compare the respective subtrahends which are positive, too, but differ in the multiplier $(2\lambda - 1)$. From the assumption about the MCPF we know that $\lambda > 1$. From this it follows that the multiplier $(2\lambda - 1)$ is greater than 1, and therefore the minuend in (3.32) is greater than this in (3.33). Because the difference in (3.32) has to equal 0, for the sign of (3.33) follows $\partial W^{jS}/\partial t^i > 0$. ■

3.C Comparative Statics of Transfer Pricing under Formula Apportionment

Totally differentiating (3.18a) and (3.18b), using the symmetry property with $t^i = t^j = t^A$, $g_i = g_j = 1$, $q_i^i = q_i^j = q_j^j = q_j^i = q^A$ and $R'(q_i^i) = R'(q_i^j) = R'(q_j^j) = R'(q_j^i) = 1$ and setting $dt^i \neq 0$ and $dt^j = 0$ yields

$$-dt^i\frac{\partial A^i}{\partial g_i}\Pi + (1-t^A)R''(q^A)\left(\frac{\partial q_i^j}{\partial g_i}\right)^2 dg_i - 2cq^A dg_i = 0 \tag{3.34a}$$

$$-dt^i\frac{\partial A^i}{\partial g_j}\Pi + (1-t^A)R''(q^A)\left(\frac{\partial q_j^i}{\partial g_j}\right)^2 dg_j - 2cq^A dg_j = 0 \tag{3.34b}$$

Furthermore, under symmetry we obtain $\Pi = 4\left[R(q^A) - q^A\right]$ and $dq_i^j/dg_i = dq_j^i/dgj = 1/R''(q^A)$. Inserting into (3.34a) and (3.34b) implies

$$-4\left[R(q^A) - q^A\right]\frac{\partial A^i}{\partial g_i}dt^i + \frac{1-t^A}{R''(q^A)}dg_i - 2cq^A dg_i = 0$$
$$-4\left[R(q^A) - q^A\right]\frac{\partial A^i}{\partial g_j}dt^i + \frac{1-t^A}{R''(q^A)}dg_j - 2cq^A dg_j = 0.$$

Rearranging the results to dg_i/dt^i and dg_j/dt^i proves equation (3.20).

3.D Adjustment of the Apportionment Factor

Under the origin principle plugging equation (3.3) into equation (3.21) and using symmetry, i.e. $q^O = \left(\frac{\sigma-1}{\sigma}\right)^\sigma$, $R(q^O) = (q^O)^{\frac{\sigma-1}{\sigma}}$, $R'(q^O) = \frac{\sigma-1}{\sigma}(q^O)^{-\frac{1}{\sigma}}$ and $R''(q^O) = -\frac{\sigma-1}{\sigma^2}(q^O)^{-\frac{1+\sigma}{\sigma}}$, gives

$$\frac{\partial O^i}{\partial g_i} = -\frac{\partial O^i}{\partial g_j} = \frac{1}{8}\frac{R'(q^O)}{R(q^O)R''(q^O)} = \frac{1-\sigma}{8} < 0 \tag{3.35}$$

Inserting into (3.20) and using $R(q^O) - q^O = \frac{1}{\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}$ gives (3.22).

Under the destination principle plugging equation (3.3) into equation (3.23) and applying symmetry, i.e. $q^D = \left(\frac{\sigma-1}{\sigma}\right)^\sigma$, $R(q^D) = (q^D)^{\frac{\sigma-1}{\sigma}}$, $R'(q^D) = \frac{\sigma-1}{\sigma}(q^D)^{-\frac{1}{\sigma}}$, $R''(q^D) = -\frac{\sigma-1}{\sigma^2}(q^D)^{-\frac{1+\sigma}{\sigma}}$, leads to:

$$\frac{\partial D^i}{\partial g_i} = -\frac{\partial D^i}{\partial g_j} = -\frac{1}{8}\frac{R'(q^D)}{R(q^D)R''(q^D)} = \frac{\sigma-1}{8} > 0 \tag{3.36}$$

Inserting into (3.20) and using $R(q^D) - q^D = \frac{1}{\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}$ gives (3.24).

3.E Sign of Welfare Externality under Formula Apportionment

We calculate the first-order condition of welfare maximization in country i by applying the welfare function defined in equation (3.5). We use the equations (3.17) for the profit income and (3.26) for the public good financing in combination with the symmetry assumption, i.e. $g_i^A = g_j^A = 1$, q^A and $R(q^A)$.

For the origin principle we differentiate the welfare function for country i with respect to the tax rate in country i, t^i, and obtain

$$\begin{aligned}\frac{\partial W^{iO}}{\partial t^i} =& 2\lambda\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1}-\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1}\\ &+\frac{1}{2}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\frac{1}{(1-t^O)\sigma+2c}-\frac{1}{2}\lambda t^O\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^O)\sigma+2c}\\ =&(2\lambda-1)\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1}\\ &-\frac{1}{2}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^O)\sigma+2c}\left(-\frac{\sigma}{\sigma-1}+\lambda t^O\right)=0\\ =&\frac{1}{2}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^O)\sigma+2c}\left(-\frac{\sigma}{\sigma-1}+\lambda t^O\right)-(2\lambda-1)\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1}=0.\end{aligned} \tag{3.37}$$

Solving equation (3.37) for the equilibrium tax rate yields

$$t^O=\frac{\sigma(4\lambda-1)+4c(2\lambda-1)}{2\sigma(2\lambda-1)+\lambda(\sigma-1)}>0 \tag{3.38}$$

and proves that there is a positive solution for the rate t^O in (3.37). Additionally, we focus on solutions where the tax rate t^O in equation (3.38) is less then unity. This is the case if

$$t^O<1\Leftrightarrow c<\frac{\lambda(\sigma-1)-\sigma}{4(2\lambda-1)}. \tag{3.39}$$

To control for positive compliance costs we have also to ensure that $c>0\Leftrightarrow\lambda>\sigma/(\sigma-1)$.

To prove the sign in equation (3.28) we rewrite the sum of the sub-externalities summarized in equation (3.28) as

$$\frac{\partial W^{jO}}{\partial t^i}=\frac{1}{2}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^O)\sigma+2c}\left(-\frac{\sigma}{\sigma-1}+\lambda t^O\right)-\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1}. \tag{3.40}$$

The minuends in equation (3.37) and (3.40) are identical and positive, and in the relevant range of t^O, i.e. equations (3.38) and (3.39) are fulfilled.

To derive the sign of equation (3.40), we compare the respective subtrahends in (3.37) and (3.40) which are positive, but differ in the multiplier $(2\lambda-1)$. From the assumption about the MCPF we know that $\lambda>1$. From this it follows that the multiplier $(2\lambda-1)$ is greater than 1 and, therefore the subtrahend in (3.37) is greater than this in (3.40).

Because the difference in (3.37) has to equal 0, for the sign of (3.40) follows $\partial W^{jO}/\partial t^i > 0$ taking into account (3.39). ■

For the destination principle we differentiate the welfare function for country i with respect to the tax rate in country i, t^i. We obtain

$$\begin{aligned}\frac{\partial W^{iD}}{\partial t^i} =& 2\lambda\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1} - \left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1} \\ &- \frac{1}{2}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\frac{1}{(1-t^D)\sigma+2c} - \frac{1}{2}\lambda t^D\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^D)\sigma+2c} = 0 \\ =& (2\lambda-1)\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1} - \frac{1}{2}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^D)\sigma+2c}\left(\frac{\sigma}{\sigma-1}+\lambda t^D\right) = 0 \\ =& \frac{1}{2}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^D)\sigma+2c}\left(\frac{\sigma}{\sigma-1}+\lambda t^D\right) - (2\lambda-1)\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1} = 0.\end{aligned} \tag{3.41}$$

To prove equation (3.29) we rewrite the sum of the subexternalities summarized in equation (3.29) as

$$\frac{\partial W^{jD}}{\partial t^i} = \frac{1}{2}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{(1-t^D)\sigma+2c}\left(\frac{\sigma}{\sigma-1}+\lambda t^D\right) - \left(\frac{\sigma-1}{\sigma}\right)^{\sigma}\frac{1}{\sigma-1}. \tag{3.42}$$

The minuends in equation (3.41) and (3.42) are identical and positive. To derive the sign of equation (3.42), we compare the respective subtrahends which are positive, too, but differ in the multiplier $(2\lambda - 1)$. From the assumption about the MCPF we know that $\lambda > 1$. From this it follows that the multiplier $(2\lambda - 1)$ is greater than 1, and therefore the subtrahend in (3.41) is greater than this in (3.42). Because the difference in (3.41) has to equal 0, for the sign of (3.42) follows $\partial W^{jD}/\partial t^i > 0$. ■

Chapter 4

Optional Formula Apportionment with Two Types of Compliance Costs[1]

4.1 Introduction

Starting in the year 2001 with the communication *Towards an Internal Market Without Tax Obstacles* (European Commission, 2001) the European Commission (EC) provided a multitude of analyses and technical reports culminating in the *Proposal for a Council Directive on a Consolidated Corporate Tax Base* in 2011 (European Commission, 2011b). The consolidation of profits including cross-border loss offset to calculate the tax base of a multinational company is seen as a more appropriate approach in an economic union than the current system of Separate Accounting (SA) with its need for transfer pricing. The proposal of the Common Consolidated Corporate Tax Base (CCCTB) also comprises a system of Formula Apportionment (FA) to allocate the tax base to the taxing countries depending on the firm's geographical economic activity.[2]

With the introduction of a CCCTB in Europe, the European Commission (2011b) also assumes that the MNEs' compliance costs would be reduced because the CCCTB would

[1] This chapter is based on Liesegang (2015).
[2] For a comprehensive discussion on the formula design see e.g. Weiner (2006).

replace the current corporate tax system of SA, where MNEs must deal with 28 different corporate tax systems within the EU (European Commission, 2001). Slemrod and Blumenthal (1996) or Shaw et al. (2010) break down compliance costs in to involuntary and discretionary compliance costs. Involuntary compliance costs must be expended to comply with tax legislation and are unavoidable. This is in contrast to discretionary compliance costs which are incurred voluntarily to reduce the tax liability. Compliance costs in general waste valuable social resources (Shaw et al., 2010). The European Commission (2011a) refers to them as deadweight costs.

For the European Commission (2011b) the specific tax planning and reporting of transfer prices for internal transactions and intangible firm-specific services to the tax authorities under SA appear to be very costly. That is why a major issue in the proposal by the Commission concerns governmental administration costs and compliance costs for multinational firms.

Furthermore, authors such as Mintz (2004) and Devereux (2004) consider the reduction of compliance costs for businesses and administration costs for tax authorities under FA to be the most striking factor in favor of the CCCTB. The reason is that MNEs are no longer forced to deal with several national tax systems. This view is supported by an expert study by Deloitte (2009) which estimates that the CCCTB will decrease compliance costs to approximately 1/3 of the current system.

Mintz (2004) stresses that were FA to be introduced, "... governments would need to feel that the benefits outweigh costs". That is why he recommends the EU-wide compulsory CCCTB as the long-term objective and the optional system as a more practicable transition method. A politically convenient way of implementing an FA system would be to allow its existence in parallel to SA using a common corporate tax rate. The Commission is pursuing this strategic approach. Making the FA system optional is one key element of the CCCTB proposal. This means that companies would be allowed to choose whether to stay in the SA system or move to FA taxation. This ability to choose a the tax regime is controversial, since prima facie it appears counterproductive: Only those firms that would reduce their taxes under the CCCTB would opt for the new system. Intuitively, one would expect corporate tax competition to accelerate with governments never benefiting from the introduction of the CCCTB. However, this argument disregards the above-mentioned saving of compliance costs: To opt for FA may

be profitable even with an increased tax bill, since MNEs have lower compliance costs and with it higher after-tax profits. If so, national tax revenues will increase and tax competition be mitigated. The aim of the paper is to prove this hypothesis within a theoretical setting.

We develop a model with two countries each of which hosts a continuum of heterogeneous MNEs. As a key feature of our model we "distinguish between involuntary costs, which must be expended to comply with the law, and discretionary costs, which are incurred in an effort to reduce tax liability" (Slemrod and Blumenthal, 1996). Within our framework MNEs are heterogeneous in the sense that they differ in their involuntary compliance costs. But whereas the reduction of involuntary cost makes the tax system more efficient, decreasing discretionary cost makes harmful tax planning more profitable. Starting from this line of thought we will show in this paper that the EC's aim to cut involuntary compliance costs with the optional introduction of FA (European Commission, 2011b) could enhance efficiency.

An MNE operates headquarters and a subsidiary in the home country and a subsidiary in the host country. Subsidiaries earn exogenous before-tax profits. Each country imposes a corporate income tax which is based on either SA or FA. Complying with tax legislation causes costs to the MNE on the headquarters-level.

An MNE faces the following trade-off when deciding whether it wants to be taxed according to SA or FA: The consolidation of profits reduces the complexity of complying with the tax legislation but hampers the tax-induced profit shifting possibilities. For example under SA the MNE shifts paper profits whereas under FA it has to reallocate real formula inputs like labor or sales, or adjust the firm's structure to capture tax savings. Therefore, opting for FA decreases involuntary costs (in the model they are set to zero) but increases discretionary costs for the MNE. We firstly derive the threshold value of involuntary compliance costs, which subdivides the MNEs into two groups. Firms below the threshold stay in the existing system, whilst MNEs above it would prefer FA. Afterwards we prove that starting from a pure SA system with national revenue maximization, its coexistence with FA increases tax rates, and therefore mitigates tax competition. In our symmetric setting SA is even completely substituted by FA.

Our model setup is closely related to the paper by Büttner et al. (2011). They analyze the implications of introducing FA for the group structure of MNEs. They model the MNE's

decision to include a subsidiary in its group (FA taxation) or not (SA taxation). In this decision the MNE faces a trade-off between better profit shifting opportunities under SA and saved non-consolidation costs under FA. It turns out that with a higher tax rate differential or low non-consolidation costs it becomes more beneficial not to consolidate the tax bases. However, in contrast to our paper, Büttner et al. (2011) elucidate the defining of the MNE's group and consolidation as a strategic planning tool for the firm's structure. In contrast, our focus lies on the relationship between involuntary compliance costs and tax saving opportunities, which renders the coexistence of SA and FA more efficient compared to the present European system of pure SA.

There are studies by Keen and Mintz (2004) and Dharmapala et al. (2011) which also aim to derive an optimal threshold level within an optimal taxation environment. Keen and Mintz (2004) analyze the optimal threshold level of turnover at which firms must register for value-added tax. Firms differ in their taxable sales. The trade-off for a revenue-maximizing government from an increased threshold consists in a loss of tax revenues against saved administrative and compliance costs. Dharmapala et al. (2011) consider the optimal taxation of firms when the government faces tax collection costs. Firm heterogeneity is attributed to taxable output. In their model countries use a fixed per-firm fee and a linear tax on output. They find that if a firm's output falls below a certain cutoff level, it renders taxation of this firm inefficient. To internalize social administrative costs a positive fee is derived as optimal. In our paper we explicitly model two types of tax compliance costs incurred by an MNE under SA and FA. We show that if consolidation reduces involuntary costs related to tax legislation, the introduction of FA enhances efficiency.

Further support for our results comes from the implications of a water's edge, which could be interpreted as a geographical rather than an administrative coexistence of SA and FA. Riedel and Runkel (2007) analyze the transition from SA to FA using a three country model. The frontier between the FA union and the third country constitutes the water's edge. Similarly to our results, their short-run analysis with fixed tax rates proves that the overall amount of profit shifted to the tax haven decreases. In the long-run analysis, the water's edge regulation enhances welfare in comparison with SA for a wide range of cases. These results are in line with the empirical findings of Bettendorf et al. (2009).

In recent years several authors such as Eichner and Runkel (2008), Fuest (2008), Mintz (2004), Mintz and Weiner (2003), Nielsen et al. (2003, 2010), Sørensen (2004) have focused on the relative merits of SA and FA. Despite different approaches they came to the conclusion that FA would create new distortions as long as tax rate differentials within the EU persist. Because the European Commission (2011b) rejects the harmonization of national corporate tax rates, the introduction of FA does not necessarily mitigate tax competition. In contrast to our paper, however, none of these studies investigates the trade-off between voluntary and discretionary compliance costs under SA and FA.

The currently available empirical studies for the EU measure the economic implications of the transition to FA, but in contrast to our theoretical model they are not able to account for optimal tax policies in a non-cooperative equilibrium of tax rates. Nonetheless, they give a better insight in to the expected distributional effects of the reform. In the *Impact Assessment*, a study by Bettendorf et al. (2009) simulates the consequences of the EC's proposal for a CCCTB with FA.[3] Their simulations account especially for the reduction of involuntary compliance costs and the adjustment of factors that underlie the apportionment share in each country. They conclude that, given existing tax rate differentials, the benefits from consolidation are offset by reactions by MNEs and by tax competition among countries for mobile capital. Oestreicher and Koch (2011) find that the total tax revenue of the EU member states will be reduced by around 4.6% either under a compulsory or an optional CCCTB. Devereux and Loretz (2008) estimate the implications for overall tax revenues for given before-tax profits. In their analysis the overall revenues for the optional and compulsory systems change only modestly. Fuest et al. (2007) estimate the effects of introducing the CCCTB with FA without behavioral responses on the size and distribution of the overall tax base between the EU member countries. In the analysis the corporate tax base shrinks significantly. Our analysis proves analytically that with the introduction of an optional FA system the non-cooperative tax rates, and with them tax revenues, increase in each country. Hence, we find that the optional system of tax base consolidation promises an efficiency enhancement for the EU.

The paper is organized as follows. Section 2 expounds the nature of compliance costs in more detail. Based on this discussion, the model is specified in Section 3. Section 4 characterizes the benchmark of non-cooperative tax competition between countries for

[3] A previous study was conducted by Van der Horst et al. (2007).

either a pure SA or a pure FA system. Section 5 analyzes tax competition under the mixed system where MNEs can choose between SA and FA. Section 6 concludes.

4.2 Properties of Compliance Costs

According to the Commission, under SA involuntary compliance costs stem from the following corporate income tax compliance activities: record keeping, transfer pricing documentation, preparation of tax computations, completing tax returns and payments, dealing with tax authorities, mutual agreement procedures on transfer pricing, clearances and rulings and staff learning and education (European Commission, 2011a). Discretionary compliance costs arise from tax planning, mitigation or avoidance. For example this could be expenses for additional internal compliance time and employees, external tax advice or tax-induced firm or investment restructuring.

The European Commission (2004) and Deloitte (2009) analyze compliance costs for European MNEs. The Deloitte (2009) study predicts that a transition to FA will reduce compliance costs for European MNEs to approximately 1/3. The driving force for this is considered to be the reduced transfer pricing tasks emerging from cross-border activities.

Several studies estimate compliance costs for U.S. and Canadian companies and derive firm and tax system-specific properties of this cost type. The studies -mostly indirectly- prove that the magnitude of involuntary compliance costs can be attributed to the uniformity of the tax system: A more uniform corporate tax system reduces involuntary compliance costs.

Blumenthal and Slemrod (1995) estimate the compliance costs of the U.S. system of taxing foreign-source income for large U.S. multinationals. They show that compliance costs related to foreign-source income are significantly higher than those for domestic income. With the same dataset Slemrod and Blumenthal (1996) estimated that the cost-to-revenue ratio is higher for U.S. state corporate tax systems than for the federal tax system. They relate this difference to the non-uniformity of states' tax systems. Additionally, they sent a questionnaire to corporate officers asking for practitioners' recommendations for reducing compliance costs. The experts called for greater conformity among states and between state and federal income tax systems.

Mintz and Smart (2004) conducted an empirical analysis of the corporate taxation of multi-jurisdictional companies in Canada. For historical reasons firms are assigned by law to either the SA or FA system, which has resulted in the two systems existing in parallel. As is planned for the EU member states, provinces apply a uniform statutory formula, but are allowed to choose their tax rate independently. The authors provide direct empirical evidence for tax planning constraints under FA compared to SA by estimating the income shifting elasticity with respect to the individual tax rates imposed by Canadian provinces. The corporate income shifting elasticity with respect to individual tax rates is significantly higher for companies under the SA system compared to consolidating corporations. This result points to reduced investment distortions caused by tax planning under FA.

Slemrod (2006) reviews different empirical studies concerning the compliance costs of taxing business under the U.S. corporate income tax system. He stresses that foreign operations in particular considerably increase internal compliance costs. He estimated that an MNE has 211 percent higher internal costs than a comparable firm operating domestically. Expanding business to an additional country adds costs of another 2.5 percent.[4]

Summing up, all studies -independent of the underlying data set and methodology- draw clear coherent conclusions about the properties of compliance costs:

1. The absolute value of compliance costs increases with firm size.
2. The relative value of compliance costs decreases with firm size[5], i.e. they are regressive.
   (a) Tax compliance is associated with significant fixed costs.
   (b) Tax compliance is associated with economies of scale.
3. Compliance costs are higher for firms with multiple active entities and foreign operations.
4. Compliance costs are not reducing over time.

[4]Newer surveys for the U.S. include Contos et al. (2012) and DeLuca et al. (2007), as well as a cross-country study for the U.S., Australia, the UK and South Africa by Evans et al. (2014).

[5]Examples of measures for firm size include operative revenue, turnover, asset volume, tax yield.

Having characterized the properties of compliance costs, we implement a stylized algebraic representation of the compliance cost functions in our theoretical model. For this reason we will distinguish between involuntary and discretionary compliance costs for each corporate taxation method.

4.3 The Model

4.3.1 Basic Framework

We consider a world with two symmetric countries indexed by $i, j = 1, 2$. There exists a continuum of MNEs, of which each runs production subsidiaries in both countries. All MNEs are identical with respect to their affiliates' before-tax profits P_i and P_j and allocation of input factors. The obligation to pay corporate taxes induces MNEs to manipulate the tax base, so that the after-tax profit is maximized. By assuming exogenous before-tax profits, we are able to focus on the MNEs' profit shifting strategies connected either with SA or FA.

Depending on the taxation system, different shifting instruments are available: Under SA the MNE may directly decide about profit shifting σ_i and σ_j with $\sigma_i + \sigma_j = 0$.[6] For $\sigma_i > 0$ (< 0) profit is shifted from country i (country j) to country j (country i).

Under FA, tax base consolidation removes the MNE's incentive for shifting profits. Instead, the tax base can be reallocated by the manipulating the apportionment formula. The formula triggers the MNE to restructure the apportionment factors. To keep the analysis as simple as possible, in line with Büttner et al. (2011) we use the very condensed form of these shares denoted by α_i for country i and α_j for country j. The variables α_i and α_j summarize the formula distortion activities of the MNE in country i and j. The sum of the MNE's apportionment shares must sum up to unity, i.e. $\alpha_i + \alpha_j = 1$. Based on the undistorted distribution of production factors, for earning profits under FA, the reference apportionment share for each country can be calculated as $\bar{\alpha}_i$ for country i and $\bar{\alpha}_j$ for country j with $\bar{\alpha}_i + \bar{\alpha}_j = 1$. The amount of profit adjustment equals the difference between the undistorted share of tax base apportioned to country i and j and the share resulting from formula manipulation, i.e. $(\bar{\alpha}_i - \alpha_i)(P_i + P_j) =: A_i$ and

[6] Prominent ways of manipulating profits include transfer pricing and internal debt shifting.

$(\bar{\alpha}_j - \alpha_j)(P_i + P_j) =: A_j$. If A_i is positive, the undistorted share of consolidated tax base allocated to country i (country j) is greater (less) than the chosen share with taxation. Consequently, the tax base for country i is narrowed and is expanded for country j. Overall the absolute amounts of shifted tax base must be identical, i.e. $A_i + A_j = 0$.

In what follows, we assume that the allocation of formula inputs in one country exactly originates the subsidiary's before-tax profit, so that these profits are identical for both taxation principles, i.e. $P_i = \bar{\alpha}_i(P_i + P_j)$ and $P_j = \bar{\alpha}_j(P_i + P_j)$. In doing so, we eliminate the selection effect of FA identified by Büttner et al. (2011): If before-tax profits and allocated consolidated profits deviate, there is an incentive for or against consolidation even in the absence of formula manipulation. The direction depends on the sign of the tax rate differential. If $P_i = \bar{\alpha}_i(P_i + P_j)$ and $P_j = \bar{\alpha}_j(P_i + P_j)$, then this selection effect vanishes.

4.3.2 Discretionary Compliance Costs

Manipulating the tax base is not free of cost. Profit shifting induces concealment costs and formula manipulation distorts production. We define a concealment cost function $C(\sigma_i)$ of profit shifting and a distortion cost function $D(A_i)$ of formula manipulation in such a way that the marginal cost for an additional unit of tax base manipulation should be higher under FA than under SA.[7] This means $C'(\sigma_i) < D'(A_i)$ for all $\sigma_i = A_i$. This formulation is chosen to reproduce the results of Mintz and Smart (2004), who show that the taxable income of non-consolidating Canadian corporations reacts significantly more elastically to tax rate changes than that of firms taxed by FA. To ensure an interior solution we assume convex cost functions with a minimum at zero profit shifting and zero formula distortion, respectively. Throughout the paper we will use quadratic functional forms

$$C(\sigma_i) = 0.25\sigma_i^2 \text{ and } D(A_i) = 0.5A_i^2 \tag{4.1}$$

in order to ensure tractability of the analysis.

[7] In the following analysis we consider the MNE's decisions for country i only. The values for country j result automatically from the relationships defined above.

4.3.3 Involuntary Compliance Costs

While otherwise perfectly identical, MNEs differ in their involuntary compliance costs denoted by $\kappa \in (\underline{\kappa}, \overline{\kappa})$. For the sake of simplicity these costs are defined as strictly positive for SA and vanish under FA. As mentioned above, due to economies of scale and fixed costs the relative value of compliance costs decreases with firm size. We model this fact by assuming that firms with a higher κ have greater compliance costs in relation to their (fixed and identical) before-tax profits.[8] Normalizing the sum of MNEs in the economy to unity, firm-specific compliance costs are distributed according to a cumulative distribution function

$$F(\kappa) = \int_{\underline{\kappa}}^{\kappa} f(z)dz \quad , \; z \in [\underline{\kappa}, \overline{\kappa}], \; \underline{\kappa} \geq 0 \tag{4.2}$$

where the probability density function $f(z)$ is strictly positive in the relevant range of z and z is a continuous random variable. Additional properties of the distribution function are $F(\underline{\kappa}) = 0$ and $F(\overline{\kappa}) = 1$.

4.3.4 The Nash Tax Competition Game

We solve a Nash tax competition game with two stages. In the first stage, the countries choose their optimal corporate tax rate non-cooperatively, given the tax system and the behavior of the MNEs. In stage two, MNEs optimize their after-tax profits, given the national tax rates. The game is solved by backward induction.

MNEs are assumed to choose their profit-maximizing σ_i and α_i depending on the taxation system. MNEs decide on their preferred tax regime by comparing the after-tax profit including involuntary compliance costs κ in the respective optimum. From this strategy we derive the threshold value of compliance costs below which an MNE stays in SA, and above which it moves to FA.

[8] For a similar approach compare Keen and Mintz (2004). They analyze the optimal threshold level of turnover at which firms must register for value-added tax in the presence of administrative and compliance costs. In their model firms' sizes, administrative and compliance costs are fixed and independent of sales, whereas firms differ in their taxable sales. These sales are distributed on a cumulative distribution function with positive density.

Anticipating the behavior of the MNEs, national governments maximize corporate tax revenues by choosing the optimal tax rates depending on the distribution function of κ. As a benchmark we consider the maximization of revenues for the pure SA system and the pure FA system. The resulting corporate tax rates θ_i for SA and τ_i for FA constitute the lower and upper boundary in the model. Afterwards, we analyze the implications of the mixed system consisting of SA and FA. Countries receive corporate tax revenues from taxing two differently determined tax bases with a single corporate tax rate μ_i. We calculate and compare the equilibrium tax revenues and prove that they may increase when moving from the pure SA to a mixed system.

4.4 Pure Separate Accounting System

Given the before-tax profits in both countries, MNE κ chooses profit shifting amounts σ_i and σ_j in order to maximize after-tax profit

$$p_\kappa^S(\sigma_i, \sigma_j) = (1-\theta_i)(P_i - \sigma_i) + (1-\theta_j)(P_j - \sigma_j) - 0.25\sigma_i^2 - \kappa.$$

This profit equals the sum of before-tax profits adjusted by profit shifting in both countries, less discretionary and involuntary compliance costs. Substituting σ_j with $-\sigma_i$ and deriving the first-order condition with respect to σ_i, $\partial p_\kappa^S / \partial \sigma_i = (\theta_i - \theta_j) - 0.5\sigma_i = 0$, optimal profit shifting yields

$$\sigma_i^*(\theta_i, \theta_j) = 2(\theta_i - \theta_j) = -\sigma_j^*(\theta_i, \theta_j). \tag{4.3}$$

Because it depends only on the tax rate differential, the maximized after-tax profit under SA can be written as a function of tax rates:

$$p_\kappa^S(\sigma_i^*, \sigma_j^*) = (1-\theta_i)P_i + (1-\theta_j)P_j + (\theta_i - \theta_j)^2 - \kappa. \tag{4.4}$$

The tax base of a country equals the MNE's before-tax profits adjusted by profit shifting. Mulitplied by the tax rate, tax revenues of country i and country j, respectively, can be

written as

$$R_i^S(\theta_i, \theta_j) = \theta_i \left[P_i - \sigma_i^*(\theta_i, \theta_j)\right] \int_{\underline{\kappa}}^{\overline{\kappa}} f(\kappa) d\kappa = \theta_i \left[P_i - 2(\theta_i - \theta_j)\right] \tag{4.5a}$$

$$R_j^S(\theta_i, \theta_j) = \theta_j \left[P_j + \sigma_i^*(\theta_i, \theta_j)\right] \int_{\underline{\kappa}}^{\overline{\kappa}} f(\kappa) d\kappa = \theta_j \left[P_j + 2(\theta_i - \theta_j)\right]. \tag{4.5b}$$

Governments maximize national tax revenues with respect to their own tax rate, taking the tax rate of the other country as given. The first-order conditions read

$$\partial R_i^S(\theta_i, \theta_j)/\partial\theta_i = P_i - 2(\theta_i - \theta_j) - 2\theta_i = 0$$
$$\partial R_j^S(\theta_i, \theta_j)/\partial\theta_j = P_j + 2(\theta_i - \theta_j) - 2\theta_j = 0.$$

The terms $P_i - 2(\theta_i - \theta_j)$ and $P_j + 2(\theta_i - \theta_j)$ reflect the revenue gain from the increased tax rate on the existing tax base, whereas the expressions $2\theta_i$ and $2\theta_j$ show the revenue losses due to additional profit shifting to the other country. In a non-cooperative equilibrium the first-order conditions for country i and j are fulfilled simultaneously. Solving both conditions and inserting into (4.5a) and (4.5b) gives the equilibrium national tax rates and tax revenues

$$\theta_i^* = \frac{2P_i + P_j}{6} \quad \text{and} \quad R_i^S(\theta_i^*, \theta_j^*) = \frac{(2P_i + P_j)^2}{18} \tag{4.6a}$$

$$\theta_j^* = \frac{P_i + 2P_j}{6} \quad \text{and} \quad R_j^S(\theta_i^*, \theta_j^*) = \frac{(P_i + 2P_j)^2}{18}. \tag{4.6b}$$

Note that both expressions in (4.6a) and (4.6b) depend on the before-tax profits only.

4.5 Pure Formula Apportionment System

Under FA, MNE κ decides on the apportionment shares α_i and α_j of the consolidated tax base $P = P_i + P_j$ in order to maximize their after-tax profits

$$p_\kappa^F(\alpha_i, \alpha_j) = (1 - \tau_i)\alpha_i P + (1 - \tau_j)\alpha_j P - 0.5A_i^2.$$

Substituting α_j with $(1 - \alpha_i)$ and A_i with $(\bar{\alpha}_i - \alpha_i)P$, the first-order condition with respect to α_i reads $\partial p_\kappa^F/\partial\alpha_i = -(\tau_i - \tau_j)P + (\bar{\alpha}_i - \alpha_i)P^2 = 0$. Solving for α_i yields the

optimal formula shares and profit manipulation, respectively,

$$\alpha_i^*(\tau_i, \tau_j) = \bar{\alpha}_i - \frac{\tau_i - \tau_j}{P} \quad \text{and} \quad \alpha_j^*(\tau_i, \tau_j) = \bar{\alpha}_j + \frac{\tau_i - \tau_j}{P} \tag{4.7}$$

$$A_i^*(\tau_i, \tau_j) = \tau_i - \tau_j = -A_j^*(\tau_i, \tau_j). \tag{4.8}$$

Inserting the optimal formula share into the after-tax profit function gives

$$p_\kappa^F(\alpha_i^*, \alpha_j^*) = (1 - \tau_i)\bar{\alpha}_i P + (1 - \tau_j)\bar{\alpha}_j P + 0.5\,(\tau_i - \tau_j)^2\,. \tag{4.9}$$

Compared to SA in equation (4.4) it can be seen that the net gain of profit manipulation is halved from $(\theta_i - \theta_j)^2$ to $0.5\,(\tau_i - \tau_j)^2$.

With α_i^* and α_j^* from (4.7) tax revenues can be written as

$$R_i^F(\tau_i, \tau_j) = \tau_i \alpha_i^*(\tau_i, \tau_j) P \int_{\underline{\kappa}}^{\overline{\kappa}} f(\kappa) d\kappa = \tau_i \left[\bar{\alpha}_i P - (\tau_i - \tau_j)\right] \tag{4.10a}$$

$$R_j^F(\tau_i, \tau_j) = \tau_j \alpha_j^*(\tau_i, \tau_j) P \int_{\underline{\kappa}}^{\overline{\kappa}} f(\kappa) d\kappa = \tau_j \left[\bar{\alpha}_j P + (\tau_i - \tau_j)\right]. \tag{4.10b}$$

Therefore, first-order conditions of revenue maximization read

$$\partial R_i^F(\tau_i, \tau_j)/\partial \tau_i = \bar{\alpha}_i P - (\tau_i - \tau_j) - \tau_i = 0$$

$$\partial R_j^F(\tau_i, \tau_j)/\partial \tau_j = \bar{\alpha}_j P + (\tau_i - \tau_j) - \tau_j = 0.$$

The terms $\bar{\alpha}_i P - (\tau_i - \tau_j)$ and $\bar{\alpha}_j P + (\tau_i - \tau_j)$ reflect the revenue gain from the increased tax rate on the existing tax base in each country under FA, whereas the expressions τ_i and τ_j, respectively, show the revenue losses due to additional profit manipulation in favor of the other country. From these conditions the equilibrium tax rates and revenues can then be derived as

$$\tau_i^* = \frac{2\bar{\alpha}_i P + \bar{\alpha}_j P}{3} \quad \text{and} \quad R_i^F(\tau_i^*, \tau_j^*) = \frac{(2\bar{\alpha}_i P + \bar{\alpha}_j P)^2}{9} \tag{4.11a}$$

$$\tau_j^* = \frac{\bar{\alpha}_i P + 2\bar{\alpha}_j P}{3} \quad \text{and} \quad R_j^F(\tau_i^*, \tau_j^*) = \frac{(\bar{\alpha}_i P + 2\bar{\alpha}_j P)^2}{9} \tag{4.11b}$$

Comparing the results under SA and FA, we obtain

Lemma 4.1. *Equilibrium tax rates and revenues are higher under FA than under SA, i.e.* $\tau_i^* = 2\theta_i^*$, $\tau_j^* = 2\theta_j^*$ *and* $R_i^F(\tau_i^*, \tau_j^*) = 2R_i^S(\theta_i^*, \theta_j^*)$, $R_j^F(\tau_i^*, \tau_j^*) = 2R_j^S(\theta_i^*, \theta_j^*)$.

Given the assumption that discretionary compliance costs are lower for SA than for FA, the respective last term in equations (4.4) and (4.9) proves that the resulting net advantage of profit shifting in terms of tax rate differential is twice as much under SA as that of formula manipulation. Consequently, the tax base under FA reacts less sensitively on marginal tax rate changes in a country. Therefore, the equilibrium tax rates under FA are higher and tax competition is mitigated.

Applying the optimal tax rates derived in equations (4.6a), (4.6b) and (4.11a), (4.11b), respectively, the maximized profits in (4.4) and (4.9), can be reformulated to

$$p_\kappa^S(\theta_i^*, \theta_j^*) = P - \left[\theta_i^* P_i + \theta_j^* P_j - (\theta_i^* - \theta_j^*)^2\right] - \kappa$$
$$p_\kappa^F(\tau_i^*, \tau_j^*) = P - 2\left[\theta_i^* P_i + \theta_j^* P_j - (\theta_i^* - \theta_j^*)^2\right],$$

where we have used the relations $\tau_i^* = 2\theta_i^*$, $\tau_j^* = 2\theta_j^*$ and $\bar{\alpha}_i P = P_i$, $\bar{\alpha}_j P = P_j$. The first two terms in square brackets are the corporate tax payments in country i and country j whereas the third expression reflects the net advantage of profit shifting depending on the tax rate differential among countries. Therefore, our model confirms the first idea that without involuntary compliance costs the after-tax profit is higher under SA than under FA. However, being aware of the reduction of involuntary compliance costs under FA, this intuitive result may be reversed. The comparison of equilibrium after-tax profits for SA and FA yields a positive threshold value of an MNE's involuntary compliance costs that render a switch from SA to FA profitable. This threshold is derived by

$$p_i^F(\tau_i^*, \tau_j^*) \geq p_i^S(\theta_i^*, \theta_j^*) \Leftrightarrow \kappa \geq \theta_i^* P_i + \theta_j^* P_j - \left(\theta_i^* - \theta_j^*\right)^2.$$

Lemma 4.2. *For an MNE the tax payments under FA are always higher than under SA. Whether the after-tax profits are higher under SA depends on the level of involuntary compliance costs.*

4.6 Mixed System

4.6.1 Threshold Value of Involuntary Compliance Costs

As mentioned in the Introduction, the CCCTB proposal of the EC contains the idea that MNEs should be allowed to decide whether they are taxed according to SA or FA. Under both systems, a common tax rate is applied, which in our model is denoted by μ_i for country i and μ_j for country j. An MNE would opt for FA, if the after-tax profit is expected to rise in comparison with SA. Hence, the MNE will anticipate the after-tax profits using either system and compare the results. Using equations (4.4) and (4.9), an MNE with involuntary compliance costs κ will opt for FA if and only if

$$p_\kappa^F(\mu_i, \mu_j) \geq p_\kappa^S(\mu_i, \mu_j)$$
$$(1-\mu_i)\bar{\alpha}_i P + (1-\mu_j)\bar{\alpha}_j P + 0.5(\mu_i - \mu_j)^2 \geq (1-\mu_i)P_i + (1-\mu_j)P_j + (\mu_i - \mu_j)^2 - \kappa.$$

If the involuntary compliance costs exceed the tax advantage based on the better profit shifting opportunities under SA, firms would prefer to be taxed under FA. Hence, there is a non-negative threshold value $\widehat{\kappa}$ that separates the preferences of the MNEs regarding the tax system as follows: MNEs with involuntary compliance costs below this threshold stay in SA, whereas all firms with higher costs switch to FA. With $\bar{\alpha}_i P = P_i$ and $\bar{\alpha}_j P = P_j$ this threshold is derived from $p_\kappa^F(\mu_i, \mu_j) = p_\kappa^S(\mu_i, \mu_j)$. We obtain

$$\widehat{\kappa} = 0.5(\mu_i - \mu_j)^2 =: \widehat{\mathcal{K}}(\mu_i, \mu_j). \tag{4.12}$$

Equation (4.12) reveals that the threshold value depends on the tax rate differential. The more the tax rate differential increases, the larger the threshold value becomes, and the more MNEs benefit from exploiting the better profit shifting opportunities under SA than from saving involuntary compliance costs under FA.

4.6.2 Tax Revenue Maximization

The tax revenues of country i and country j under the mixed tax system read, respectively,

$$R_i^M(\mu_i,\mu_j) = \mu_i\left[P_i - \sigma_i^*(\mu_i,\mu_j)\right]\int_{\underline{\kappa}}^{\widehat{\kappa}} f(\kappa)d\kappa + \mu_i\alpha_i^*(\mu_i,\mu_j)P\int_{\widehat{\kappa}}^{\bar{\kappa}} f(\kappa)d\kappa \tag{4.13a}$$

$$R_j^M(\mu_i,\mu_j) = \mu_j\left[P_j - \sigma_j^*(\mu_i,\mu_j)\right]\int_{\underline{\kappa}}^{\widehat{\kappa}} f(\kappa)d\kappa + \mu_j\alpha_j^*(\mu_i,\mu_j)P\int_{\widehat{\kappa}}^{\bar{\kappa}} f(\kappa)d\kappa. \tag{4.13b}$$

From the analysis of pure SA and pure FA, it follows that $\sigma_i^*(\mu_i,\mu_j) = -\sigma_j^*(\mu_i,\mu_j) = 2(\mu_i-\mu_j)$, $\alpha_i^*(\mu_i,\mu_j) = \bar{\alpha}_i - (\mu_i-\mu_j)/P$ and $\alpha_j^*(\mu_i,\mu_j) = \bar{\alpha}_j + (\mu_i-\mu_j)/P$. Applying $P_i = \bar{\alpha}_i P$ and $P_j = \bar{\alpha}_j P$, revenues can be written as

$$R_i^M(\mu_i,\mu_j) = \mu_i\left\{P_i - (\mu_i-\mu_j)\left(1+F\left[\widehat{\mathcal{K}}(\mu_i,\mu_j)\right]\right)\right\} \tag{4.14a}$$

$$R_j^M(\mu_i,\mu_j) = \mu_j\left\{P_j + (\mu_i-\mu_j)\left(1+F\left[\widehat{\mathcal{K}}(\mu_i,\mu_j)\right]\right)\right\}, \tag{4.14b}$$

where the terms in curly brackets describe the tax bases which equal the undistorted tax bases P_i and P_j adjusted by the tax base manipulation $(\mu_i-\mu_j)\left(1+F\left[\widehat{\mathcal{K}}(\mu_i,\mu_j)\right]\right)$. The tax bases diverge from P_i and P_j because of general profit shifting $(\mu_i-\mu_j)$ apparent under both taxation methods, enforced by the additional share of firms that have opted for SA, formally represented by $F\left[\widehat{\mathcal{K}}(\mu_i,\mu_j)\right]$.

The optimal national corporate tax rate results from maximizing tax revenues non-cooperatively, i.e. the foreign tax rate is taken as given. The first-order conditions with respect to μ_i and μ_j, respectively, yield

$$\frac{\partial R_i^M}{\partial \mu_i} = \underbrace{P_i - (\mu_i-\mu_j)\left[1+F(\widehat{\kappa})\right]}_{I} - \underbrace{\mu_i\left[1+F(\widehat{\kappa})\right]}_{II} - \underbrace{\mu_i(\mu_i-\mu_j)^2 f(\widehat{\kappa})}_{III} = 0 \tag{4.15a}$$

$$\frac{\partial R_j^M}{\partial \mu_j} = \overbrace{P_j + (\mu_i-\mu_j)\left[1+F(\widehat{\kappa})\right]} - \overbrace{\mu_j\left[1+F(\widehat{\kappa})\right]} - \overbrace{\mu_j(\mu_i-\mu_j)^2 f(\widehat{\kappa})} = 0. \tag{4.15b}$$

For illustration purposes, assume that country i is the high-tax country. i.e. $\mu_i > \mu_j$. Then Part I shows the increased tax revenue induced by the marginal tax rate change on the existing base. Part II results from intensified tax base reduction for both taxation methods caused by the widened tax rate differential among countries. Part III reflects a tax base cut because the tax rate change in country i increases the threshold value $\widehat{\kappa}$. Consequently, the marginal share of MNEs choosing SA and the corresponding profit

shifting opportunities increases by the density at the threshold value $f(\widehat{\kappa})$. A similar interpretation holds for the first-order condition of country j.

The first-order conditions (4.15a) and (4.15b) for revenue maximization determine the Nash tax rates of countries under the mixed system. Our main question is, whether these tax rates and the corresponding equilibrium tax revenues are higher or lower than under the pure SA and FA system; in particular the comparison to the pure SA system is interesting because this is the reform discussed for Europe. Unfortunately, in general we cannot obtain a closed-form solution for the equilibrium tax rates in the mixed system. Therefore, to ensure tractability and to give an answer to the above question, we focus on the case with perfectly symmetric countries.

For this reason we assume identical before-tax profits in both countries, i.e. $P_i = P_j = 0.5P$. Hence, the equilibrium values for SA and FA in the symmetry case simplify to

$$\theta^* = P/4 \quad \text{and} \quad R^S(\theta^*) =: R^{S^*} = P^2/8 \tag{4.16a}$$

$$\tau^* = P/2 \quad \text{and} \quad R^F(\tau^*) =: R^{F^*} = P^2/4 \tag{4.16b}$$

For perfectly symmetric countries the tax rates in both countries are identical, i.e. $\mu_i = \mu_j$. For the threshold value derived in equation (4.12) it follows that $\widehat{\kappa} = 0$. If the rate differential is zero there are no longer profit shifting opportunities to exploit under SA, and additionally choosing FA saves involuntary compliance costs. Therefore, all MNEs benefit from opting for FA, i.e. $F(\widehat{\kappa}) = F(0) = 0$. The equilibrium tax rates and revenues result as

$$\mu^* = P/2 = \tau^* \quad \text{and} \quad R_i^M(\mu^*) =: R^{M^*} = P^2/4 = R^{F^*}. \tag{4.17}$$

The result proves that with symmetry the mixed system is always equivalent to FA. If the tax rates are identical the incentive for profit shifting under SA vanishes. By choosing FA the MNEs save concealment costs, and therefore all MNEs opt for FA and the mixed system converges to an FA system. We summarize the results in

Proposition 4.1. *In a symmetric Nash equilibrium with involuntary compliance costs countries benefit compared to the pure SA system from providing an optional FA system. With symmetry the mixed system is equivalent to the pure FA system and leads in relation to pure SA to higher Nash equilibrium tax rates and increasing tax revenues.*

Our results show that providing an optional FA system involves no disadvantages for the associated countries. We aware of the fact that this strong result is directly related to the symmetry assumption. For a more intermediate answer to the posed question regarding the consequences of a mixed system, the model needs to be solved for asymmetric countries.

4.7 Conclusion

The EC proposes the CCCTB in combination with FA to replace the current corporate tax system of SA with its need for transfer pricing. By introducing FA, MNEs are subject to a more uniform system of corporate taxation within the EU. For this reason a reduction in compliance costs for businesses is expected. In our model we make an explicit distinction between an MNE's tax compliance costs under SA and FA. We consider involuntary compliance costs to comply with the tax legislation and discretionary compliance costs to reduce tax liability.

Initially, the Commission intends to introduce FA in parallel to SA, i.e. the FA system will be optional. Companies would be allowed to choose between SA and FA. This ability to choose a tax regime raises the question of whether corporate tax competition will be even intensified since only tax-saving MNEs will opt for FA. This argumentation disregards the decreased involuntary compliance costs under FA, because the consolidation of profits reduces the complexity of complying with tax legislation. On the contrary, tax-induced profit shifting possibilities are hampered under FA and discretionary compliance costs increase. Hence, whether the after-tax profits of an MNE and national tax revenues are higher under SA or FA depends on the relation between involuntary and discretionary compliance costs.

We develop a model with two countries each of which hosts a continuum of heterogeneous MNEs in the sense that they differ in their involuntary compliance costs. Additionally, MNEs using the FA system are restricted in their tax base manipulation activities due to higher discretionary compliance costs. In a first step, the conventional wisdom that without involuntary compliance costs and different national tax rates MNEs would never opt for FA is confirmed. The reason is that the marginal shifting of profit is more expensive under FA than under SA. Taking involuntary compliance costs into account,

there is a non-negative threshold value constituting the type of MNE that would be in favor of the FA system.

We show that if consolidation reduces involuntary costs related to tax legislation, the introduction of FA enhances efficiency, and tax competition is mitigated. Afterwards we prove in a symmetric setting that starting from a pure SA system with national revenue maximization, a transition from SA to an optional FA increases the non-cooperative tax rates and national revenues for both countries and results in an FA system. This is because with identical tax rates the MNE cannot benefit from the better profit shifting opportunities under SA but saves involuntary compliance costs.

In our analysis the optional system of tax base consolidation promises an efficiency enhancement for the member countries. Hence, we deliver an additional argument in support of an international agreement on the CCCTB proposal.

Our analysis has only focused on the symmetric case for the mixed system. To extent the model to intermediate results it would be necessary to introduce asymmetry in to the model. Another conceivable alternative would be to have specific tax rates for SA and FA. The implications of these extensions in a Nash tax competition environment are left for future research.

Chapter 5

Summary and Conclusion

This doctoral thesis investigates the implications for corporate tax competition of introducing a CCCTB with Formula Apportionment within the EU. We consider certain aspects of the European Commission's proposal *Towards an Internal Market Without Tax Obstacles* (European Commission, 2001) and the *Proposal for a Council Directive on a Consolidated Corporate Tax Base* (European Commission, 2011b). To derive our results we rely on the standard Nash tax competition framework with symmetric countries. We analyze how countries' non-cooperative tax policies influence the efficiency outcome in equilibrium.

Chapter 2 addresses the question of whether pecuniary and fiscal externalities arising in tax competition among countries can be internalized by fiscal equalization. The main innovation of the analysis is that it explicitly models a corporate income tax and distinguishes different taxation principles, whereas previous studies interpreted corporate taxation as a unit (wealth) tax on capital. In contrast to the previous literature, we can show that, with symmetric countries and an exogenously given capital supply, tax base equalization is not capable of rendering non-cooperative tax rates Pareto-efficient. The reason is that tax base equalization does not internalize the pecuniary externalities, which in our framework are usually different from zero, and only partially internalizes the fiscal externalities since a tax rate reduction in one country lowers the worldwide tax base. Tax revenue equalization aggravates the latter problem, but combined with private income equalization it just internalizes all externalities and ensures efficient tax rates. These results hold for both taxation principles considered.

If private income equalization is not feasible under Formula Apportionment, then tax base equalization may be superior to tax revenue equalization depending on the apportionment formula used.

Probably the most important policy implication of the analysis is the finding that it does not matter whether MNEs are taxed according to Separate Accounting or Formula Apportionment if there is equalization of national income (i.e. private income plus tax revenues). We would not conclude that the European income redistribution is already sufficient to ensure efficiency of corporate income taxation, since the EU budget is not an equalization system in the sense of our analysis. However, the very existence of income redistribution in Europe might indicate that reforming the member states' contributions to the budget in a suitable way might be easier to achieve politically than replacing a whole corporate tax system.

Chapter 3 discusses the controversial issue of whether sales in the formula should be measured at the place of consumption (destination) or at the place of production (origin). To focus on this question we use a sales-only formula either following the origin principle or the destination principle. It is shown that tax competition is weakest using the origin principle and strongest for Separate Accounting. The efficiency outcome of the destination principle lies inbetween.

For Separate Accounting we derive a positive profit shifting, a positive consumption and a negative income externality. Contrary to the initial intention, under Formula Apportionment an MNE will also manipulate transfer prices, and in so doing, revenues, and finally the apportionment formula. With the origin-based sales factor a tax increase in one country triggers the MNE to increase export prices and lower import prices in this country, whereas under the destination principle, import prices are increased and export prices decreased. This leads in both cases to an identical positive formula externality and additionally, to an identical negative income externality. For our result it is decisive that the diametrical setting of transfer prices triggers a negative consumption externality for the origin principle and a positive one under the destination principle. Therefore, under the origin principle the consumption externality counteracts the positive formula externality, whereas under the destination principle the consumption externality reinforces it. Hence, Formula Apportionment with only sales in the formula is more efficient than Separate Accounting and argues for implementing Formula Apportionment with a sales factor measured at origin.

Regarding the policy implications we refer to the amendments of the European Parliament and the *Committee of the Internal Market and Consumer Protection*, which call for a scaling down or simply omission of the sales factor. Under Formula Apportionment with the destination principle, they fear a turning away from the source principle.
Apart from the fact that considering of the composition of the EU, this does not seem to be a politically smart choice, our results confirm that Formula Apportionment with sales mitigates tax competition compared to Separate Accounting and that the sales factor is a meaningful tool in the apportionment formula. We make an explicit argument for implementing Formula Apportionment with sales measured at the place of origin and thereby supply a reasonable compromise in the political discussion in Europe and also a middle course for retaining the sales factor.

Chapter 4 refers to the expected reduction in compliance costs for businesses resulting from more uniform corporate taxation within the EU when Formula Apportionment is introduced. In our model we make an explicit distinction between an MNE's tax compliance costs under Separate Accounting and Formula Apportionment. We consider involuntary compliance costs for complying with tax legislation and discretionary compliance costs for reducing tax liability.
During a transitional period the Commission intends to introduce Formula Apportionment in parallel with Separate Accounting, i.e. the Formula Apportionment system will be optional. Companies would be allowed to choose between Separate Accounting and Formula Apportionment. This ability to choose a tax regime raises the question of whether corporate tax competition will even be intensified since only tax-saving MNEs will opt for Formula Apportionment. This argumentation disregards the decreased involuntary compliance costs under Formula Apportionment because the consolidation of profits reduces the complexity of complying the tax legislation. On the contrary, tax-induced profit shifting possibilities are hampered under Formula Apportionment and discretionary compliance costs increase. Hence, whether the after-tax profits of an MNE and national tax revenues are higher under Separate Accounting or Formula Apportionment depends on the relationship between involuntary and discretionary compliance costs.
We show that if consolidation reduces involuntary costs, the introduction of Formula Apportionment enhances efficiency, and tax competition is mitigated. We prove in a symmetric setting that starting from a pure Separate Accounting system with national

revenue maximization, a transition from Separate Accounting to an optional Formula Apportionment increases the non-cooperative tax rates and national revenues for both countries. We end up with the results of Formula Apportionment. This is because with identical tax rates the MNE cannot benefit from the better profit shifting opportunities under Separate Accounting but saves involuntary compliance costs.
In our analysis the optional system of tax base consolidation promises an efficiency enhancement for the member countries. Hence, we deliver an additional argument in support of an international agreement on the CCCTB proposal.

Nonetheless, the problems detected in 1997 of tax base erosion, tax burden deflection and profit shifting persist and are worsening (European Commission, 1997). From a superordinate perspective there is an urgent need for action. That is why since 2013 the OECD (2013) has been conducting the "Base Erosion and Profit Shifting Project" (BEPS). A finalized package of measures was delivered to the G20 Finance Ministers in October 2015. The G20/OECD member countries as well as the EU committed to implement the new corporate taxation standards in their national legislation. The EC has developed a strategy for relaunching the CCCTB (European Commission, 2015). One key measure should be the stepwise introduction of the CCCTB, starting with a common corporate tax base (CCTB) definition in the Single Market. Consolidation should be the second step after having fully implemented the CCTB. Another main difference to former proposals is that the CCCTB should be mandatory for large MNEs above a certain global turnover.

In general, 2015 and 2016 saw an intensification of activity in the field of reforming the international corporate tax system. It remains to be seen how countries will react on such suggestions. If we take in to account for the empirical results and the current European political climate, reaching an agreement between all of the member states on such comprehensive reform of the corporate taxation system as is proposed by the EU seems ambitious. This is especially so since countries would self-restrict their taxation latitude. This would also explain the long-lasting stagnation of the reform process.
Starting with a tax base harmonization in the EU, i.e. the CCTB, might be a good first step. The implications of a water's edge also suggest that the possibility of enhanced cooperation among similar member states would be a transitional solution.

The (European Commission, 2015) expressed the author's thoughts in the following way:

"Ultimately, the key to reforming corporate taxation in the EU, to make it fairer and more efficient, is in the hands of the Member States. Member States need to overcome their differences for the sake of fairness, competitiveness and efficiency. It is therefore time to move forward."

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