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Chapter 1

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1.1 Introduction

With economic integration capital investment has become increasingly mobile across national borders. In the last decades, many OECD countries have hence politically debated measures to attract this mobile investment from abroad and to refrain national capital from leaving the country. The major attention was thereby concentrated on corporate taxes and their effect on the migration of capital investment. Although critics claim that other, possibly more important factors determine the corporate investment location, including market proximity, labor market conditions and political stability, most academic observers note that according to empirical studies corporate taxes mattered and that they belonged to the few direct policy instruments at governments' disposal. Other investment determinants, in turn, could only be influenced in the long run - if at all (BMF (2007)).

It is well known that governments in the Organisation for Economic Co-operation and Development (OECD) have strongly reduced their corporate tax rates in the last years. Considering the major economies in the OECD, the average statutory corporate tax rate dropped from 49% in 1982 to 32% in 2005.[1] The same picture emerges with respect to the average effective corporate tax rate that additionally takes into account the regulations for the tax base calculation. The development of corporate tax rates is therefore consistent with a race-to-the-bottom scenario in which countries compete for the increasingly mobile capital investment. Since countries maximize their own welfare, they do not take into account that a reduction in their national corporation tax attracts capital from abroad and lowers neighboring countries' tax revenues. This constitutes a positive fiscal externality on the foreign economies and leads to inefficiently low equilibrium tax rates from a world welfare perspective.

[1]The numbers are taken from Haufler (2006) and are calculated as an unweighted average of the statutory corporate tax rates of the following OECD countries: Austria, Belgium, Canada, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, Portugal, Spain, Sweden, United Kingdom, USA.

Beyond international capital mobility, the last years have witnessed increased academic and political attention for another form of resource mobility that may be even more worrying from an efficiency point of view. Detached from the capital investment choice, multinational enterprises (MNEs) have become known to shift profit within the corporate group to affiliates located in tax havens. This profit relocation becomes possible since MNEs are not taxed as a unitary group under the current tax scheme but the tax base is accounted separately for each affiliate. Usually the corporate tax regime is therefore denoted as 'Separate Accounting' system which we will abbreviate with 'SA' in the following. A growing empirical literature provides evidence for this kind of shifting behavior and indicates paper profit to be more responsive to tax rate changes than real economic activity (Mintz and Smart (2004), Clausing (2003)). Therefore, profit shifting activities have been perceived as a major source of allocative inefficiency by academics and politicians for the last years (Heinemann and Janeba (2007)).

As a result of the described inefficiencies, the SA regime has recently come under political pressure. In 2001, the European Commission proposed a fundamental reform for the taxation of MNEs within the European Union (EU) and suggested to switch from SA to a system of formula apportionment (FA). FA thereby prescribes that the profit of a MNE shall be consolidated at the group level. The consolidated profit is then apportioned to the affiliates on the basis of a formula which measures a location's relative corporate activity. In the aftermath of the proposal a debate on merits and limits of a corporate tax system based on FA has taken place in the economic literature. The aim of this chapter is to review this literature and to outline the author's own contributions in this area which are presented in detail in the Chapters 2 to 6.

Before we turn to the analysis, it seems appropriate to make clear under which criteria the alternative corporate taxation schemes shall be judged. We focus on three objectives. First, a corporate tax reform should follow the goal to implement an efficient taxation scheme in the sense that corporate tax differences between countries do not distort economic decisions. This applies to the location of investments as well as to the location of profits. The lion share of our analysis below will focus on this objective.

Second, conceptual aspects have to be taken into account. The corporate tax scheme has to assure that the corporation tax can fulfill its function as income and equivalence tax. Moreover, the system should not discourage the systematics of the tax legislation (BMF (2007)). Third, the costs for taxpayers to comply with the tax scheme as well as the administrative cost on the side of the tax authorities to ensure and control the keeping of the tax rules shall be as small as possible.

1.2 Limits to the Separate Accounting System

As mentioned in the introduction, SA is currently applied for the corporate taxation of MNEs at the international level. Since it prescribes corporate profits to be taxed in the country where they accrue, MNEs have an incentive to shift profits from high-tax to low-tax locations. The purpose of this chapter is twofold. First, we discuss the channels through which profits may be shifted within a MNE and describe bilateral and multilateral measures implemented today to limit shifting activities. Second, we present empirical evidence for shifting behavior and show that the amount of profit shifted to tax havens is quantitatively relevant.

1.2.1 Separate Accounting and Measures against Profit Shifting

Conceptually, MNEs may relocate profits through two channels. First, they might distort transfer prices for goods traded within the corporation. Consider for example a MNE which is headquartered in a country with a high corporate tax rate. The MNE provides a management service to its subsidiary located in a country with low corporate taxes. In this scenario, the multinational has an incentive to charge the subsidiary with a lower than the true transfer price for the service delivered since it thereby enlarges pre-tax profit taxed at the low-tax location and keeps taxable profit

down at the high-tax headquarter. Second, the MNE may shift profit by distorting the corporate debt-equity structure, for example through intra-firm capital lending. If the low-tax subsidiary provided a loan to the headquarter, it receives interest payments that lower pre-tax profit at the headquarter location, and reallocate it to the subsidiary at the tax haven.

Governments in the OECD have reacted to the emergence of intra-group profit shifting in the last decades and pursued several policy directions to shore up capital income tax revenues and arrest their decline. These include bilateral and multilateral attempts to coordinate corporate income tax policies, such as strengthening transfer pricing guidelines and limiting intra-firm capital lending.

The OECD has for example adopted the so-called 'arm's length principle' in Article 9 of the OECD Model Tax Convention, to ensure that transfer prices between affiliates of multinational enterprises are established on a market value basis. The principle means that prices should be the same as they would have been, had the parties to the transaction not been related to each other. MNEs have to document transfer prices for intra-firm transactions and national tax authorities control compliance with the transfer pricing guidelines on a regular basis.

Besides these transfer pricing regulations, many countries restrict the capital structure choice of MNEs to limit the scope of tax planning strategies. In fact, the imposition of so called thin-capitalization rules, which deny interest deductions on intercompany debt, if the debt-equity ratio or interest expenses exceed certain thresholds, is widespread. In 1996, around half of the major OECD countries had imposed those rules. Until today the share has increased to almost 75% (see Büttner et al. (2006)).

However, all these regulations come at a cost. On the side of the MNE the compliance with the 'arm's length principle' is associated with the administrative burden of calculating and documenting transfer prices. National tax authorities in turn have to monitor transfer pricing and cost allocation within MNEs which incurs administrative costs, and may even be conceptually impossible in some cases in which the goods

traded within a multinational are unique patents and services for which an objective market value is not known to the authorities. Moreover, the OECD Model Tax Convention acts as guideline for bilateral treaties only. Hence, transfer pricing rules are not fully coordinated internationally and there is potential for conflicts between states that happen to apply different standards to the same transaction (Raimondos-Moeller and Scharf (2002), Nielsen et al. (2003)).

Furthermore, the regulations to shore off the corporation tax revenue have often come in conflict with national and international law. For example, the European Court of Justice has disapproved limits to intra-firm lending by foreign affiliates since this puts investments abroad in a disadvantaged position compared to national investment and henceforth contradicts the freedom of establishment. Germany and other countries had to react to this judgment by extending their thin-capitalization rules to purely national cases to align with European law. Thus, international law has hampered national efforts to undermine profit shifting activities in the past since it forced governments either to extend restrictions for MNEs to purely national firms or vice versa.

To summarize, the current SA system comes at high administrative cost associated with the compliance of transfer pricing regulations and monitoring costs on the side of the national governments. Moreover, the regulations to limit profit shifting by MNEs have violated the systematics of the corporate tax system which introduces additional compliance costs for the tax payer and possible inefficiencies by the forced extension of MNE-regulations to national firms.

Moreover, it shall be noted that one conceptual justification for the corporation tax roots in its function as equivalence tax. Since corporations profit from goods and services provided by the hosting country, the tax payment may be seen as compensation for these services. With profit shifting, the equivalence function may be eroded since corporate profit is not taxed in the country where the corporate activity takes place but may be shifted to foreign tax havens. Hence, this aspect should be taken into account when discussing a possible abolishment of the SA system. However, considering the

literature on the optimal tax scheme for MNEs, most authors are mainly concerned not with tax systematics, but rather with the allocative efficiency of the corporate tax system. To judge on that, we have to turn to the empirical evidence that quantifies profit shifting behavior.

1.2.2 Empirical Evidence of Profit Shifting Behavior

In the last years, a growing empirical literature has provided evidence that MNEs engage in profit shifting that is quantitatively relevant. The following paragraphs will give a short overview over the main contributions in this area. For a more detailed survey on the topic see Devereux (2006).

Methodologically, most papers follow the approach to give indirect evidence for shifting behavior by comparing corporate profitability across different countries. The idea thereby is that profitability of corporate investments should be equal in all countries, and should not depend on corporate taxes. Observed differences in the sense that profitability in low-tax countries exceeds profitability in high-tax countries are then attributed to profit shifting behavior. The first papers in this tradition were brought forward by Grubert and Mutti (1991) and Hines and Rice (1994). Both studies use aggregated country data for 1982, comprising 33 and 59 host countries respectively. Regressing total reported pre-tax income on measures of the statutory tax rate both studies find large tax effects on reported profits. For example Hines and Rice (1994) provide estimation results according to which a 1% increase in the corporate tax rate reduces profit by 6%. Since the data sets constitute small country cross sections only, the authors can, however, not or only deficiently account for unobserved characteristics of the host country. This makes the estimation prone to biases caused by endogeneity problems and casts some doubt on the estimated effects. Follow-up studies accounted for this and investigated the impact of corporate taxes on pre-tax profits based on firm panel data with which they could handle the endogeneity problems mentioned above (e.g. Collins et al. (1998)). These studies also find evidence in line with substantial

profit shifting behavior.

Two other influential papers give indirect evidence for shifting behavior by investigating the decision of US MNEs to locate in international tax havens. Grubert and Slemrod (1998) use data on US affiliates in Puerto Rico that effectively pay taxes neither in Puerto Rico nor in the US. They obtain cross sectional data for 1987 on 150 US corporations owning affiliates in Puerto Rico, and compare these firms to 4000 other US companies which did not locate in Puerto Rico. They analyze which corporate parameters determine the location in tax havens and thereby focus on measures related to the costs of income shifting like R&D and advertising. In line with basic intuition, the authors find significant data patterns in the sense that firms with low shifting costs have a higher probability to be located in Puerto Rico. A similar study was conducted by Desai et al (2006). They estimate the determinants of whether US multinationals choose to locate in tax havens using confidential US firm level data from 1982, 1989, 1994 and 1999. In line with Grubert and Slemrod (1998), they find that larger, more international firms, and those with extensive intra-firm trade and high R&D intensities, are more likely to use tax havens.

All studies presented above are restricted to the US. Therefore, the last years have witnessed the emergence of papers that investigated profit shifting based on non-US data. Demingüc and Huizinga (2001) provide evidence on profit shifting activities using a data set on the profitability of banks in 80 countries. Bartelsman and Beetsma (2003) employ industry level data on value added to investigate profit shifting within 16 OECD countries between 1979 and 1997 and also find significant and quantitatively substantial effects. The latest evidence was brought forward by Ramb and Weichenrieder (2005), Overesch (2006) and Dischinger (2007) who use micro data on multinational corporations provided by the German Federal Bank (MIDI) and Bureau van Dijck (AMADEUS).

A recent paper by Dischinger and Riedel (2007) shows that profit shifting activities of MNEs are strongly tied to the location of intangible assets and service units (like R&D,

management and administration) *within* a corporate group. Precisely, the authors demonstrate that profit shifting behavior is significantly more pronounced if these units are located in countries with a low tax rate compared to other group affiliates. Furthermore, the authors provide evidence that MNEs actually distort the location of their intangible assets towards countries with a relatively small corporation tax.

One major shortcoming of the studies cited above is that they give only indirect evidence on profit shifting behavior. The results thereby rely on the assumption that the observed corporate tax effects on profitability cannot be generated by other mechanisms apart from shifting behavior. Therefore, the literature acknowledged the need for direct evidence on shifting activities. This gap has been filled by two studies on transfer pricing distortions conducted by Swenson and Clausing. Swenson (2001) uses US import data for the period from 1981 to 1988. Since the data does not allow for a differentiation between intra-firm and arms-length prices, she identifies transfer pricing incentives by regressing price choices on the differences in corporate tax rates. She finds significant results, although they are quantitatively small. The follow-up study by Clausing (2003) employs data of the US Bureau of Labor Statistics (BLS) on international trade prices for 1997, 1998 and 1999. The major advantage of this data set (compared to Swenson's work) is that it allows to differentiate between intra-firm trade prices and arms-length trade prices since half of the observations reflect trade between two unrelated parties. She finds strong evidence for income shifting since US intra-firm trade with low-tax countries exhibits lower export prices and higher import prices. Quantitatively, a 10% increase in the foreign corporate tax rate lowers US intra-firm export prices by 9.4% and raises US intra-firm import prices by 6.4%.

Last, it shall be mentioned that several papers estimate corporate tax effects on MNEs' debt-equity structure. A recent study by Desai et al. (2004) exploits US firm data for 1982, 1989 and 1994 which includes information on the total amount of external debt in each affiliate and on the amount of debt from the parent. They find evidence that tax rates strongly affect the use of debt by affiliates. Their central estimate suggests that a 10% increase in the corporate tax rate is associated with 2.8% higher affiliate debt

as a proportion of assets. Moreover they find internal debt to be even more sensitive to tax rate changes: a 10% increase in the corporate tax rate raises affiliate debt by 3.5%.

Thus, we can conclude that profit shifting behavior is rather well documented and that the estimates indicate that the tax planning strategies of multinational corporations are quantitatively relevant. This profit shifting behavior gives therefore rise to distortions in the international tax scheme since countries try to attract the shifty tax base (without accounting for welfare effects of foreign countries) which leads to inefficiently low corporate tax rates in equilibrium.

1.3 The Alternative - Formula Apportionment?

Given the deficiencies of the SA system outlined in the previous section, policy makers and economists have thought about alternative regimes to tax the corporate profit of MNEs for quite some time.

One possibility to abolish the allocative inefficiencies described above lies in the complete harmonization of national tax regimes. Early studies of the European Commission on the corporate taxation within the EU were largely inspired by this goal. The tendency to harmonize national tax laws can be found in the 'Neumark-Report' from 1962 where the authors emphasize the necessity to harmonize the income taxation systems, including harmonized corporate taxes rates and tax bases. The Ruding-Report which was published in 1992 draws comparable conclusions, and suggests a minimum corporate tax as well as the harmonization of accounting standards and advocates the implementation of a common EU corporate taxation system in the medium run.

However, both reports could not exert any influence on the political debate or action. The reasons for this failure are complex but probably root to a large extend in the suggestions' strong intervention in the national tax sovereignty. Considering these past

experiences and valuing the subsidiarity principle, the European Commission currently refrains from the goal of corporate tax rate harmonization although many of the distortions described above could be abolished by harmonizing taxes (European Commission (2001) and BMF (2007)).

In 2001, the Commission instead suggested to abolish the SA system within the EU and to introduce a system based on profit consolidation and formula apportionment (FA). The general idea behind FA is that the multinational profit is consolidated at the group level and is afterwards apportioned to the affiliates on the basis of a formula that shall measure the relative corporate activity. The Commission's report thereby comprises four reform scenarios that differ in the degree of planned changes.

1.3.1 The Proposal of the European Commission

The first model carries the name 'Home State Taxation' and "involves all or a group of Member States agreeing to accept that certain enterprises with operations in a number of Member States should compute their taxable base according to the tax code of a single Member State − the 'Home State'..." (Commission study (2002)). Under Home State Taxation, a MNE's income within the EU is calculated under the tax rules of the country in which the corporate headquarter is located. Hence, Home State Taxation is based on mutual recognition, that is, participating member countries have to accept each others systems for calculating and consolidating the profits of corporate groups in the participating member states. Aggregate income is apportioned among participating states in which the group's operations were located using a formula and are then taxed at the national corporate tax rate.

The second model is named 'Common Consolidated Corporate Tax Base' and "involves all Member States, or possibly initially only a group, agreeing on a set of common rules for establishing the taxable base of certain enterprises with operations in a number of Member States (or even in a single member state)" (Commission study (2002)). Thus, in contrast to Home State Taxation the tax base is calculated under one set of common

European rules. The design of the Common Consolidated Tax Base has thereby still to be defined.

The third model prescribes a 'Harmonized Tax Base' and extends the tax base definition applied to MNEs under the 'Common Consolidated Corporate Tax Base' to national firms. This would imply a common tax base regulation for all corporations within the EU. The fourth model is named 'European Union Company Income Tax' and extends the third proposal by a harmonized corporate tax rate within the EU. However, the latter two models are commonly perceived to be too far reaching to receive political acceptance from EU member states. Hence, the focus of the academic and political discussion lies instead on the suggestions of 'Home State Taxation' and the 'Common Consolidated Tax Base'.

Many authors have pointed out that 'Common Consolidated Base Taxation' is superior to a system of 'Home State Taxation' from an efficiency point of view as it would imply a larger decrease in complexity. Moreover, 'Home State Taxation' gives rise to the problem that the tax base of corporations located in the same host country is calculated according to different tax base definitions if their parent firms resided in different European countries. This regulation might come in conflict with European non-discriminatory laws. However, on the other hand an agreement between the European member states on a common tax base may not be feasible in the near future as this would imply a considerable decline in tax autonomy of the single governments. Therefore, 'Home State Taxation' is usually seen as a passable short run option and pilot project (Mintz and Weiner (2003)).

Apart from the question which FA model should be chosen and how the system shall be designed, one should keep in mind that a transition to FA is only reasonable if the problems caused by SA are solved (or at least largely reduced) and no equally problematic distortions are caused. This should be investigated carefully since a real world experiment might be costly. In the following we will give an overview on the strand of the literature that analyzes allocation effects of corporate taxation under FA

and compares it to distortions under SA.

1.3.2 Distortions and Welfare under FA and SA

The main advantage of FA compared to SA is usually seen in the abolishment of profit shifting activities. Since profits are consolidated at the group level, MNEs have no incentive to engage in costly transfer pricing or distortions of the debt-equity structure to move profits between locations. Thus, the introduction of FA may eliminate the allocative distortions of profit shifting behavior as well as the attached problems of conceptual corporate tax justification (equivalence taxation) and the administrative costs of monitoring multinational transfer pricing and financing choices.

Moreover, the application of a common group-wide tax base definition would reduce the MNEs' compliance cost of handling 27 different tax systems.[2] Another advantage named by several authors in the corporate tax literature is that FA is already operated for the division of corporate income on state level in the US, Canada, Germany and Switzerland (e.g. Mintz (1999)). Thus, one may learn from previous experiences with the FA scheme and can thereby ensure that a system switch would not be prone to (too many) unexpected problems.

Despite these appealing advantages many authors have also pointed out limits to the system as well as disadvantages only present under FA. To tie in with the last point presented in the previous paragraph, Weiner (2002) claims that the success of FA systems on the subnational level is largely due to factors that are particular to subnational federations and that do not exist within the EU. First, US states and Canadian provinces as well as German municipalities operate under the umbrella of the federal tax system and may call on the federal tax authorities for assistance in administering the system. Second, she notes that the tax environment in these countries differs dramatically from the one in the EU. For example, barriers to cross-state expansions or mergers do not

[2]Note however, that apart from the introduction of a FA system, this could also be realized by a harmonization in tax bases.

exist, and there are no withholding taxes levied on cross-border payments which may be relevant for the functioning of the FA system. Last, she raises concerns that problems may arise since the provinces and states are in general much more integrated economically than are the individual EU member states.

Moreover, although profit shifting incentives are abolished, the introduction of FA may give rise to new allocative distortions that possibly outweigh the gains from reduced profit shifting activities. In the following, we will present theoretical models that compare allocative efficiency under SA and FA from different perspectives. All models in this section have in common that they investigate FA systems in which formula factors as well as the formula weights are taken as given. Thus, the qualitative and quantitative inefficiencies are derived under the assumption of an exogenous, possibly suboptimal formula design. The question of optimal formula choice will be addressed in the subsequent section 3.3.

Path breaking theoretical contributions with respect to allocative distortions under FA were made by McLure (1980) and Gordon and Wilson (1986). McLure (1980) examines how the system of FA affected business decisions, and found that by using a formula based on firm specific factors to determine state income, the states effectively transformed the formula into a direct tax on whatever factors are included in the formula. Gordon and Wilson (1986) present a theoretical model that shows the complex ways in which the apportionment formula affects the incentives of firms to undertake new investment, or change employment or sales in a state. Under taxation based on a property formula, price distortions differ in general among corporations within the same state, creating incentives for firms producing in different states to merge their operations. Moreover they show that apportionment of the tax based on payroll creates many similar incentives. With this tax, however, the merging incentive of firms producing different goods is discouraged. When a sales component to the tax is added, there are incentives for the cross-hauling of output, with production in low-tax states sold in high-tax states and vice versa. In contrast, the authors emphasize that none of these distortions is present in a system of SA on basis of arm's length prices.

Moreover, Nielsen et al. (2003) demonstrate that transfer pricing may not be abolished under FA if the MNEs operate in imperfectly competitive product markets. Under oligopolistic competition, the MNE has an incentive to distort the intra-firm transfer price for tax saving as well as for strategic reasons (see also Schjelderup and Soergard, (1997)). The strategic effect arises if the MNE delegates the sales decision in the product market to its local affiliate. Since the affiliate takes the transfer price as given, the MNE may employ the price as strategic device to win shares in local markets. The strategic effect is shown to determine transfer pricing choices under SA and under FA. Moreover, the transfer price is also distorted for tax saving reasons under FA. This is due to the fact that apportionment is assumed to take place according to the relative sales share. If the MNE now distorts its transfer price, it influences the revenues at the foreign and at the local subsidiary and thereby changes the apportionment shares according to which the consolidated profit is apportioned under FA. In general, the strategic benefits may be counteracted or enhanced by the incentive to reduce tax payments, depending on the relation between tax rates in countries in which the MNE operates. The authors show that a switch from SA to FA may actually increase transfer pricing distortions.

While the papers presented so far, investigate the adaption of economic agents to a given tax rate distribution under SA and FA, another strand of the literature has investigated tax competition under the two corporate tax schemes. By comparing equilibrium tax rates to the benchmark case of tax coordination one may quantify the inefficiencies caused by the multinational tax scheme which are represented by the fiscal externalities exerted on foreign jurisdictions' social welfare. The basic fiscal externalities derived from these models comprise a positive profit shifting externality under SA and a positive formula externality under FA (see e.g. Mintz, 1999). With a SA system, an increase in the corporate tax rate of one country raises the corporate tax base of neighboring jurisdictions since the tax increase induces MNEs to shift profits abroad. As the tax setting government does not take the tax base effect on the foreign jurisdiction into account, this constitutes a positive fiscal externality. Under

FA corporate taxation exerts a positive externality as well since an increase in the corporate tax rate causes MNEs to distort their apportionment formula in favor of the foreign country, which enlarges the share of consolidated profit that is apportioned to this country and enhances the foreign tax base. Thus, these basic externalities suggest corporate tax rates to be inefficiently low under both taxation schemes. Theoretically, the relative size of these two inefficiencies is ambiguous and it calls for empirical analysis to quantify the effects.

Several theoretical papers have extended this basic analysis in different directions. Nielsen et al. (2001) analyze fiscal externalities under FA and SA. They consider a model with two small countries that host the affiliates of a MNE. Under FA, income is apportioned according to the relative capital share. The authors show that in this setting corporate tax rates may be inefficiently high or low under both SA and FA systems. The basic externalities under SA are the positive profit shifting externality described above and a negative externality that is caused by the presence of a public input factor within the MNE. The intra-firm public good is produced by the corporate headquarter and enhances capital productivity at the headquarter and subsidiary location. The basic mechanism of this externality can be described as follows: If the headquarter country increases its corporate tax rate, the provision of the public good is reduced which in turn diminishes capital productivity at the subsidiary level and henceforth capital investment at the subsidiary. This leads to a profit reduction and establishes a negative fiscal externality on the foreign country. Under FA, corporate tax rates may equally be inefficiently high or low due to two effects. Besides the positive formula externality described above, the authors derive a negative investment externality caused by distortive profit taxation. An increase in the corporate tax rate leads to a rise in the MNE's average corporate tax rate and thereby enlarges capital costs in both countries and reduces corporate investment in the home and in the foreign country. Since the government does not take the effect on the foreign country into account when it decides on the corporate tax rate, this constitutes a negative fiscal externality. A structurally similar model was presented by Peter Soerensen (2004).

Kind et al. (2005) build a model similar to Nielsen et al. (2003). The innovation of their paper is that the transfer price applies to a traded commodity that can only be shipped to the subsidiary at a (trade) cost. This allows the authors to analyze the impact of economic integration on the welfare under FA and SA. Following Nielsen et al. (2003), the authors assume apportionment according to the relative sales share and take into account that the transfer price is distorted for tax saving and for strategic purposes. Their analysis shows that a reduction in trade barriers lowers equilibrium corporate taxes under SA, but leads to higher taxes under FA. From a welfare point of view, the choice of tax principle is shown to depend on the degree of economic integration, with high degrees of integration favoring the FA regime and low degrees of economic integration favoring the SA scheme.

Two recent papers examine the effect of corporate taxation on welfare in the presence of labor market imperfections. Eichner and Runkel (2006) consider a model with unemployment caused by a minimum wage. They find that corporate taxes exert no additional externality on foreign welfare through the introduction of the labor market rigidity under SA. However, with a FA regime that apportions income according to the relative payroll share, the race-to-the-bottom in corporate tax rates is enforced by the introduction of minimum wages. Riedel (2006), in turn, investigates corporate tax effects on labor market outcomes, employing a union wage bargaining model. She finds that a raise in the corporate tax rate increases wages bargained at home and diminishes wages bargained in the foreign country under SA. A transition to FA is likely to turn these results on the head. Thus, the author finds that corporate taxes tend to lower the domestic wage rate while they tend to enlarge the wages set at the foreign country. The main insight derived from a tax competition analysis is the derivation of an ambiguous wage income externality caused by the presence of union wage bargaining under SA, while the wage income externality is unambiguously positive under FA. Moreover, some empirical results in line with the model predictions are provided.

Most of the above cited papers derive ambiguous results with respect to a welfare comparison of SA and FA. One of the few studies with a clear-cut prediction was

brought forward by Eggert and Schjelderup (2003). They show in a symmetric setting that under SA a combination of a residence-based capital tax and a property tax ensures the efficient outcome, while a switch to FA with a two-factor formula based on the sales and capital share, combined with a residence-based capital tax, in turn, leads to an inefficient solution.

Therefore, one may conclude that it is far from being obvious that the introduction of FA within the EU may reduce distortions caused by corporate taxation. The theoretical studies cited above often derive ambiguous results, some like Eggert and Schjelderup (2003) suggest to refrain from the introduction of FA. The welfare effects under FA thereby strongly depend on the apportionment formula chosen. The next section will therefore discuss questions related to the optimal (formula) design of a FA union.

1.3.3 The Design of a FA System within the EU

Firstly, it has to be decided whether the countries should be able to choose the apportionment formula autonomously or if it is set by agreement on a central level. If the latter should be the case, the EU has to decide according to which formula corporate income shall be apportioned. Moreover, practical issues also comprise the question according to which criteria corporate affiliates shall be included in the group consolidation. These questions will be discussed in the following.

Formula Choice

The literature presented in section 3.2 assumes the apportionment formula to be exogenous to the tax-setting jurisdictions. Although this assumption is in line with FA systems in Canada and Germany, subnational taxation in the US follows the principle that states can autonomously choose the design of their apportionment formula.

Although autonomous formula choice is appealing with regard to the subsidiarity prin-

ciple, the economic literature clearly shows that from a welfare point of view jurisdictions should bind themselves to a common apportionment formula. Anand and Sansing (2000) demonstrate in a two state equilibrium model of location choice by firms that aggregate social welfare is maximized when both states use the same formula, regardless of which formula is chosen. However at least one of the states can increase its welfare by deviating from this coordinated solution; thus the Nash equilibrium features the states choosing different formulas. Moreover, the authors show that importing states have an incentive to increase the sales factor, whereas exporting states will tend to increase the input factors. They confirm their theoretical predictions by empirical tests for the US.

Provided that the participating EU member countries could agree on a common apportionment formula, the question remains which formula should be chosen. Existing FA systems rely on different apportionment factors and weights. While local business taxation in Germany is based on apportionment according to the relative payroll shares, FA in Canada uses a formula comprising payroll and sales. As mentioned above, US states can autonomously choose their apportionment formula. However, since US authorities have recommended to use an equal-weighted three-factor formula of capital, payroll and sales, traditionally most states relied on this formula scheme in the past. However, the last years have witnessed a tendency to put an increased weight on the sales share. Thus, nowadays some states apportion the business tax according to the sales share only, while others double weight sales in their formulas.[3]

Following Hellerstein and McLure (2004) one may state three central demands on the factors included in the apportionment formula: first, the factors must be economically mandatory. Second, they must be administratively practical and third, they must not be easily manipulated.

With respect to the economic justification of the apportionment formula, one may

[3]Since a lower weight on the input factors capital and labor reduces the effective tax burden on these resources (McLure (1980)), a relatively larger weight on the sales share is perceived to boost business investment.

consider two views on the apportionment of consolidated profit that were originally proposed by Musgrave (1984). First, a supply based view that suggests profit to be apportioned to the production units of the corporate output. This approach claims that economic profit depends on the location of production, and hence the factors used in the formula shall be origin based. In turn, the supply/demand based view suggests profit to be partially apportioned to the jurisdictions where production took place and partially to the market jurisdictions where the output was sold. The rationale behind this approach is that a part of the multinational profit may be linked to markets, such as profits resulting from tariff protection and advertising. Under the supply-based view Musgrave argues that property should be used to apportion income which reflects the normal return to capital. The payroll factor could only be an indirect solution. Nevertheless if production functions and relative factor prices were the same in all taxing jurisdictions, it makes no difference from a theoretical point of view whether payroll or property is used to apportion income. In contrast, under the supply/demand based view, a share of the apportionment formula should reflect the sales of the MNE at the destination principle.

Moreover, the factors included in the formula shall be easy to measure. If one decided to include property in the apportionment formula, capital measurement can either follow a 'stock' approach or a 'flow' approach (Musgrave (1984)). While the former employs the current (depreciated) market value of assets, the latter grounds on economic depreciation and interest (the user cost of capital). Many authors favor the value based approach since the value of an asset reflects the contribution to the creation of profit probably in a better way than the asset's cost or the user cost of capital (see e.g. Hellerstein and McLure (2004)). Others claim that it is more appropriate from a theoretical point of view to base the definition of property on the flow of capital services, as measured by the user cost of capital. McLure (1999) presents examples in which the apportionment based on asset values leads to theoretically incorrect apportionment outcomes. Nevertheless, irrespective of which approach is chosen to measure an affiliate's property, the measurement of the property factor will be problematic,

since neither asset values nor depreciation and interest rates to calculate the cost of funds are obvious.

Moreover, many authors note that the property factor should include intangible assets, such as intellectual property, since modern corporations are largely characterized by the presence of intangibles (Weiner (2002)). This contrasts the existing FA system in the US which accounts for tangible assets only. While the inclusion of intangible assets is justified from a conceptual point of view, it may nevertheless give rise to severe administrative problems since the valuation of intangible assets may be even more problematic than the valuation of tangible assets.

Therefore, if the choice of apportionment factors was based on administrative efficiency, the payroll factor is claimed to be superior to the property factor by most authors (e.g. McLure and Hellerstein (2004)) since measurement and testing is much easier than with property. The same is true for the sales factor although one might arrive at relatively mild conceptual problems with respect to the question which kind of sales should be included in calculating apportionment shares. In the US for example, the sales factor is not limited to the sale of goods, but it includes, inter alia, receipts from the provision of services, rentals, and royalties; whether it includes gross receipts from sales or financial assets, or is solely based on net sales, is often subject to controversy.

Apart from the stated administrative and conceptual aspects, another goal to guide the formula choice should be to avoid economic distortions. While tax planning of firms takes the form of manipulating transfer prices under a system of SA, they might reallocate income under FA by manipulating the location of factors as already presented above. If the sales factor was included in the apportionment formula, a company could shift the location of its sales by altering the location where sales reach their ultimate destination, for example by delivering the sales to a location where the company does not have a permanent establishment. In turn, if the property factor was included in the apportionment formula, a company could store its inventory (which is included in the calculation of the capital share) in a low-tax area to reduce the property fraction and

consequently the amount of income attributed to a high tax area. The payroll factor could be reduced in a state by hiring independent contractors, whose compensation is not included in the payroll factor. All these possibilities can be restricted by law to some extend, but can surely not totally be abolished (see McLure and Hellerstein (2004)).

Pethig and Wagener (2003) investigate apportionment formula choices in a tax competition model. Intuitively, they find that tax competition is sharper the higher the tax elasticity of the apportionment formula which, in turn, depends on the production technology. In particular, if labor input is fixed, tax competition is sharpest if apportionment is based on property shares, followed by the sales and payroll shares. If capital and labor are endogeneous and technologies are Cobb-Douglas, tax competition under the property- and the payroll share rule is sharper than under the output-share rule.

Eichner and Runkel (2006) consider the optimal choice of the formula weights under FA for the apportionment factors capital, labor and *origin based* sales from an efficiency point of view. Their analysis is build on the well-known positive formula externality and the negative investment externality derived by Nielsen et al. (2001) and Soerensen (2004) under FA. Since the two described externalities point in different directions corporate tax rates may in general be inefficiently high or low under the FA system. The authors now show that apportionment based on the input factors lead to inefficient under-taxation. This result is due to a strong formula externality caused by direct formula manipulation incentives of the MNE. In turn, if apportionment was based on the sales formula, the formula externality will be dampened since apportionment is directed on the production inputs only indirectly. This leads to inefficient over-taxation in equilibrium. The authors now show that the economy may achieve the efficient outcome if the sales factor is double-weighted in the apportionment formula.

Wellisch (2004) analyzes tax competition for mobile capital under FA whereas the jurisdictions are assumed to choose their apportionment formulas autonomously. The

analysis reveals that jurisdictions choose apportionment according to immobile factors like labor. The result thus resembles the outcome of standard models on tax competition behavior (Zodrow and Mieskowski (1986) and Gordon (1986)) which show that the tax burden is shifted on to the owners of immobile resources. Interestingly, Runkel and Schjelderup (2007) show in a slightly modified setting that a positive weight on mobile capital is chosen, irrespective of decentralized or centralized choice of the apportionment formula. Under decentralized choice of the apportionment formula, the positive weight on capital follows from the principle that a tax on capital is an efficient way of taxing economic rents. Under centralized choice of the apportionment formula, the central planner uses the decision on the formula weights as corrective instrument to internalize fiscal externalities. Since the model accounts for the positive formula externality as well as for negative externalities, the authors show that it is optimal to put a strictly positive weight on the capital factor.

When discussing the optimal formula design within a FA system, one may also draw from the results in section 1.3.2., in which tax competition under FA was investigated, assuming given formula weights. The main insight from this section might be that from the viewpoint of additional externalities derived under different factor weights, property apportionment seems advantageous compared to payroll apportionment. Remember that Nielsen et al. (2001) show that the inclusion of capital in the apportionment formula may be beneficial since it generates a negative investment externality that tends to compensate for the positive formula distortion.[4] In contrast, Eichner and Runkel (2006) as well as Riedel (2006) find that the inclusion of payroll in the apportionment enhances the race-to-the bottom in corporate tax rates in the presence of labor market imperfections.

All studies presented so far are based on apportionment according to the firm-specific factors capital, payroll or sales. The central advantage of using micro factors for the

[4]Note, however, that this result relies on the assumption that the participating member states are small with respect to the rest of the world and therefore changes in their capital demand do not alter the capital market interest rate.

apportionment of profits lies in the direct justification of the tax claim as the formula refers to firm specific features. The drawback of including micro factors is the generation of tax planning incentives as illustrated above. Contrary to micro-factors, the apportionment due to macro factors is founded on industry-averages. The advantage lies in the elimination of the tax planning incentives of MNEs and its administrative simplicity. However, the use of macro factors can result in attribution of income to member states that bear little or no relation to where the income is earned. As pointed out by several authors this violates fairness considerations concerning the inputs involved and the equivalence principle of taxation. In general, apportionment according to macro factors does not seem to be considered a serious option for a FA scheme within the EU.

The discussion in this section makes clear that there is no easy answer to the question which formula should be adopted by the EU if it decided to switch to FA. While from a conceptual point of view, the inclusion of capital as apportionment factor is appealing, the measurement difficulties referred to above suggest to follow the examples of FA in Canada and Germany and refrain from the inclusion of property in the apportionment formula. The payroll factor in turn is easy to measure, but may lead to additional distortions which enforce the race to the bottom in corporate tax rates (Eichner and Runkel (2006), Riedel (2006)). However, since from a conceptual point of view the inclusion of a origin based factor seems appropriate, one has to weight the measurement problems with respect to the property factor against possibly higher allocative distortions with the inclusion of payroll.[5] Last, the sales factor is as a destination-based variable disputed to be included in the apportionment formula at all. From an efficiency point of view, distortions caused under the relative sales share depend on the flexibility of multi-jurisdictional corporations to adjust their sales to tax rate differentials. This, as well as behavioral responses to tax rate differentials under payroll and

[5]Note, however, that the presence of additional externalities with a payroll factor does not necessarily mean that the sum of distortions under payroll apportionment must be larger than under property apportionment. Capital might instead be more responsive to changes in the corporate tax rate which may outweigh the additional distortions in a system with a payroll formula.

property apportionment respectively are in the end an empirical question to which we will turn in section 3.4.

Group Definition

Most authors moreover note that the avoidance of transfer pricing problems under FA demands the mandatory consolidation of affiliates since otherwise the incentives for the MNE to shift profits to low-tax jurisdictions are not eliminated (Hellerstein and McLure (2004)). In general, there are two different approaches to define a corporate group: unitary combination and consolidation based on ownership. Unitary combination considers the economic connection of the related entities to the parent company and consolidates all those affiliates which are economically related to the parent company irrespective of the percentage of legal ownership. The integrated units are treated as a single unity for tax purposes, while economically independent affiliates are excluded. Thus, the unitary tax treats a highly-integrated company as a single operation even though that group may be composed of legally separate entities. In contrast, consolidation based on ownership defines a legal threshold ownership level, i.e. affiliates of which the parent company owns the threshold level percentage or above are consolidated irrespective of the economic relationship of the affiliate to the parent company.

The main argument in favor of unitary taxation is that profit consolidation and formula apportionment are appealing from a conceptional point of view only if two parties are economically related and contribute to the production process of an output good. However, there are a number of problems with this approach from the standpoint of practical administration. As known from the US, group consolidation according to economic criteria does not rely on hard facts but is rather a matter of interpretation. Hence, this may introduce tax planning possibilities and inconsistency in the definitions of corporate groups.

From an administrative perspective, it is therefore more appealing to use legal own-

ership for the definition of a multi-jurisdictional group. However, two principal weaknesses of the concept show up: First, income may be misattributed because the income from affiliated - but economically unrelated - enterprises would be sourced by reference to consolidated apportionment factors that would not have contributed to the income in question. Second, a definition of the consolidated apportionable tax base predicated solely on legal control could give rise to tax planning incentives in form of adjustment of ownership interests in other corporations to minimize the tax burden, depending on whether consolidation or separate company reporting was more advantageous from a tax standpoint.[6] One possible solution to this problem might be to include affiliates only by pro rata share when ownership is above a certain threshold and an affiliate is considered to belong to the group (Hellerstein and Hellerstein, (1998)). However, the drawback would certainly be enlarged administrative complexity. The literature does not agree on the question which group consolidation method shall be used within a FA system. While Hellerstein and McLure (2004) recommend to rely on a legal definition of the consolidated group, McLure and Weiner (2000) point out the advantages of unitary combination.

Another related question is how a FA union within the EU would treat multinational affiliates in outside countries that stick to SA. Following the legislation in existing FA systems, the European Commission's (2002) proposal suggests to limit group taxation to income earned in the EU which is traditionally called 'Water's Edge Taxation'. This is in line with the recommendation of practitioners who claim several reason for limiting consolidation to the FA area, among others the international differences in accounting standards and the need to translate documents in foreign languages.

The most pressing problem with 'Water's Edge Taxation' is usually seen in the fact that profit shifting channels remain open to multinational affiliates located outside the FA union. Several authors thus worried that the profit shifting distortions are reintroduced to a FA system through the back-door in the sense that MNEs start substituting the

[6] A recent empirical project by Büttner, Riedel and Runkel (2007) shows that multi-jurisdictional corporations indeed adjust their group definition in line with tax planning behavior.

lost profit shifting opportunities within the union by enhanced shifting to outside tax havens. However, Riedel and Runkel (2007) show that these worries may be causeless. They present a theoretical model that predicts profit shifting to tax havens to go down with the foundation of a FA union. Moreover, the authors show that the water's edge regulation gives rise to a negative fiscal externality that tends to compensate for other distortions and brings the economy closer to the efficient outcome.

1.3.4 The Empirical Literature on FA (versus SA)

The previous sections have shown that theoretical considerations cannot derive a clear-cut recommendation whether the European Union shall introduce FA within its borders. Apart from considerations concerning the systematics and administrative simplicity of the tax scheme, theoretical papers that compare distortive corporate tax effects under SA and FA usually derive ambiguous results. This calls for empirical analysis to quantify the distortions described above and henceforth to provide guidance on the question if a system switch to FA can (at least) be recommended from an efficiency point of view.

However, the empirical literature on corporate tax effects under FA is rather thin. Most existing work is largely inspired by the FA system implemented for subnational taxation in the US. Hence, a large share of the relevant articles focuses on the US-peculiarity that states may choose their apportionment formula autonomously and investigates the effect of changes in the apportionment formula on real investment and the sales decision. Weiner (1994) and Weiner (1999) examine how the apportionment factor choice affects multi-regional firms' investment decisions employing cross sectional state-level data for the year 1977 and state-level data for 1982 and 1990 respectively. She could derive no or only marginally significant effects. Her research was followed by a paper by Klassen and Shackelford (1998). They use a panel of data on US states and Canadian provinces and find that the apportionment formula impacts on the multi-regional firms' sales decision, but has no effect on property investment or employment.

Goolsbee and Maydew (2000) were, hence, the first paper that found a significant effect of the apportionment formula on the corporate employment decision. Similar to the studies cited above, the authors use US state-level data for the period from 1978-1994. They find that for the average state, reducing the payroll weight from one-third to one-quarter increases manufacturing employment by around 1.1%.

A study with a slightly different focus was published by Mintz and Smart (2004). They make use of a peculiarity in the Canadian corporate tax system at the province level that prescribes dependent production and sales units to be taxed according to FA while for independent subsidiaries SA applies. They employ aggregated tax base data for dependent corporate units (FA applies) and independent subsidiaries (SA applies) respectively and investigate corporate tax effects on the tax base of these firms. The central result emerging from their analysis is that the corporate tax base reacts significantly more elastic to tax rate changes for firms taxed according to SA rules than for firms taxed according to FA. Under the former system a 1% increase in the corporate tax rate is suggested to decrease the local tax base by 4.9% while under the latter system the tax base elasiticity to corporate tax changes is measured to be 2.3.

All empirical evidence presented above examines FA systems implemented in the US and Canada. Moreover, the studies relied on macro data which may be prone to endogeneity problems with respect to the tax rate and formula choice. The results of the cited studies therefore rely on the validity of the estimation approaches to handle these endogeneity concerns. Goolsbee and Maydew (2000) are for example cautious with respect to their findings since "there may be other unobserved policy changes contributing to the result". Additionally, apart from the study by Mintz and Smart (2004), the papers strongly focus on the endogeneity of the formula choice. This, however, is of minor relevance with respect to FA systems in Canada and Germany that rely on a centrally set apportionment formula. Note, that the EU equally considers the introduction of FA based on a formula set at the central level.

This gap is filled by a study of Riedel (2007) who quantifies the formula externality using data for the population of German firms. The data is available for 1998 and 2001 whereas the two cross sections can be added to a panel. Since affiliates of a multi-regional group can be identified in the data, she can estimate investment distortions by corporate taxation at the affiliate's home jurisdiction as well as by corporate taxation at foreign group locations. Her results indicate that corporate taxation under FA substantially distorts the multi-jurisdictional firms' input factor choice.

Another strand of empirical papers has been concerned with the short-term tax revenue consequences of a switch from SA to FA. These studies argue that to make the regime transition politically supportable it must be assured that there are no negative revenue implications for the jurisdictions who join the FA union.

Shackelford and Slemrod (1998) examine the 1989-1993 publicly available financial reports of 46 U.S.-based multinationals to estimate the revenue implications of implementing a U.S. federal FA system. Ignoring behavioral responses, they estimate the tax revenue effect from shifting to an equal-weighted, three-factor formula. According to their results the transition would have increased MNEs' U.S. tax liabilities by 38 percent, with an 81 percent increase for oil and gas firms.

A similar exercise was conducted by Fuest et al. (2007) for the European Union. Using data on German MNEs they estimate revenue effects of a transition from SA to FA within the EU. Their results suggest that due to border crossing loss-offset, the EU wide corporate tax base represented by the data sample shrinks significantly. Smaller countries which are usually considered to attract book profits under the current system, i.e. Ireland and the Netherlands, tend to lose a larger part of their tax base than larger countries like Germany, Italy, France or Great Britain. However, analogously to Shackelford and Slemrod (1998) they cannot account for behavioral responses which limits their analysis.

Recently, Devereux and Loretz (2007) brought forward a follow-up paper in which they estimate the revenue consequences of a switch to FA within the EU based on a large

data set for European MNEs. According to their estimates, overall tax revenues are likely to drop by 1% if companies can choose whether to participate. By contrast, if they are forced to participate, total tax revenues are likely to increase by more than 8%, leaving most European countries, especially Spain, Sweden and the United Kingdom better of. However, it should be noted that they, too, assume that corporations do not adopt their investment decision to the new corporate taxation system.

Thus, it can be concluded that far too few empirical research has been conducted in this area yet. Although the studies by Fuest et al. (2007) and Devereux and Loretz (2007) provide some indication on the short-run revenue effects of the introduction of a FA union, they are unsatisfactory in the sense that they have to rely on the assumption that companies do not adjust their capital investment to the new system. This is highly unrealistic in the medium run and calls for evidence on fiscal distortions under existing FA systems. The paper by Riedel (2007) is one of the first that tries to fill this gap since she quantifies externalities for the German FA system which apportions income according to the relative payroll share. Her analysis suggests that corporate tax distortions under FA may be substantial.

1.4 Conclusion

The main insight from this survey is probably that a clear cut answer to the question according to which scheme, FA or SA, MNEs should be taxed, is hard to find. While the abolishment of profit shifting incentives with a switch to FA seems appealing, the transition may give rise to new inefficiencies and administrative problems that might well outweigh the gains from reduced shifting activities.

Some new empirical work moreover suggests that the allocative distortions under SA may not be as large as considered so far. Becker and Riedel (2007a) show that the profit shifting externality under SA is partly compensated by a negative externality based on complementarities within multinational firms. Following papers by Desai

et al. (2006), Egger and Pfaffermayer (2003) and Jaeckle (2006), the authors build on the observation that increased activity at one affiliate location generates positive spillovers on other affiliates within the corporate group. The rationale is commonly seen in complementarities in the production process. From a public finance perspective, this implies that an increase in the corporate tax rate at one affiliate reduces local capital investment which translates in reduced investment at other affiliates. This constitutes a negative fiscal externality that tends to compensate for the positive profit shifting spillover. Employing a large panel for European MNEs, the authors provide evidence for the negative causal effect of corporate taxes on foreign affiliate investment and estimate that around one third of the profit shifting effect on foreign countries' corporate tax bases may be compensated by this negative spillover. If one considered welfare components beyond the national corporate tax base, the fraction of the profit shifting externality that is compensated by the complementarity effect may be even larger. This suggests, that at least from an efficiency point of view, the current SA system may not be as bad as usually considered with the narrow view on the profit shifting externality alone.

The following Chapters contain the author's contribution to the debate on corporate taxation of MNEs.[7] The Chapters are in the order of their inception and can be read independently.

[7]Note, that Chapter 2 is based on joint work with Marco Runkel, Chapter 5 is based on joint work with Johannes Becker and Chapter 6 is based on joint work with Matthias Dischinger.

Chapter 2

Company Tax Reform with a Water's Edge

2.1 Introduction

At an international level, corporate income taxation is based on the separate accounting (SA) principle. Profits of a multinational enterprise (MNE) are assigned to the state where they accrued using standard accounting methods. It is well documented that MNEs take advantage of this legislation and distort transfer prices and the debt-equity structure to shift income from high-tax to low-tax countries and reduce their overall tax burden (e.g. Hines (1999)). Owing to such profit shifting activities, corporate tax policy causes a fiscal externality as governments have an incentive to reduce their corporate tax rates in order to attract profit from abroad and improve the national tax base. The negative effect on the tax bases of other countries is ignored and governments tend to engage in a race-to-the-bottom with inefficiently low tax rates (e.g. Mintz (1999)).

At a national level, several countries tax multiregional companies applying a formula apportionment (FA) regime instead of SA. Under FA, the corporate income of a multiregional company is consolidated and allocated to the tax regions according to a certain formula, for example, a combination of the corporation's capital, payroll and sales shares in the respective region. Prominent examples of FA systems are the corporate taxation on state and province level in the US and Canada, respectively, and the German local business tax ("Gewerbesteuer").[1] Moreover, the European Commission (2001) proposed to replace the SA principle by a FA regime within EU-borders. Due to the consolidation of tax bases, the central advantage of FA over SA is usually seen in the abolishment of the MNEs' profit shifting incentives and, in consequence, the erasement of the fiscal externality mentioned above (McLure (1980), Mintz (1999)).

This argument implicitly supposes that the headquarters and affiliates of MNEs are located in countries joining the FA union. In reality, however, many MNEs headquartered in a FA union run subsidiaries in countries outside the union. Given the growing importance of international (intra-firm) trade and FDI, this connection between a FA

[1] While the US and Germany apply consolidation across companies of a group, in Canada consolidation is only applied to dependent branches. For our purpose, this distinction is immaterial.

union and the outside world is not a minor issue. FDI of US multinational companies, for example, amounted to 2,063 billion US dollar in 2003 (OECD, 2004), FDI of Canadian and German MNEs to 312 and 718 billion US dollar, respectively. Similarly, if the EU introduces FA, the outside connection to non-EU countries will be substantial as a large part of the member countries' FDI is located outside Europe.

The borders of a FA union are called "water's edge", a concept shaped in the US 20 years ago when world wide corporate income consolidation was abandoned in response to protests from non-US states, mainly concerning double taxation issues. Subsequently, profit has been consolidated within US borders only and affiliates overseas have been taxed according to SA. The water's edge consolidation is also part of the European FA proposal. Thus, if the EU decides to form a FA union, European MNEs will stay linked to non-European affiliates by means of SA. This implies that shifting channels to countries outside the FA union will remain open. Politicians and economists expressed reservations that shifting to affiliates located in countries outside a FA union may undermine the aim of FA. For example, McLure and Weiner (2000) state that " ... world-wide unitary combination might need to be considered as an option for ..." solving the limitations of the water's edge.

The aim of this paper is to investigate the taxation of MNEs under SA and FA in the presence of a water's edge. We develop a model with three countries. Each country hosts a MNE with a headquarter in the home country and subsidiaries in the other two countries. A MNE decides on investment in each of its entities and may shift profit by transfer pricing methods. Profit shifting is assumed to entail convex concealment costs. Within this framework, we analyze the effects of a transition from a pure SA system to a system in which two countries form a FA union and the third country sticks to SA. In the FA union, tax bases are consolidated and apportioned to member countries according to the MNEs' relative investment and sales shares. The analysis is carried out under a short-run perspective, defined as a situation where corporate tax rates are fixed, and a long-run perspective where governments engage in tax competition.

The basic insight emerging from the short-run analysis is that the MNEs' overall volume of profit shifted to non-participating tax havens *diminishes* with the formation of a FA union. This result may seem counterintuitive since MNEs might be expected to substitute eliminated profit shifting opportunities to low-tax countries within the union by intensified shifting to tax havens outside the union. But MNEs do not shift a fixed volume of profit but rather tie their shifting decision to the tax rate differential between home and host countries. Under SA profit is taxed at the respective national tax rate while in a FA union an effective tax rate applies which equals the average of the national union tax rates weighted by a combination of the MNEs' investment and sales shares. Thus, the introduction of FA increases (decreases) the tax rate differential between the low-tax (high-tax) union country and a non-participating tax haven thereby increasing profit shifting from the low-tax union country to the tax haven and reducing profit shifting from the high-tax union country to the tax haven. The latter effect dominates as investment in the low-tax FA country is relatively more attractive and therefore the effective tax rate is biased towards the lower national tax rate within the union.

The results from our long-run tax competition analysis are less clear-cut but basically point in the same direction. For both tax systems we identify fiscal externalities which represent the marginal effects of a country's corporate tax rate on the other countries' welfare. These externalities cause inefficiencies in international tax policy. The effect of a transition from SA to FA turns out to be ambiguous, i.e. it cannot be excluded that FA exacerbates the inefficiencies. Besides other well-known cross country effects, we derive a fiscal externality which is caused by the water's edge regulation under FA: If a union country increases its national tax rate, the MNEs' effective tax rates in the FA union will rise. Hence, the tax rate differential to low-tax (high-tax) non-FA countries increases (falls) and profit shifting to (from) the non-FA country is intensified (lowered). In consequence, taxable resources of all FA countries decline. This effect establishes a negative fiscal externality within the union and may lead to inefficient overtaxation. But this water's edge externality tends to be less detrimental than the profit shifting externality under SA and it may even bring the union closer to the efficient policy

by compensating other positive externalities, at least if the union countries choose a suitable design of the apportionment formula. In this sense, also the long-run tax competition analysis draws a positive picture on the water's edge regulation under FA.

Previous literature provides several studies on the short-run effects of FA, for example, McLure (1980), Weiner (1994), Mintz (1999), Mintz and Smart (2004) and Nielsen et al. (2003). But all of these articles assume either a pure SA and/or a pure FA system and do not capture interactions between union and non-union countries. Hence, in contrast to our analysis, they do not address the question whether in the presence of a water's edge the transition from SA to FA increases or decreases profit shifting to tax havens outside the FA union. Moreover, there are several articles which consider tax competition under FA, for instance, Gordon and Wilson (1986), Eggert and Schjelderup (2003, 2005), Pethig and Wagener (2003), Gérard and Weiner (2003), Kind et al. (2005) and Gérard (2005, 2006). Our paper is related most closely to Nielsen et al. (2004) and Sørensen (2004). In line with our results, they show that the welfare effects of the transition from SA to FA are ambiguous. However, since they consider a two-country framework and do not account for the water's edge regulation, they cannot point to the positive role of the water's edge externality.

This chapter is organized as follows. In Section 2, we present the basic model and characterize the MNEs' profit maximization under SA and FA. Section 3 analyzes the short-run effects of introducing FA while Section 4 considers the long-run tax competition game. Section 5 discusses some extensions and Section 6 concludes.

2.2 Model

Consider three small countries labeled a, b and c. Let $N = \{a, b, c\}$ be the set of all countries and $N^i = N/\{i\}$ be the set of all countries except for country i with $i \in N$. Each country hosts a MNE which owns two subsidiaries located in the other countries. In each country, the MNEs produce an output using mobile capital as input. Let

subscripts denote the country where a MNE has its headquarter and superscripts the country where the economic activity takes place. Accordingly, k_i^j is investment of MNE i in country j.[2] Output of MNE i in country j is given by the production function $F(k_i^j)$ with $F'(k_i^j) > 0$ and $F''(k_i^j) < 0$. The concavity of F implies that there is a fixed factor like e.g. entrepreneurial knowledge which gives rise to positive pure profit.

MNEs may shift profit between their headquarters and entities by transfer pricing methods. The basic idea is that the MNE's headquarter delivers an input good or overhead service to its entities which is essential for production. The true transfer price of the good is not observable by the tax authority.[3] MNEs may over- or understate the transfer price in order to shift profit. The simplest way to model transfer pricing is to assume that the headquarter of MNE i provides the entity in $j \in N^i$ with exactly one unit of the overhead service, for example, a single patent which is necessary for production.[4] The true transfer price (or true cost) of the service is normalized to unity while the MNE declares a transfer price equal to p_i^j. If MNE i overstates (understates) the transfer price, it will shift profit $p_i^j - 1$ from the entity in j to the headquarter (from the headquarter to the entity in j). This approach to profit shifting is also used, for instance, by Haufler and Schjelderup (2000).

Profit shifting involves a concealment cost that reflects the corporation's risk of being detected and the associated expected penalty (e.g. Kant (1988)) or the effort cost of hiding the true transfer price from tax authorities (e.g. Huber (1997), Haufler and Schjelderup, (2000)). The concealment cost of MNE i for shifting income between the headquarter and the entity in country $j \in N^i$ is given by $Q(p_i^j)$ with

$$Q(1) = 0, \quad \operatorname{sign}\{Q'(p_i^j)\} = \operatorname{sign}\{p_i^j - 1\}, \quad Q''(p_i^j) > 0. \tag{2.1}$$

[2]Since we consider a static model reflecting the steady state of the countries, the terms "investment" and "capital" are used interchangeably. This is the usual procedure in previous models.

[3]In reality, the true price for goods traded within a MNE is often hard to determine by tax authorities as comparable market goods do not exist. An example are intangible assets like patents.

[4]One formalization of the underlying production technology is to introduce an indicator variable s_i^j which will be one (zero) if the service is (not) provided to the affiliate. Production of the entity in j is $s_i^j F(k_i^j)$. If we suppose the MNE to produce in j ($s_i^j = 1$), production will reduce to $F(k_i^j)$.

The concealment cost is convex with a minimum at the point $p_i^j = 1$ where the firm honestly reports the true transfer price. Convexity may be due to decreasing economies of scale in transfer pricing. For simplicity, we ignore economies of scope, i.e. the cost of shifting profit to one affiliate is independent of shifting to the other affiliate.[5]

In each country, the MNEs have to pay a corporate income tax. The tax rates and the precise rules of taxation will be explained below. For the time being, only the MNEs' tax bases have to be specified. The user cost of capital is assumed to be tax deductible since most tax systems grant depreciation allowances and the deduction of debt financing cost. To capture such features of tax systems, we introduce a general parameter $\gamma \in [0,1]$ representing the part of the capital cost which can be deducted from the corporate tax base. The case $\gamma = 1$ ($\gamma = 0$) indicates full (no) deduction. For $\gamma \in]0,1[$, the user cost of capital is partially deductible. Denoting the (exogenously given) world interest rate by $r > 0$, the tax base of MNE $i \in N$ in the home country is

$$\pi_i^{it} = F(k_i^i) - \gamma r k_i^i + \sum_{j \in N^i} (p_i^j - 1), \tag{2.2}$$

while the tax base of MNE $i \in N$ in the host country of its entity $j \in N^i$ amounts to

$$\pi_i^{jt} = F(k_i^j) - \gamma r k_i^j - (p_i^j - 1). \tag{2.3}$$

According to (2.2) and (2.3), the MNE's tax base equals revenue corrected by deductible user cost of capital and the profit shifting term.

[5] A more general concealment cost function is $\widetilde{Q}(p_i^j, p_i^\ell)$ with $j, \ell \in N^i$ and $j \neq \ell$. In principle, the sign of the cross derivative of $\widetilde{Q}$ is indeterminate. It may be positive as the detection risk of profit shifting to one affiliate may be positively correlated with the detection risk of shifting to the other affiliate. But the sign may also be negative since e.g. lawyer cost for shifting to one affiliate falls due to accumulated concealment knowledge from shifting to the other affiliate. To the best of our knowledge, such economies of scope have been analyzed neither empirically nor theoretically and thus we leave a detailed analysis to future research.

Separate Accounting

Under SA, profit is taxed in the country where it accrues. In computing the after-tax profit, we assume that the countries apply the exemption method. This is consistent with the observation that international taxation is mainly characterized by the source principle (e.g. Keen (1993)). The before-tax profit of MNE $i \in N$ in country $j \in N$ can be written as $\pi_i^{jt} - (1-\gamma)rk_i^j$. Denoting the tax rate in country $j \in N$ by $\tau^j \in]0,1[$, the after-tax (pre-concealment-cost) profit of MNE $i \in N$ in country $j \in N$ reads

$$\pi_i^j = (1-\tau^j)\pi_i^{jt} - (1-\gamma)rk_i^j. \tag{2.4}$$

Summing up the headquarter's and the affiliates' profit net of concealment cost yields total profit of MNE $i \in N$, i.e.

$$\pi_i = \sum_{j \in N} \pi_i^j - \sum_{j \in N^i} Q(p_i^j). \tag{2.5}$$

MNE $i \in N$ chooses p_i^j for $j \in N^i$ and k_i^j for $j \in N$ to maximize (2.5). Differentiating and taking into account (2.2) – (2.4), we obtain for all $i \in N$ the first-order conditions

$$Q'(\tilde{p}_i^j) = \tau^j - \tau^i, \quad j \in N^i, \qquad F'(\tilde{k}_i^j) = \frac{r(1-\gamma\tau^j)}{1-\tau^j}, \qquad j \in N. \tag{2.6}$$

The tilde indicates profit maximizing values under SA. The first part of (2.6) states that MNE i sets the transfer price of the service good delivered to the entity j such that marginal concealment cost equals the marginal gain from profit shifting, i.e. the tax rate differential between host country j and home country i. Hence, if the tax rate in j exceeds the tax rate in i, the marginal concealment cost will be positive. MNE i overstates the transfer price and shifts profit from the entity in j to the headquarter. If the tax rate in j falls short of the tax rate in i, shifting will be the other way round.[6]

[6]One may argue that there are single MNEs with zero concealment cost which shift their whole profit earned in high tax countries to affiliates located in tax havens. Nevertheless, this assumption is implausible with respect to the aggregate of MNEs since in reality we do not observe all multinational profit to accrue in low-tax countries. Thus, the MNEs in our model may also be interpreted as representatives for the aggregate of MNEs. Moreover note, that most of the previous studies on corporate tax evasion made use of the positive concealment cost assumption.

The second part of (2.6) characterizes MNE i's optimal investment decision. Capital investment in country j will be undistorted if the user cost of capital is fully deductible ($\gamma = 1$). The marginal return to investment then equals the interest rate. If the user cost is (at least partially) deductible ($\gamma < 1$), however, the corporate income tax will distort the MNE's capital investment in country j downwards.

Formula Apportionment with Water's Edge Consolidation

Suppose countries a and b form a FA union while country c sticks to SA. Let $U = \{a, b\}$ be the set of FA countries. In the union, a MNE has to consolidate its tax bases and apportion it to the two countries according to a certain formula. The apportionment formula is supposed to contain the investment and sales shares in convex combinations.[7] The part of the consolidated tax base of MNE $i \in N$ allocated to country a equals

$$A(k_i^a, k_i^b) = \theta \frac{k_i^a}{k_i^a + k_i^b} + (1 - \theta) \frac{F(k_i^a)}{F(k_i^a) + F(k_i^b)}, \tag{2.7}$$

where $\theta \in [0, 1]$ is the weight the formula places on the investment share. The sales share receives the weight $1 - \theta$. The part of MNE i's consolidated tax base which is allocated to country b amounts to $B(\cdot) = 1 - A(\cdot)$. By differentiating (2.7), we obtain $A_{ia}(\cdot) := \partial A(\cdot)/\partial k_i^a > 0 > \partial A(\cdot)/\partial k_i^b =: A_{ib}(\cdot)$. This means that an increase in MNE i's investment in country a increases the relative investment and sales shares in country a and thereby raises the fraction of the consolidated tax base which is allocated to country a. A rise in MNE i's investment in country b has the opposite effect.

The MNE's tax burden in a FA country is calculated by multiplying the tax base

[7] We follow Eggert and Schjelderup (2003) and assume that the sales share is computed on an origin basis. This can be motivated, for example, by the proposal of the European Commission (2001) to use an origin-based value added factor in the apportionment formula. Many US states apply the origin principle to the sales of services or employ a throwback rule (Mazerov, 2001), though generally the destination rule is the main principle. Destination-based sales shares are used in the models of Gérard (2005, 2006) and Kind et al. (2005). Note also that most existing FA systems use payroll as third apportionment factor. We do not explicitly model this factor since our framework ignores labor input in production. But we expect our basic arguments to carry over to a model with labor.

allocated to that country by the national corporate tax rate. Thus, the after-tax (pre-concealment-cost) profit of MNE $i \in N$ in the FA countries a and b reads

$$\pi_i^a = \pi_i^{at} - (1-\gamma) r k_i^a - \tau^a A(k_i^a, k_i^b)(\pi_i^{at} + \pi_i^{bt}), \tag{2.8}$$

$$\pi_i^b = \pi_i^{bt} - (1-\gamma) r k_i^b - \tau^b \big[1 - A(k_i^a, k_i^b)\big](\pi_i^{at} + \pi_i^{bt}). \tag{2.9}$$

The tax due in country c is calculated on the grounds of SA. The after-tax (pre-concealment-cost) profit of MNE $i \in N$ in country c is therefore still equal to (2.4) for $j = c$. Total profit of MNE $i \in N$ becomes

$$\pi_i = (1-\tau_i)(\pi_i^{at} + \pi_i^{bt}) + (1-\tau^c)\pi_i^{ct} - \sum_{j \in N}(1-\gamma) r k_i^j - \sum_{j \in N^i} Q(p_i^j), \tag{2.10}$$

with

$$\tau_i = \tau^a A(k_i^a, k_i^b) + \tau^b \big[1 - A(k_i^a, k_i^b)\big] \tag{2.11}$$

representing the effective tax rate MNE i faces in the FA countries. This average union tax rate calculates by weighting the national tax rates with the MNE's apportionment shares according to which the consolidated tax base is allocated to countries a and b.

Let us start with profit maximization of MNEs headquartered in the FA union. From (2.2), (2.3) and (2.7) – (2.11), we obtain the first-order conditions for MNE $i \in U$

$$Q'(\hat{p}_i^j) = 0, \quad j \in U, \quad j \neq i, \qquad Q'(\hat{p}_i^c) = \tau^c - \tau_i, \tag{2.12}$$

$$F'(\hat{k}_i^j) = \frac{r(1-\gamma\tau_i)}{1-\tau_i} + \frac{(\tau^a - \tau^b) A_{ij}(\hat{k}_i^a, \hat{k}_i^b)}{1-\tau_i}(\pi_i^{at} + \pi_i^{bt}), \qquad j \in U, \tag{2.13}$$

$$F'(\hat{k}_i^c) = \frac{r(1-\gamma\tau^c)}{1-\tau^c}. \tag{2.14}$$

The hat indicates the profit maximizing solution under FA. Equation (2.12) confirms the conventional wisdom that any profit shifting incentive between FA countries is abolished by tax base consolidation, i.e. $\hat{p}_i^j = 1$ for $i, j \in U$ and $j \neq i$. Nevertheless, owing to the water's edge regulation, profit shifting activities persist between the headquarters located in FA countries and subsidiaries in countries that stick to SA. In contrast to the pure SA system, however, the transfer price now depends on the

difference between the tax rate in country c and MNE i's effective tax rate as under FA the latter applies to all corporate income earned within the union.

Optimal capital investment of MNEs headquartered within the FA union is described by (2.13) and (2.14). Compared to a pure SA system, the first-order condition with respect to investment in country c remains unchanged as country c sticks to SA. This directly follows from the comparison of (2.14) and (2.6) for $j = c$. In contrast, the optimality condition (2.13) for capital investment in the union countries is characterized by an additional term which reflects the MNE's incentive to manipulate the apportionment shares through favorably adjusting the capital investment. By increasing (reducing) capital investment in the FA country with the lower (higher) corporate tax rate, the MNE increases the relative share of the consolidated tax base which is apportioned to the low-tax country and thereby reduces its effective tax rate. This investment distortion effect was derived in previous articles referred to in the introduction.

It will be helpful to highlight some important properties of the profit maximizing solutions for MNEs a and b. For all national tax rates, it is straightforward to show that the solution to (2.12) – (2.14) for $i = a$ is also a solution to (2.12) – (2.14) for $i = b$, i.e.

$$\hat{k}_a^a = \hat{k}_b^a =: \hat{k}^a, \quad \hat{k}_a^b = \hat{k}_b^b =: \hat{k}^b, \quad \hat{k}_a^c = \hat{k}_b^c =: \hat{k}^c, \quad \hat{p}_a^c = \hat{p}_b^c =: \hat{p}^c, \quad \hat{p}_a^b = \hat{p}_b^a = 1, \tag{2.15}$$

$$\pi_a^{at} + \pi_a^{bt} = \pi_b^{at} + \pi_b^{bt} = \sum_{j \in U} \left[F(\hat{k}^j) - \gamma r \hat{k}^j \right] + \hat{p}^c - 1 =: \hat{\pi}, \tag{2.16}$$

$$\tau_a = \tau_b = \tau^a A(\hat{k}^a, \hat{k}^b) + \tau^b \left[1 - A(\hat{k}^a, \hat{k}^b) \right] =: \hat{\tau}. \tag{2.17}$$

According to equation (2.15), MNEs a and b choose the same investment levels in countries a, b, and c and the same transfer prices. Consequently, both MNEs have the same consolidated union tax base $\hat{\pi}$ defined in (2.16) and face the same effective tax rate $\hat{\tau}$ defined in (2.17). With this information, Appendix A proves

Lemma 1. *The effective tax rate of MNEs a and b satisfies* $\hat{\tau} \in] \min\{\tau^a, \tau^b\}, (\tau^a + \tau^b)/2 [$.

Lemma 1 will be central for our short-run analysis. It states that MNE a's and MNE

b's common effective tax rate $\hat{\tau}$ is biased towards the lower national tax rate within the FA union, i.e. it is smaller than the (unweighted) average tax rate $(\tau^a + \tau^b)/2$ and therefore lies closer to the lower national tax rate in the union. The intuition is as follows: MNEs have an incentive to invest more capital in the union country with the lower national tax rate. According to the apportionment formula specified in (2.7), it is then clear that the share of the consolidated tax base allocated to the low-tax union country is higher than the share allocated to the high-tax union country. Hence, the lower national tax rate is weighted overproportionally in the calculation of the MNEs' effective tax rate given by (2.17).

Differentiating (2.10) for $i = c$ yields the first-order conditions of MNE c

$$Q'(\hat{p}_c^j) = \tau_c - \tau^c, \qquad j \in U, \tag{2.18}$$

$$F'(\hat{k}_c^j) = \frac{r(1-\gamma\tau_c)}{1-\tau_c} + \frac{(\tau^a - \tau^b)A_{cj}(\hat{k}_c^a, \hat{k}_c^b)}{1-\tau_c}(\pi_c^{at} + \pi_c^{bt}), \qquad j \in U, \tag{2.19}$$

$$F'(\hat{k}_c^c) = \frac{r(1-\gamma\tau^c)}{1-\tau^c}. \tag{2.20}$$

Equation (2.18) indicates that MNE c's profit shifting behavior differs from that of MNEs a and b in two aspects. First, even though the tax bases of MNE c's subsidiaries located in the FA union are consolidated, there is no consolidation between the headquarter in the non-union country and the subsidiaries due to the water's edge regulation. Therefore, MNE c engages in shifting between the headquarter and *both* subsidiaries. Second, compared to MNEs a and b the differential of the effective and the national tax rate enters the shifting decision of MNE c with the *reversed* sign. The reason is that MNE c's headquarter is located in the non-FA country while its subsidiaries reside in the union. MNE c's investment decision is determined by (2.19) and (2.20) and qualitatively complies with the investment decisions of MNEs a and b. Nevertheless, it is important to note that MNE c's investment *levels* in the union countries will not necessarily correspond to those of MNEs a and b, basically due to differences in profit shifting incentives and therefore in the consolidated union tax bases.

Equation (2.18) immediately implies that MNE c charges the same transfer price to its

entities in a and b as both entities are taxed by the effective tax rate τ_c. Hence

$$\hat{p}_c^a = \hat{p}_c^b =: \hat{p}_c, \qquad \pi_c^{at} + \pi_c^{bt} = \sum_{j \in U} \left[F(\hat{k}_c^j) - \gamma r \hat{k}_c^j - \hat{p}_c + 1 \right] =: \hat{\pi}_c, \tag{2.21}$$

$$\tau_c = \tau^a A(\hat{k}_c^a, \hat{k}_c^b) + \tau^b [1 - A(\hat{k}_c^a, \hat{k}_c^b)] =: \hat{\tau}_c. \tag{2.22}$$

Analogously to the proof of Lemma 1 in Appendix A, we can show

Lemma 2. *The effective tax rate of MNE c satisfies $\hat{\tau}_c \in]\min\{\tau^a, \tau^b\}, (\tau^a + \tau^b)/2[$.*

MNE c's effective tax rate is likewise biased towards the national tax rate of the low-tax union country since, analogously to MNEs a and b, it invests relatively more capital in the FA country with the lower corporate tax rate.

2.3 Short-Run Analysis: Given National Tax Rates

The main purpose of this section is to analyze changes in the MNEs' profit shifting activities triggered by the transition from SA to FA. In doing so, we will assume that national tax rates remain unaffected by the transition. This may be interpreted as a short-run analysis since governments usually need some time to adjust tax rates.

Without loss of generality, the national tax rate in the FA country a is assumed to exceed the national tax rate in the FA country b. Furthermore, we first focus on the most interesting case that the non-participating country c is a tax haven with $\tau^c < \tau^b < \tau^a$. Under SA, (2.6) then implies that both MNE a and MNE b shift profit from their headquarters to the subsidiaries in country c. Shifting is higher for MNE a than for MNE b since the tax rate differential between the countries a and c is larger than the differential between countries b and c. In Appendix B, we prove

Proposition 2.1. *Suppose $\tau^c < \tau^b < \tau^a$. Then the transition from SA to FA increases profit shifting of MNE b to country c, but reduces shifting of MNE a to country c.*

Proposition 2.1 shows that the introduction of FA does not necessarily induce a MNE headquartered in one of the FA countries to increase profit shifting to non-FA tax havens. While MNE b shifts more income to country c, profit shifting of MNE a to country c declines. The latter effect seems counterintuitive since the introduction of FA eliminates any shifting opportunity between FA countries and one might expect that the MNEs fall back on transfer pricing channels to countries outside the union. But this first intuition treats the volume of profit shifting as fixed. Instead, the extent of profit shifting is determined by the tax rate differentials, and introducing FA changes these differentials. While under SA the home country profit of MNE b is taxed at the national tax rate τ^b, this profit is taxed at the effective tax rate $\hat{\tau} > \tau^b$ under FA. The introduction of FA thus increases the difference to the tax rate in country c and, consequently, MNE b expands income shifting to country c. This argument is reversed for MNE a. Under SA it faces the national tax rate τ^a in its home country while under FA its home country profit is taxed at the effective tax rate $\hat{\tau} < \tau^a$. Hence, the tax rate difference to country c declines and MNE a shifts less profit out of the FA union.

The opposing effects on the behavior of MNEs a and b immediately raise the question how the sum of profit shifting is affected by the introduction of FA. Appendix B proves

Proposition 2.2. *Suppose $\tau^c < \tau^b < \tau^a$ and $Q''' \geq 0$. Then the transition from SA to FA reduces total profit shifting of MNEs a and b to country c.*

The rationale may best be explained by first focusing on the special case $Q''' = 0$. In this case, the marginal concealment cost is linear and, by (2.6) and (2.12), a change in the tax rate differential between the FA countries and country c leads to a proportional change in transfer prices and profit shifting. In other words, we may measure changes in profit shifting directly by changes in the tax rate differentials. Given $\tau^c < \tau^b < \tau^a$, we know from Lemma 1 that the introduction of FA decreases the tax rate differential of MNE a to country c by more than it increases the differential of MNE b to country c. The reduction in shifting of MNE a thus outweighs the increase in shifting of MNE b and total shifting of both MNEs to country c declines. This line of reasoning also

holds for convex marginal concealment cost, i.e. $Q''' > 0$. The transfer price and profit shifting are then concave in the tax rate differential and Lemma 1 still ensures that the reduction in MNE a's shifting more than offsets the shifting increase by MNE b.[8]

Proposition 2.2 hinges on the curvature of marginal concealment cost since in case of $Q''' < 0$ it cannot be excluded that the increase in shifting of MNE b dominates the reduction in shifting of MNE a. There is hardly an interpretation of Q''' that allows plausibly judging its sign. The determination of the sign is an empirical question which goes beyond the scope of our paper. However, it can be shown that for $Q''' < 0$ total shifting to country c will increase only if the effective tax rate $\hat{\tau}$ is close to the average tax rate $(\tau^a + \tau^b)/2$. Thus, the difference in the national tax rates of countries a and b has to be quite small.[9] But with nearly harmonized tax rates profit shifting would be a minor problem and incentives to form a FA union would be low. This case therefore seems of little relevance for our short-run analysis. Thus, even for $Q''' < 0$ total shifting of MNEs a and b to non-FA tax havens is likely to be reduced by FA.

Regarding the change in profit shifting of MNE c, Appendix B shows

Proposition 2.3. *Suppose $\tau^c < \tau^b < \tau^a$ and $Q''' \leq 0$. Then the transition from SA to FA reduces total profit shifting of MNE c to country c.*

Hence, we obtain nearly the same result as for shifting of MNEs a and b. The only

[8]Interestingly, Proposition 2 does not depend on the shape of the apportionment formula. The parameter θ only determines the size of the total profit shifting decline. Intuitively, the MNEs' incentive to manipulate the formula for tax purpose is stronger under a pure property formula ($\theta = 1$) than under a pure sales formula ($\theta = 0$). The reason lies in the fixed production factor which makes a pure property formula more sensitive to the MNEs' manipulation efforts than a pure sales formula. Hence, the difference between the MNEs' investment in countries a and b is the highest (lowest) for $\theta = 1$ ($\theta = 0$). Under a pure property formula, the effective tax rate of MNEs a and b is then closer to the lower tax rate in the union (τ_b) than under the pure sales formula. This argument suggest that the decline in total profit shifting is increasing in the formula weight θ and, thus, is maximized under a pure property formula.

[9]Referring to Appendix B, $Q''' < 0$ implies $H'(x_i) > 0$, i.e. profit shifting $p_i^c - 1$ is convex in x_i. Plotting this function, we see that $-dp_a^c - dp_b^c > 0$ only if $\hat{\tau} \approx (\tau^a + \tau^b)/2$ or, equivalently, $\tau^a \approx \tau^b$.

difference is that now $Q''' \leq 0$ (instead of $Q''' \geq 0$) ensures the decline in total shifting since the tax rate differentials enter the shifting decision of MNE c with the opposite sign compared to MNEs a and b. However, for $Q''' > 0$ we can again show that the result will be reversed only if the tax rates in countries a and b are almost equal. Finally, it should be noted that we will obtain qualitatively the same results if country c is not a tax haven, but has a higher tax rate than the union countries, i.e. $\tau^c > \tau^a > \tau^b$. The MNEs then shift income into the union and FA tends to intensify this shifting.

To summarize, the analysis in this section suggests that against the first intuition the transition from a pure SA tax system to a FA regime with water's edge consolidation is likely to change profit shifting *in favor* of the countries joining the FA union.

2.4 Long-Run Analysis: Tax Competition

We will now relax the assumption of fixed corporate tax rates and model a (Nash) tax competition game between the three countries. Each government chooses the tax rate that maximizes national welfare, taking as given the other countries' tax rates.

Separate Accounting

Following Nielsen et al. (2004), each government is supposed to maximize a welfare (social surplus) function containing the MNEs' profits accruing to residents of the respective country and the corporate tax revenue weighted by the marginal cost of public funds $\mu \geq 1$. Denoting the share of MNE j owned by residents of country i with $z_j^i \in [0,1]$ for $i,j \in N$, welfare of country $i \in N$ reads

$$W^i(\tau^a, \tau^b, \tau^c) = \sum_{j \in N} z_j^i \pi_j + \mu \tau^i \sum_{j \in N} \pi_j^{it}, \tag{2.23}$$

where π_j and π_j^{it} are determined by (2.2) – (2.5). Equation (2.23) is evaluated at the MNEs' profit maximizing solutions $\tilde{k}_i^j$ for $i,j \in N$ and $\tilde{p}_i^j$ for $i \in N$ and $j \in N^i$ which

depend on τ^a, τ^b and τ^c due to (2.6). Accounting for these relations, the government of country i determines its optimal tax rate by $\partial W^i(\cdot)/\partial\tau^i = 0$. Setting $z_j^i = 0$ for all $i, j \in N$ yields tax revenue maximization as a special case of welfare maximization.

To ensure tractability, we follow most previous studies and focus on a symmetric Nash equilibrium of the tax competition game with the equilibrium tax rate $\tilde{\tau} = \tau^a = \tau^b = \tau^c$. Equation (2.6) then implies $\tilde{k}_i^j = \tilde{k}$ for $i, j \in N$ and $\tilde{p}_i^j = 1$ for $i \in N$, $j \in N^i$ so that there is no profit shifting in equilibrium. Obviously, this stands in contrast to our short-run analysis and real world observations. But even though there is no profit shifting in a symmetric equilibrium, profit shifting behavior influences the countries' tax policy choice. As we will see shortly, each country has a marginal incentive to reduce its tax rate in order to attract profit and to improve its tax base. The symmetry assumption only ensures that this incentive is equal for all countries. Put differently, with the symmetry assumption we abstract from redistribution effects and focus on the efficiency implications of the countries' marginal incentives.[10]

We investigate the efficiency of international tax policy by deriving fiscal externalities that capture the influence of one country's corporate tax rate on the other countries' welfare. As, by the Nash assumption, governments do not take these cross effects into account, the tax rate will be inefficiently low (high) if the fiscal externality is positive (negative), i.e. if the tax rate of one country increases (decreases) welfare in another country. The marginal effect of the corporate tax rate in country $\ell \in N$ on welfare in country $i \in N^\ell$ is obtained by differentiating (2.23), making use of the envelope theorem and the comparative static properties reported in Appendix C, and finally

[10] We briefly discuss asymmetries in Section 5. Note that according to the first-order conditions of welfare maximization, $\sum_{j\in N} z_j^i = \bar{z} \in [0,1]$ for $i \in N$ is a necessary condition for a symmetry equilibrium. The residents of all three countries have to own the same shares in the MNEs. Examples are $z_j^i = 1/3$ for $i, j \in N$ (i.e. the residents of country $i \in N$ own one third of every MNE $j \in N$), $z_i^i = 1$ and $z_i^j = 0$ for $i \in N$ and $j \in N^i$ (i.e. MNE i is fully owned by residents of country i) and $z_j^i = 0$ for $i, j \in N$ (i.e. tax revenue maximization or the MNEs are fully owned by a fourth party).

applying the symmetry assumption. This yields

$$\frac{\partial W^i(\tau^a,\tau^b,\tau^c)}{\partial \tau^\ell}\Big|_{\tau^a=\tau^b=\tau^c=\tilde{\tau}} = \widetilde{\mathrm{ZE}} + \widetilde{\mathrm{PE}} \tag{2.24}$$

with

$$\widetilde{\mathrm{ZE}} = \sum_{j\in N} z_j^i \frac{\partial \pi_j}{\partial \tau^\ell} = \left[\gamma r\tilde{k} - F(\tilde{k})\right] \sum_{j\in N} z_j^i < 0,\ \widetilde{\mathrm{PE}} = \mu\tilde{\tau}\left[\frac{\partial \tilde{p}_i^\ell}{\partial \tau^\ell} - \frac{\partial \tilde{p}_\ell^i}{\partial \tau^\ell}\right] = \frac{2\mu\tilde{\tau}}{Q''(1)} > 0 \tag{2.25}$$

where $F(\tilde{k}) - \gamma r\tilde{k} = F(\tilde{k}) - \tilde{k}F'(\tilde{k}) + r\tilde{k}(1-\gamma)/(1-\tilde{\tau}) > 0$ according to (2.6) and the concavity of F, i.e. $F(\tilde{k}) > \tilde{k}F'(\tilde{k})$. Due to symmetry, all cross effects are identical and comprise two externalities. $\widetilde{\mathrm{ZE}}$ is a negative private income externality: If country ℓ increases its tax rate, the corporate after-tax profit will decline leading to a drop in private income for the residents in country i who own shares in the MNEs. $\widetilde{\mathrm{PE}}$ describes a profit shifting externality: If country ℓ raises its tax rate, MNEs will increase profit shifting to country i thereby improving country i's tax base. Hence, we obtain a positive fiscal externality. As the externalities point in different directions it is unclear whether international tax policy is characterized by inefficient over- or undertaxation. Nevertheless, if we reduce the governments' objective to tax revenue maximization ($z_j^i = 0$ for all $i, j \in N$), the private income externality will disappear and the profit shifting externality will render equilibrium tax rates inefficiently small. Similar results are obtained by Nielsen et al. (2004) and Sørensen (2004) in a two-country setting.[11]

[11] Nielsen et al. (2004) point out that the ambiguous externality result will hold even if governments maximize tax revenue. They find a negative fiscal externality under SA by assuming that MNEs endogenously choose the quantity of a service good which is publicly provided within the corporation and acts as a complement to capital in the production process.

Formula Apportionment with Water's Edge Consolidation

Assume that countries a and b form a FA union while country c sticks to SA. Welfare in the FA countries a and b reads

$$W^a(\tau^a,\tau^b,\tau^c) = \sum_{j\in N} z_j^a \pi_j + \mu\tau^a\Big\{2A(\hat{k}^a,\hat{k}^b)\hat{\pi} + A(\hat{k}_c^a,\hat{k}_c^b)\hat{\pi}_c\Big\}, \tag{2.26}$$

$$W^b(\tau^a,\tau^b,\tau^c) = \sum_{j\in N} z_j^b \pi_j + \mu\tau^b\Big\{2\big[1-A(\hat{k}^a,\hat{k}^b)\big]\hat{\pi} + \big[1-A(\hat{k}_c^a,\hat{k}_c^b)\big]\hat{\pi}_c\Big\}. \tag{2.27}$$

π_j, $\hat{\pi}$ and $\hat{\pi}_c$ are determined by (2.10), (2.16) and (2.21). In contrast to SA, tax revenue under FA is given by the MNE's consolidated tax base within the FA union multiplied by the relative apportionment share and the national tax rate. Since country c sticks to SA, its welfare function is structurally unaltered, therefore (2.23) applies. The welfare functions of all three countries are now evaluated at the profit maximizing solutions under FA, i.e. $\hat{k}^j$, $\hat{k}_c^j$ for $j \in N$, $\hat{p}^c$ and $\hat{p}_c$, which depend on the national tax rates according to (2.12) – (2.14) and (2.18) – (2.20). Country i takes these relations into account and sets $\partial W^i(\cdot)/\partial\tau^i = 0$.

Even with fully identical countries it is not suitable to assume a fully symmetric Nash equilibrium as only a subset of countries joins the FA union. Nevertheless, the union members are identical and, thus, we assume them to choose equal tax rates $\tau^a = \tau^b = \tau^*$ while the non-participating country sets $\tau^c = \tau^o$. This implies the following equilibrium properties: First, (2.17) and (2.22) lead to $\hat{\tau} = \hat{\tau}_c = \tau^*$, i.e. all three MNEs face the same effective tax rate which equals the union countries' equilibrium tax rate. Second, from (2.13), (2.14), (2.19) and (2.20) we obtain $\hat{k}^a = \hat{k}^b = \hat{k}_c^a = \hat{k}_c^b =: \hat{k}$ and $\hat{k}_a^c = \hat{k}_b^c = \hat{k}_c^c =: \hat{k}^c$. In each country, all MNEs invest the same amount of capital. Additionally, investment levels in countries a and b are identical. Finally, (2.7) yields $A_{ia}(\hat{k},\hat{k}) = -A_{ib}(\hat{k},\hat{k}) = \theta/4\hat{k} + (1-\theta)F'(\hat{k})/4F(\hat{k}) > 0$ for all $i \in N$ and $A(\hat{k},\hat{k}) = 1/2$. Thus, each FA country receives half of the MNEs' consolidated tax bases.

Analogously to SA, we investigate whether the equilibrium tax rates are inefficiently low or high. Since country c sticks to SA, it can be shown that the externalities between

union and non-union countries are qualitatively identical to the externalities derived under SA. New insights can be gained from an evaluation of policy efficiency within the FA union. Therefore, we derive the fiscal externalities one union member $\ell \in U$ imposes on the other union member $i \in U$ with $i \neq \ell$. Differentiating (2.26) and (2.27) and applying the envelope theorem, the comparative static properties in Appendix C and the equilibrium properties described above yields

$$\frac{\partial W^i(\tau^a, \tau^b, \tau^c)}{\partial \tau^\ell}\Big|_{\tau^c=\tau^o}^{\tau^a=\tau^b=\tau^*} = \widehat{\text{ZE}} + \widehat{\text{FE}} + \widehat{\text{IE}} + \widehat{\text{WE}} \tag{2.28}$$

with

$$\widehat{\text{ZE}} = \sum_{j \in N} z_j^i \frac{\partial \pi_j}{\partial \tau^\ell} = -(z_a^i + z_b^i)\frac{\hat{\pi}}{2} - z_c^i \frac{\hat{\pi}_c}{2} \leq 0, \tag{2.29}$$

$$\begin{aligned}\widehat{\text{FE}} &= 2\mu\tau^*\hat{\pi}A_{\ell i}(\hat{k}, \hat{k})\left[\frac{\partial \hat{k}^a}{\partial \tau^\ell} - \frac{\partial \hat{k}^b}{\partial \tau^\ell}\right] + \mu\tau^*\hat{\pi}_c A_{ci}(\hat{k}, \hat{k})\left[\frac{\partial \hat{k}_c^a}{\partial \tau^\ell} - \frac{\partial \hat{k}_c^b}{\partial \tau^\ell}\right], \\ &= -\frac{\mu\tau^*(\hat{\pi}^2 + \hat{\pi}_c^2/2)}{4(1-\tau^*)F''(\hat{k})}\left[\frac{\theta}{\hat{k}} + \frac{(1-\theta)F'(\hat{k})}{F(\hat{k})}\right]^2 > 0,\end{aligned} \tag{2.30}$$

$$\widehat{\text{IE}} = \mu\tau^*\big[F'(\hat{k}) - \gamma r\big]\left[\frac{\partial \hat{k}^a}{\partial \tau^\ell} + \frac{\partial \hat{k}^b}{\partial \tau^\ell} + \frac{1}{2}\left(\frac{\partial \hat{k}_c^a}{\partial \tau^\ell} + \frac{\partial \hat{k}_c^b}{\partial \tau^\ell}\right)\right] = \frac{3\mu\tau^* r^2(1-\gamma)^2}{2(1-\tau^*)^3 F''(\hat{k})} \leq 0, \tag{2.31}$$

$$\widehat{\text{WE}} = \mu\tau^*\left[\frac{\partial \hat{p}^c}{\partial \tau^\ell} - \frac{\partial \hat{p}_c}{\partial \tau^\ell}\right] = -\frac{\mu\tau^*}{2Q''(\hat{p}^c)} - \frac{\mu\tau^*}{2Q''(\hat{p}_c)} < 0. \tag{2.32}$$

Equation (2.28) shows that the total cross effect between union members comprises four externalities. $\widehat{\text{ZE}}$ in (2.29) is a private income externality with the same interpretation and consequences as the one derived under SA. $\widehat{\text{FE}}$ in (2.30) represents a formula externality: If a FA country increases its corporate tax rate, MNEs will reallocate capital to the foreign FA country thereby increasing the foreign apportionment share. Since this FA effect raises the tax base in the other FA country, it reflects a positive fiscal externality. It is obvious that both $\widehat{\text{ZE}}$ and $\widehat{\text{FE}}$ increase in the tax bases $\hat{\pi}$ and $\hat{\pi}_c$ which, in turn, tend to be increasing in the pure profit or, equivalently, in the importance of the fixed production factor. In addition, $\widehat{\text{FE}}$ will gain importance if investment receives a higher weight in the apportionment formula (high θ). This is driven by the existence

of the fixed production factor which ensures that the MNEs' formula manipulation incentive is the weaker the higher the sales share in the formula.[12] $\widehat{\text{IE}}$ in (2.31) reflects an investment externality: If a union country raises its corporate tax rate, the MNEs' effective tax rate will increase thereby lowering investment in both union countries. This implies a shrinking tax base in the foreign FA country and therefore imposes a negative externality. $\widehat{\text{IE}}$ tends to be important for a low deductibility parameter γ as corporate taxation then heavily distorts investment. The three externalities described so far are well-known from Nielsen et al. (2004) and Sørensen (2004).

Our analysis contributes a fourth externality $\widehat{\text{WE}}$ in (2.32) which is caused by the water's edge regulation and therefore could not be derived by previous studies that abstracted from this legislation. The underlying intuition may be described as follows: If a FA union country increases its corporate tax rate, it will trigger enlarged effective tax rates within the FA union for all MNEs. As this raises (lowers) the tax rate differential to low-tax (high-tax) non-FA countries, profit shifting from the FA union members to the non-FA countries increases (profit shifting from the non-FA countries towards the FA union declines). In consequence, the MNEs' consolidated tax bases in the union are reduced and tax revenues of all FA countries decline. The increase in the tax rate of one union country thereby reduces welfare of the other union country and establishes a negative fiscal externality motivating inefficiently high corporate tax rates. The described water's edge externality will gain importance if profit shifting cost becomes lower, indicated by a smaller Q''. MNEs then have high profit shifting incentives and corporate income tax policy creates a considerable distortion.

Although the creation of a FA union abolishes the profit shifting externality between the union member countries, our water's edge externality indicates that profit shifting to non-participating countries leads to new inefficiencies within the union. Interestingly, under FA profit shifting causes a *negative* externality and inefficient overtaxation while under SA profit shifting opportunities give rise to a *positive* externality rendering tax rates inefficiently small. To highlight the role of the water's edge externality, suppose

[12]Formally, the existence of a fixed factor implies concavity of F and, thus, $1/\hat{k} > F'(\hat{k})/F(\hat{k})$.

for the time being that governments maximize tax revenue and the capital cost is fully deductible, i.e. $z_j^i = 0$ for all $i, j \in N$ and $\gamma = 1$. The income and investment externalities then disappear and (2.28) – (2.32) yield

Proposition 2.4. *Suppose the tax competition game under FA attains a Nash equilibrium with $\tau^a = \tau^b = \tau^*$. Then τ^* may be inefficiently large even if governments maximize tax revenue and the capital cost is fully tax deductible. Overtaxation will occur, ceteris paribus, if the tax bases $\hat{\pi}$ and $\hat{\pi}_c$, the formula weight on investment θ and/or concealment cost Q'' are small.*

Focusing on tax revenue maximization and abstracting from tax deductibility of capital cost leaves two fiscal externalties under FA: the positive formula externality and the negative water's edge externality. Whether tax policy in the FA union is characterized by overtaxation or undertaxation will depend on the relative size of these two externalities. As a low concealment cost tends to create a high water's edge externality in absolute terms, and small tax bases and a low formula weight on investment motivate a small formula externality, this constellation leads to inefficiently high corporate tax rates. Note the difference between Proposition 2.4 and the result under SA. While in a SA regime overtaxation is coupled with welfare maximization, overtaxation under FA may also occur if the governments' objective function comprises corporate tax revenue only. Moreover, Proposition 2.4 complements the findings by Nielsen et al. (2004) and Sørensen (2004) who identify the investment externality as a reason for inefficiently high corporate tax rates under FA. Our analysis derives a second source of overtaxation and therefore strengthens the existing results as now overtaxation may occur even for a negligible investment externality.

Comparison of SA and FA with Water's Edge Consolidation

By comparing the fiscal externalities under the two tax regimes, we will now discuss whether a transition from SA to FA is beneficial. Unfortunately, an analytical treatment of such a comparison is considerably hampered by asymmetric equilibrium tax

rates under FA. Our analysis therefore relies on two strategies. First, some analytical insights are gained by considering a purely hypothetical situation with fully symmetric tax rates. Second, we will account for asymmetries by running numerical simulations.

For equal tax rates $\tau^* = \tau^o$ under FA, it follows $\hat{p}^c = \hat{p}_c = 1$. If we evaluate the fiscal externalities under SA and FA for the same tax rate $\tilde{\tau} = \tau^* = \tau^o =: \bar{\tau}$, (2.25) and (2.32) will imply $\widetilde{\text{PE}} = 2\mu\bar{\tau}/Q''(1) > \mu\bar{\tau}/Q''(1) = |\widehat{\text{WE}}|$. Hence, we obtain

Proposition 2.5. *For equal tax rates $\tilde{\tau} = \tau^* = \tau^o =: \bar{\tau}$, the water's edge externality under FA is smaller in absolute terms than the profit shifting externality under SA.*

Consider a situation in which country a rises its corporate tax rate by one percentage point. Then, compared to FA, profit shifting reacts twice as strongly under SA. This is true as under SA the gains from profit shifting between countries a and b (represented by $\tau^a - \tau^b$) are increased by one percentage point, while under FA the effective union tax rate increases by half a percentage point, raising the gains from profit shifting between the FA union and country c (represented by $\hat{\tau} - \tau^c$) by half a percentage point only. Hence, starting from a fully symmetric situation, we show that the profit shifting effect on country b's tax base is larger under SA. This implies that the water's edge externality falls short of the profit shifting externality in absolute terms.

On the basis of this insight, one may argue that the water's edge externality is beneficial for the union countries. Consider first the special case of revenue maximization and full deductibility. Under SA, tax rates are inefficiently small due to the profit shifting externality. Under FA, the formula externality points to inefficiently low tax rates while the water's edge externality carries the opposite sign and tends to offset the formula externality. According to Proposition 2.4, the water's edge externality may thus cause inefficiently high tax rates. But as suggested by Proposition 2.5 the resulting overtaxation will be less detrimental than the undertaxation under SA since the sum of formula and water's edge externality, if negative, falls short of the profit shifting externality under SA in absolute terms. If the sum of formula and water's edge externality is positive, the resulting undertaxation may be more pronounced than

under SA. But the increased inefficiency is then caused by a strong formula externality while the water's edge externality brings tax rates closer to the optimum.

This line of reasoning must not necessarily be true under welfare maximization and partial deductibility. Under FA, the negative income and investment externalities may already offset the formula externality. The water's edge externality then aggravates inefficient overtaxation. Moreover, accounting for asymmetric tax rates between the FA union and the outside world could alter the results. But in the following we numerically simulate our model and thereby show that the main insights and implications of Proposition 2.5 will be preserved in the general setting, at least if the union countries choose a suitable design of the apportionment formula.

Our numerical analysis uses a Cobb-Douglas production function $F(k) = u^{1-\lambda}k^{\lambda}$ with $\lambda \in]0,1[$. The parameter u represents the fixed production factor. The concealment cost is quadratic, i.e. $Q(p) = q(p-1)^2/2$ with $q > 0$. All MNEs are equally owned by the residents of the three countries so that $z_j^i = 1/3$ for all $i, j \in N$.[13] In order to make the results as reliable as possible, we try to choose realistic values for the model parameters. Similar to calibrated growth models, e.g. Ortigueira and Santos (1997), we set $\lambda = 0.33$. Following estimations by Kleven and Kreiner (2006), the marginal cost of public funds is assumed to be $\mu = 1.65$.[14] To determine r and γ, we distinguish between the deductibility of debt financing cost and depreciation allowances. Assume the MNEs finance a share γ_ρ of their activities by debt and the interest rate is ρ. In the long-run, economic depreciation is $\delta = 1$ while we assume a share γ_δ to be tax deductible. Our model will reflect these two reasons for deductibility if we set $\gamma r = \gamma_\rho \rho + \gamma_\delta$ in (2.2) and (2.3) and $(1-\gamma)r = (1-\gamma_\rho)\rho + 1 - \gamma_\delta$ in (2.4) and (2.8) – (2.10). Desai et al. (2004) show that $\gamma_\rho \approx 0.4$ and Devereux et al. (2002) estimate $\gamma_\delta \approx 0.7$. Setting $\rho = 0.05$ yields $\gamma r = 0.72$ and $(1-\gamma)r = 0.33$ or, equivalently, $r = 1.05$ and $\gamma = 0.69$. The parameters q and u are set such that the model derives an

[13] Other symmetric distributions of ownership leave the results completely unchanged.

[14] The authors estimate the marginal cost of public funds to range from 1.3 to 2.0. Our numerical results are robust against variations of μ in this interval.

equilibrium tax rate and tax revenue under SA that equal the EU-25 average in 2002. This is suitable as SA is the current tax regime in Europe. The average tax rate and corporate tax revenue in EU-25 equal 27.4% and 9.35 billion euros.[15] The calibration yields $q \approx 0.04$ and $u \approx 26.63$.

With these parameter values, we can compute the equilibrium tax rates, welfare and the values of the externalities. The results are displayed in Table 1 which can be found in the appendix. As predicted by Proposition 2.5, the water's edge externality under FA turns out to be less detrimental than the profit shifting externality under SA in all our numerical simulations. Whether the water's edge externality still plays the positive role described above, however, depends on the shape of the apportionment formula. The third row of Table 1 considers sales to be the only apportionment factor ($\theta = 0$). The water's edge externality is then not beneficial as income and investment externalities overcompensate the (small) formula externality and the (large) water's edge externality further increases the already inefficiently high tax rates. In contrast, the first row in Table 1 shows that with a pure capital formula ($\theta = 1$) income and investment externalities are too small to offset the (large) formula externality. Here, the water's edge externality is advantageous as it shifts tax rates upward towards the efficient solution. For an intermediate apportionment weight ($\theta = 0.5$), formula and water's edge externality are both of medium size in absolute terms and the sum of externalities turns out to be negative, but close to zero. Put differently, with a suitable design of the apportionment formula, namely intermediate weight on capital, the union countries can optimally exploit the positive effect of the water's edge externality.

Given the fiscal externalities, welfare in the union countries under FA is inverted U-shaped in the apportionment share θ implying that the overall welfare effect of the transition from SA to FA is most likely to be positive for an intermediate weight on capital in the apportionment formula. From a worldwide perspective we arrive at a different conclusion. Welfare in the non-participating country is monotonically decreasing in the apportionment share θ and it can be shown that the sum of all three

[15]These values are taken from the Eurostat website under http://epp.eurostat.cec.eu.int/.

countries' welfare is the highest under a pure sales formula ($\theta = 0$). Interestingly, however, it is again the water's edge externality which renders FA more favorable than SA in this case: From a worldwide perspective, we additionally have to account for externalities between FA and non-FA countries which are found to be positive and relatively large. For $\theta = 0$, it is mainly the large water's edge externality that compensates for these as well as for the positive formula externality under FA.

Finally, Table 1 also shows how the other model parameters influence the comparison between SA and FA. For this, we take the first row of Table 1 as benchmark and then conduct a sensitivity analysis with respect to the model parameters. The results are displayed in the last three rows of Table 1. They reveal that a welfare-enhancing effect of FA becomes more likely with decreasing concealment cost q, a lower share $1 - \lambda$ on the fixed production factor (or lower pure profit) and/or higher deductibility γ of capital cost. In all three cases, the main reason is again that the formula externality becomes less and the water's edge externality becomes more important.

2.5 Discussion and Possible Extensions

Our modeling strategy relied on a number of simplifying assumptions. In this section we discuss the robustness of our results when some of these assumptions are relaxed.

We suppose the volume of profit shifted depends on the misreporting of the transfer price for *one* unit of the service good traded within the firm. A slightly more general approach is employed by Sørensen (2004) and Eggert and Schjelderup (2005) who presume that shifting opportunities additionally depend on investment at the affiliate's location. Formally, profit shifted by MNE i to country j equals $(p_i^j - 1)k_i^j$ and concealment cost becomes $Q(p_i^j)k_i^j$. A possible interpretation is that the internally traded number of goods depends on the capital investment in the subsidiary, e.g. one unit of a overhead service is provided for every machine installed at the entity or the quantity of a headquarter's management service increases with the affiliate's size. This approach

to transfer pricing implies that investment abroad eases profit shifting in the sense that for given p_i^j the volume of shifting increases with k_i^j. It can be shown that all our results remain qualitatively unchanged for this more general shifting technology as investment simply amplifies the shifting induced by the distortion of transfer prices.[16]

Next, there may be concerns that our short-run results hinge on the assumption of equal deductibility parameters while empirical observations suggest considerable cross country heterogeneity in the tax base legislation. For the results of Section 3 to hold, the MNEs' effective tax rate within the union must be biased towards the tax rate of the low-tax union country (Lemmas 1 and 2). If the deductibility parameters differ across countries, these lemmas may not be true.[17] However, it is straightforward to show that deductibility has to be equal for *member countries after* the formation of the FA-union only. The deductibility parameters may differ between FA and non-FA countries and between SA and FA. In reality, many existing FA unions are characterized by a common definition of the corporate tax base, for example, local and regional business taxation in Germany and Canada. Moreover, the proposal of the European Commission (2001) emphasizes the need for a homogeneous legislation with respect to the tax base definition across EU countries. Therefore, the condition of an equal tax base definition in the FA-union is in line with the planned design of a potential European FA system.

Our analysis so far assumed that corporate income taxation follows a pure source principle. If instead the residence principle with a limited tax credit was in operation, our results might not hold.[18] Nevertheless, worldwide corporate taxation is to a large

[16]Formal proofs are contained in an earlier draft of this paper (Riedel and Runkel, 2005). Further information can be obtained from the authors upon request. The logic of our results will also hold if profit is shifted by a distortion of the MNEs' debt-equity structure. The reason is that even with this shifting technology the volume shifted depends on the tax rate differential between two countries.

[17]Intuitively, if the low-tax FA country allows fewer deductions, one might think of a situation in which the MNEs invest relatively more capital in the high-tax country and the effective tax rate under FA is biased towards the higher national tax rate within the FA union.

[18]For example, consider Propositions 2.1 and 2.2 with $\tau^c < \tau^b < \tau^a$. Under a SA system with tax crediting, MNEs a and b do not shift any profit to c since their foreign income is taxed at their

extent consistent with the source principle (e.g. Keen (1993), Haufler and Schjelderup (2000)). A related question which is consistent with the predominance of the exemption principle is whether the EU should combine the introduction of FA with the adoption of other instruments to protect its tax base against outflows to non-participating tax havens. Gérard (2006) discusses a so-called Controlled Foreign Company (CFC) rule which means that profit of an entity in a third country is included in the consolidated tax base. Such a rule resembles worldwide consolidation and preserves our short-run results as MNEs do not shift profit under FA. Alternatively, Gérard (2006) suggests the EU might reject granting exemption to profit from water's edge countries and apply the tax credit method instead. In this case, our short-run results are equally preserved: We now have to compare a SA-exemption system with a FA system where exemption is applied within the FA union and crediting to countries outside the union. Under SA-exemption, MNEs a and b shift profit to country c. Under the FA system, the union profit of MNEs a and b is again taxed at the effective tax rate. Hence, MNE b's tax rate differential to country c changes from $\tau^b - \tau^c$ to $\tau_b - \tau^b$. As $\tau_b - \tau^b$ always falls short of $\tau^a - \tau^c$, shifting of MNE b under the FA system is smaller than shifting of MNE a (!) under the SA-exemption system. In addition, MNE a reverses its direction of profit shifting as all profit earned within the FA union is taxed at rate τ_a while upon repatriation profit earned in country c is taxed at the national tax rate $\tau^a > \tau_a$. In sum, total shifting of MNEs a and b to country c declines.

Finally, we suppose fully symmetric countries within the FA union. Under this assumption our analysis shows that replacing SA by FA will increase the union countries' welfare if the apportionment formula is suitably designed. From tax competition models like e.g. Wilson (1991) it is well known that in case of country asymmetry the smaller country chooses the smaller tax rate and may benefit from tax competition.

home countries' national tax rate. Under FA with crediting, all profit of MNE a is taxed at rate τ^a. MNE a therefore still refrains from shifting. But MNE b's profit in the FA union is taxed at the effective tax rate $\tau_b > \tau^b$. As profit earned in c is taxed at τ^b, MNE b starts shifting from the union to country c. Thus, under crediting FA raises total shifting by MNEs a and b from the union to country c.

Tax harmonization is then not Pareto improving as the small country's welfare declines. Similar, in case of asymmetric countries the introduction of FA may be beneficial for some union countries but detrimental for others. The optimal formula design under homogenous countries is then different from the design which ensures a strict Pareto improvement in case of asymmetric countries. However, before investigating the conditions for a Pareto improvement in the presence of a water's edge it is important to understand the implications of country asymmetries in the absence of a water's edge. To the best of our knowledge, such an analysis is missing in the literature so far.[19] As a rigorous analysis is beyond the scope of our paper, we have to leave it for future research.

2.6 Conclusion

Many policy-makers and researchers have been skeptic about replacing SA principles by FA. One main objection concerns the necessity to restrict profit consolidation to the local area of a FA union (water's edge), since FA systems with world wide consolidation rules proved to be politically non-feasible in the past. With the water's edge regulation, profit shifting channels to countries outside the union stay open and thereby may undermine the aim of FA regarding the abolishment of income shifting and the associated fiscal externalities. Using a three-country model with MNEs, our paper shows that this fear is basically unfounded. On the contrary, for given national tax rates, introducing FA with a water's edge consolidation is likely to reduce profit shifting to tax havens outside the union. Our paper shows that MNEs tie their shifting decision to the tax rate differential between two countries and that a switch to FA reduces the effective tax rate differential between high-tax FA countries and outside tax havens by more than it increases the effective tax differential between low-tax FA countries and outside tax havens. Under tax competition, the water's edge causes a fiscal externality

[19] Asymmetric FA is considered by Anand and Sansing (2000) and Gérard (2005, 2006). But their framework is different from ours and they do not investigate the conditions for a Pareto improvement.

that distorts corporate tax rates upward. But this externality is smaller in absolute terms than the profit shifting externality under SA and tends to compensate for other externalities under FA. Therefore, the existence of a water's edge is likely to be beneficial. A numerical simulation of our model suggests that the suitable design of the apportionment formula is important for this positive role of the water's edge to evolve.

2.7 Appendix

Appendix A: Proof of Lemma 1

Consider first the case of $\tau^a > \tau^b$ so that $\min\{\tau^a, \tau^b\} = \tau^b$. With the help of $A_{ia}(\cdot) > 0 > A_{ib}(\cdot)$, (2.13) and (2.15) – (2.17) we can then write

$$F'(\hat{k}^a) - \frac{r(1-\gamma\hat{\tau})}{1-\hat{\tau}} = \frac{(\tau^a-\tau^b)A_{ia}(\cdot)\hat{\pi}}{1-\hat{\tau}} > \frac{(\tau^a-\tau^b)A_{ib}(\cdot)\hat{\pi}}{1-\hat{\tau}} = F'(\hat{k}^b) - \frac{r(1-\gamma\hat{\tau})}{1-\hat{\tau}}.$$

Hence, $F'(\hat{k}^a) > F'(\hat{k}^b)$, $\hat{k}^a < \hat{k}^b$ and $F(\hat{k}^a) < F(\hat{k}^b)$. Investment and sales shares in a become $\hat{k}^a/(\hat{k}^a + \hat{k}^b) < 1/2$ and $F(\hat{k}^a)/[F(\hat{k}^a) + F(\hat{k}^b)] < 1/2$, respectively. We obtain $A(\hat{k}^a, \hat{k}^b) < 1/2$ due to (2.7). The effective tax rate $\hat{\tau}$ from (2.17) can then be written as $\hat{\tau} = \tau^b + (\tau^a - \tau^b)A(\hat{k}^a, \hat{k}^b) < \tau^b + (\tau^a - \tau^b)/2 = (\tau^a + \tau^b)/2$. $\tau^a > \tau^b$ and $A(\cdot) > 0$ ensure $\hat{\tau} > \tau^b$. The proofs in case of $\tau^a < \tau^b$ and $\tau^a = \tau^b$ are completely analogous.

Appendix B: Proof of propositions 2.1 – 2.3

According to (2.6) and (2.12), the transfer price of MNE $i \in U$ in country c is determined by $Q'(p_i^c) - \tau^c + x_i = 0$. Setting $x_i = \tau^i$ yields the solution under SA, i.e. $p_i^c = \tilde{p}_i^c$, while for $x_i = \tau_i = \hat{\tau}$ we obtain the FA solution $p_i^c = \hat{p}^c$. Hence, the impact of the transition from SA to FA on profit shifting to country c can be characterized by totally differentiating the above condition with respect to x_i. This yields

$$H(x_i) := \frac{dp_i^c}{dx_i} = -\frac{1}{Q''(p_i^c)}, \qquad H'(x_i) := \frac{d^2p_i^c}{dx_i^2} = -\frac{Q'''(p_i^c)}{[Q''(p_i^c)]^3}. \tag{2.33}$$

$\tau^c < \tau^b < \tau^a$ implies $p_i^c - 1 < 0$. Due to (2.33), we have $dp_i^c/dx_i < 0$. For MNE b the variable x_b increases from τ^b to $\hat{\tau}$. Hence, replacing SA by FA increases MNE b's profit shifting $-(p_b^c - 1)$ to country c. In contrast, for MNE a the variable x_a is reduced from τ^a to $\hat{\tau}$ so that its shifting $-(p_a^c - 1)$ to country c falls. This proves Proposition 2.1.

To prove Proposition 2.2, write the change in total profit shifting of MNEs a and b as

$$-dp_a^c - dp_b^c = -H(\tau^a)dx_a - H(\tau^b)dx_b. \tag{2.34}$$

$Q'' > 0$, $Q''' \geq 0$ and (2.33) imply $H'(x_i) \leq 0$. It follows $H(\tau^a) \leq H(\tau^b) < 0$. Since $\hat{\tau} \in]\tau^b, (\tau^a + \tau^b)/2[$ due to Lemma 1, we have $dx_b = \hat{\tau} - \tau^b < -(\hat{\tau} - \tau^a) = -dx_a$. Using this in (2.34) yields $-dp_a^c - dp_b^c < 0$, i.e. total shifting $-(p_a^c - 1) - (p_b^c - 1)$ to c falls.

Profit shifting of MNE c is determined by $Q'(p_c^i) - x^i + \tau^c = 0$ with $x^i = \tau^i$ under SA and $x^i = \tau_c$ under FA, $i \in U$. Proposition 2.3 immediately follows by the same arguments as for Propositions 2.1 and 2.2, if we additionally take into account that the tax rate differential $x^i - \tau^c$ enters MNE c's shifting decision with the opposite sign.

Appendix C: Comparative Statics under SA and FA

Profit maximization of MNE $i \in N$ under SA is characterized by (2.6). Totally differentiating and then applying the symmetry assumption yields, inter alia,

$$\frac{\partial \tilde{k}_i^j}{\partial \tau^\ell} = 0, \qquad j, \ell \in N, \qquad j \neq \ell, \tag{2.35}$$

$$\frac{\partial \tilde{p}_i^j}{\partial \tau^i} = -\frac{\partial \tilde{p}_i^j}{\partial \tau^j} = -\frac{1}{Q''(1)} < 0, \qquad j \in N^i, \tag{2.36}$$

$$\frac{\partial \tilde{p}_i^j}{\partial \tau^\ell} = 0, \qquad j, \ell \in N^i, \qquad j \neq \ell. \tag{2.37}$$

These expressions are true for all MNE $i \in N$ and are used to derive (2.24) and (2.25).

Under FA, the profit maximum of MNEs a and b is determined by (2.12) – (2.14). Totally differentiating and then applying the equilibrium assumption yields for $i, j \in U$

$$\frac{\partial \hat{k}^i}{\partial \tau^i} = \frac{r(1-\gamma)}{2(1-\tau^*)^2 F''(\hat{k})} + \frac{\hat{\pi}}{4(1-\tau^*)F''(\hat{k})}\left[\frac{\theta}{\hat{k}} + \frac{(1-\theta)F'(\hat{k})}{F(\hat{k})}\right] < 0, \tag{2.38}$$

$$\frac{\partial \hat{k}^i}{\partial \tau^j} = \frac{r(1-\gamma)}{2(1-\tau^*)^2 F''(\hat{k})} - \frac{\hat{\pi}}{4(1-\tau^*)F''(\hat{k})}\left[\frac{\theta}{\hat{k}} + \frac{(1-\theta)F'(\hat{k})}{F(\hat{k})}\right] \gtreqless 0, \quad i \neq j, \tag{2.39}$$

$$\frac{\partial \hat{k}^c}{\partial \tau^i} = 0, \qquad \frac{\partial \hat{p}^c}{\partial \tau^i} = -\frac{1}{2Q''(\hat{p}^c)} < 0. \tag{2.40}$$

The solution of MNE c's profit maximization is determined by (2.18) – (2.20). The impact of the union tax rates on MNE c's investment $\hat{k}_c^i$, $i \in U$, is the same as in (2.38) and (2.39) except for replacing $\hat{\pi}$ by $\hat{\pi}_c$. We also obtain $\partial \hat{k}_c^c / \partial \tau^i = 0$ and $\partial \hat{p}_c / \partial \tau^i = 1/[2Q''(\hat{p}_c)] > 0$ for $i \in U$. These results are used to derive (2.28) – (2.32).

Table 1: Numerical Simulations

Parameter Values	**Separate Accounting**					**Formula Apportionment**								
	$\tilde{\tau}$	$\widetilde{W}$	$\widetilde{\text{ZE}}$	$\widetilde{\text{PE}}$	$\widetilde{\sum}$	τ^*	τ^o	W^*	W^o	$\widehat{\text{ZE}}$	$\widehat{\text{FE}}$	$\widehat{\text{IE}}$	$\widehat{\text{WE}}$	$\widehat{\sum}$
benchmark: $\theta = 1$, $r = 1.05, u = 26.63, \gamma = 0.69$, $\lambda = 0.33, \mu = 1.65, q = 0.04$	0.274	36.22	−11.36	21.46	10.10	0.251	0.265	35.85	35.76	−11.62	35.25	−0.84	−9.80	12.99
intermediate formula weight on investment: $\theta = 1 \rightarrow \theta = 0.5$	0.274	36.22	−11.36	21.46	10.10	0.385	0.320	37.18	38.96	−10.16	23.17	−1.91	−15.04	−3.93
no formula weight on investment: $\theta = 1 \rightarrow \theta = 0$	0.274	36.22	−11.36	21.46	10.10	0.535	0.381	36.28	44.42	−8.36	7.64	−4.46	−20.91	−26.08
lower concealment cost: $q = 0.04 \rightarrow q = 0.03$	0.200	34.68	−11.46	22.05	10.59	0.239	0.217	35.18	35.60	−10.92	29.21	−0.77	−13.15	4.35
less important fixed factor: $\lambda = 0.33 \rightarrow \lambda = 0.4$	0.237	29.63	−9.86	18.53	8.67	0.266	0.249	29.95	30.17	−9.55	26.15	−1.15	−10.40	5.05
higher deductibility: $\gamma = 0.686 \rightarrow \gamma = 0.95$	0.261	35.51	−10.33	20.37	10.04	0.274	0.266	35.70	35.80	−10.21	29.55	−0.03	−10.73	8.59

($\widetilde{W}$ = welfare of a country under SA (in billion euro), W^* = welfare of a union country under FA (in billion euro), W^o = welfare of a non-union country under FA (in billion euro), $\widetilde{\sum}$ = sum of externalities under SA, $\widehat{\sum}$ = sum of externalities under FA)

Chapter 3

Taxing Multinationals under Union Wage Bargaining

3.1 Introduction

With increasing economic integration the importance of multinational entities (MNEs) has steadily grown for the last decades. Today, more than one third of international trade flows through intra-firm channels (OECD (2002)). The outward FDI stock of companies headquartered in the OECD has sextupled since the early 1990ies (OECD Statistics (2007)). Hence, it is not surprising that the public finance literature has extensively studied the interaction between corporate taxation and the behavior of MNEs. Key results are that a multinational's investment and profit declaration decision depends on the prevailing corporate tax rates. MNEs are shown to reduce their overall tax burden by relocating investment to low-tax countries and shifting pre-tax profits through intra-firm channels (see for example Hines (1999), Devereux (2006)). In consequence, governments compete to attract the mobile corporate tax base which results in inefficiently low equilibrium tax rates (e.g. Mintz (1999)).

Although the interaction between corporate taxation and MNEs is generally well studied, the literature has so far neglected that taxation may impact on the wage bargaining process between MNEs and labor unions. This analysis is especially relevant since labor markets in the OECD are characterized by substantial market imperfections. It is well known that the system of wage formation is determined by unionization in most OECD countries (see e.g. Nickell et al. (2005)). Union coverage especially tends to be high and stable in Continental Europe and Scandinavia. Additionally, MNEs have become strong players in the markets for factor demand. Thus, a substantial fraction of the workforce within the OECD is employed by MNEs (OECD (2005)), in the manufacturing industry, for example, almost every second worker.

The paper's central aim is to investigate how corporate taxes affect wage bargaining between MNEs and national labor unions. Departing from these results, we will derive implications for the tax competition game. We develop a theoretical model with two symmetric countries. Each country hosts the affiliate of a representative MNE. The MNE produces a homogeneous good using labor as input factor. We assume that the

corporation is led by a central management which maximizes the MNE's total after-tax profit. Our model considers a three stage game in which labor demand, workers' wages, transfer prices for internally traded goods and corporate tax rates are endogenously determined. The structure of the game is as follows: At the first stage, the governments simultaneously choose their corporate tax rates ignoring the effect of their decisions on the social welfare of the other country. At the second stage, the representative MNE and local labor unions bargain over the wage level in a standard right-to-manage setting. Therefore at the third stage, the MNE sets labor demand and the transfer price. The model is solved by backward induction.

The third stage of the analysis delivers the standard results for the MNE's corporate labor demand and transfer pricing decision. Our model's innovation is the introduction of a wage bargaining game between the MNE and national labor unions at the second stage. Contrary to the first intuition, we find that increases in the local corporate tax rate *raise* the wage level bargained for the MNE's domestic workers. This result constitutes from two effects. Obviously, increasing the corporate tax surges the MNE's corporate tax burden and therefore directly reduces the multinational's after-tax profit. Consequently, the wages bargained for local workers tend to decline. However, in addition we find that increasing the corporate tax rate reduces the MNE's profit sensitivity with respect to the domestic wage level. This is because - in line with prevailing legal regulations - we model payroll cost to be deductible from the corporate tax base. The value of this payroll deduction rises with the domestic corporate tax rate. Hence, the higher the corporate tax rate the less sensitive the MNE's profit reacts to changes in the local wage rate since higher payroll cost become less detrimental. In consequence, the local workers' wage rate tends to increase. Our analysis proves that the latter effect globally exceeds the former and hence, local wages rise in the corporate tax rate.

In contrast, we show that corporate tax increases reduce the wage level bargained at the foreign affiliate. Since foreign wages are deductible from the foreign tax base only, an increase in the domestic corporate tax does not impact on the MNE's profit sensitivity with respect to the *foreign* wage level. However it lowers the MNE's after-

tax profit and thus reduces wages bargained at the foreign affiliate.

At the first stage we consider a tax competition game in which each country maximizes a social welfare function comprising tax revenues and residents' wage income. We obtain the well-known positive profit shifting externality reflecting that a rise in the domestic corporate tax rate induces the MNE to shift profits to the foreign country. Since this directly increases the foreign corporate tax base, the domestic tax policy imposes a positive fiscal externality on the foreign country. In addition, we derive an ambiguous wage income externality established by the endogenous remuneration level. On the one hand, a rise in the domestic corporate tax rate lowers foreign workers' wages. The wage decline reduces the MNE's foreign payroll cost thereby increasing the affiliate's pre-tax profit and the foreign corporate tax base. On the other hand, the reduction in the foreign wage level translates in a direct decline of foreign residents' utility from wage income. The sign of the wage income externality depends on the relative size of these effects. Ceteris paribus, low marginal cost of public funds and low labor demand sensitivity to wage changes lead to a negative fiscal externality.

We test the theoretically predicted corporate tax effects on workers' wages employing a panel dataset of subsidiaries located in the countries of EU 15. Our data comprises the years 1995 to 2005 and enables a link between the accounting information for subsidiaries and their direct and ultimate parent companies. Estimating a fixed effect model, we find corporate tax effects on workers' wages in line with the predictions of our model.

Our investigation so far presumed that MNEs are taxed according to separate accounting (SA) principles. SA is currently employed for the taxation of multinational corporations and prescribes profit to be taxed in the country where it accrues. In an extension to our theoretical model, we investigate how the interaction between corporate taxation and union wage bargaining is affected by a switch to a tax system following formula apportionment (FA) regulations. Taxation according to FA is currently employed at the subnational level in the US, Canada and Germany. According

to its legislation, profits of multi-jurisdictional corporations are consolidated and apportioned to the jurisdictions by a formula measuring the MNE's relative activity. The last years observed increased scientific interest in a comparison of SA and FA since the European Commission proposed to switch to FA within European borders in 2001 (European Commission (2001)). Our analysis shows that the impact of corporate taxation on wage bargaining between local labor unions and MNEs is fundamentally altered by the introduction of FA. Explicitly, in contrast to SA, increases in the corporate tax rate are likely to reduce the domestic wage level while they are likely to increase foreign workers' wages. A tax competition game under FA derives a positive fiscal externality established by the endogenous wage level.

Our paper touches several strands of the theoretical and empirical economic literature. Our theoretical model is closely related to the literature on international tax coordination. Fuest and Huber (1999) investigate capital and labor taxation in open economies with union wage bargaining. In line with our results, they find that corporate tax rates may be inefficiently high or low. Since they assume nationally operating firms and focus on distortive capital and labor taxation, they cannot derive the results presented in this paper. A similar setting was analysed by Koskela and Schöb (2002). Moreover, our paper relates to Lejour and Verbon (1996) who model tax competition assuming that countries finance a social insurance system by a wage tax and corporations bargain over workers' wages with a monopoly union. They show that foreign workers benefit from domestic tax increases while foreign capital owners are negatively affected. Our analysis contrasts their results since we find that increases in the domestic tax decrease foreign workers wages and increases foreign corporate profits.

Our paper might also be connected to a small literature that explicitly investigates how union wage bargaining is affected by the presence of MNEs. Zhao (1998) models a MNE's subsidiary that is located in a unionized market and shows that with decentralized wage bargaining and centralized transfer pricing choice, the MNE uses the transfer price to decrease the pre-tax profit at the subsidiary location. Leahy and Montagna (2000) investigate the welfare effects of FDI in an economy with union wage

bargaining discriminating for different degrees of centralization in union wage setting. Naylor and Santoni (2003) examine a similar question concentrating on the impact of the union bargaining power on corporate FDI decisions. However, all papers in this field abstract from taxation aspects and hence, could not derive corporate tax effects on the wage bargaining outcome.

Additionally, we contribute to the literature on multiregional corporations which compares taxation systems based on SA and FA principles respectively (see e.g. McLure (1980), Gordon and Wilson (1986)). Existing papers assume perfectly competitive labor markets and are not concerned with corporate tax effects in the presence of labor market imperfections due to union wage bargaining. The wage effects found in these papers thus fundamentally differ from our results. Moreover, our model replicates the standard findings derived by the literature on tax competition under SA and FA (see e.g. Nielsen et al. (2004), Kind et al. (2005) and Riedel and Runkel (2006)) but additionally contributes new fiscal externalities under SA and FA established by the introduction of wage bargaining. Recently, Eichner and Runkel (2006) brought forward a paper closely related to our work. They investigate corporate taxation under SA and FA with a minimum wage. While they do not derive additional externalities due to the labor market imperfection under SA, in line with our results they find that the labor market imperfection enforces the race-to-the bottom in corporate tax rates under FA.

The empirical literature on MNEs has so far been silent on possible wage effects of corporate taxation. There exists a large literature which investigates the causal impact of corporate tax rates on the investment and employment decision of multi-jurisdictional corporations (e.g. Hines (1996) and (1999)). Our empirical section is most closely related to Budd et al. (2005) who investigate how corporate profit at the subsidiary and parent location affects the subsidiary's workers' wages. They find evidence that own as well as foreign parent profit positively influences the remuneration level.

The remainder of this chapter is structured as follows: in section 2 we develop the

theoretical model. Section 3 presents the results of our empirical analysis. In section 4 we consider possible extension to our model, section 5 discusses policy implications and concludes.

3.2 Theoretical Model

We consider a simple model with two symmetric countries a and b which have the same size, production technology and labor supply. Each country hosts the affiliate of a representative MNE. The MNE produces a homogeneous good using labor as input factor. The labor demand of the MNE in country i, $i \in \{a, b\}$ is denoted by L_i. The workers' remuneration in country i is symbolized by w_i. Domestic labor supply N is assumed to be fixed as workers are immobile between the two countries. The MNE earns an after-tax profit

$$\Pi \;=\; \sum_i \Pi_{Ti} - \sum_i T_i - \sum_i \theta(p_i - 1), \qquad i, j \in \{a, b\} \tag{3.1}$$

with Π_{Ti} and T_i describing pre-tax profits and tax payments in country i; p_i represents the transfer price for an internally traded good delivered from affiliate i to affiliate j with $i, j \in \{a, b\}$ and $i \neq j$. Formally the affiliates' pre-tax profit calculates

$$\Pi_{Ti} \;=\; F(L_i) - w_i L_i + (p_i - 1) - p_j, \quad i, j \in \{a, b\}, \quad i \neq j \tag{3.2}$$

The MNE's output is given by the production function $F(L_i)$ which is identical across countries and has the usual properties $F'(L_i) > 0$ and $F''(L_i) < 0$. As the MNE's workers at location i receive a remuneration w_i and provide one unit labor L_i, MNE i's payroll cost at location i calculates $w_i L_i$. Additionally, we assume that each affiliate i delivers one good or service to the foreign affiliate in the country j for which the true price is normalized to 1. Since the true price is not observable to tax authorities, the MNE might attach a transfer price p_i which deviates from the true price to shift profits between its affiliates. To derive an interior solution we assume transfer pricing to entail convex concealment costs with the following properties

$$\theta(p_i = 1) = 0, \quad sign(\theta') = sign\,(p_i - 1)\,, \quad \theta''\,(p_i - 1) > 0 \tag{3.3}$$

The concealment costs are not deductible from the corporate tax base. This corresponds to a perception of the costs as penalty fees which an MNE has to pay if the tax authority detects profit shifting activities.[1]

In the theoretical part of our paper we investigate a three stage game in which labor demand, wages, transfer prices and tax rates are endogenously determined. The structure of the game is as follows: At the first stage, the governments of countries a and b simultaneously choose their corporate tax rates ignoring the effect of their decisions on the tax base of the other country. At the second stage, the representative MNE and national labor unions bargain over the wage level in a standard right-to-manage setting. Finally at the third stage, the MNE decides about labor demand and sets the intra-firm transfer prices for the goods traded. The model will be solved by backward induction.

3.2.1 Labor Demand and Transfer Prices

Under SA profit is taxed in the country where it is earned. Therefore the multinational's tax payments in country i are $T_i = t_i \Pi_{Ti}$, where t_i is the corporate tax rate in country $i \in \{a, b\}$. The MNE maximizes its total after-tax profit by choosing the optimal values for L_i and p_i, which yields the following first order conditions

$$t_j - t_i = \theta'(p_i - 1), \tag{3.4}$$

$$F'(L_i) = w_i. \tag{3.5}$$

for $i, j \in \{a, b\}$. The MNE's optimal transfer pricing decision is determined by equation (3.4). If $t_j > t_i$ the marginal concealment cost θ' is positive and therefore the MNE overstates its transfer price $p_i > 1$ to shift profits from the foreign affiliate in country

[1] In contrast, if the MNE spends effort to refrain the tax authority from observing its profit shifting activities, it might declare these expenditures (e.g. lawyer fees) as administration costs and may deduct them from the corporate tax base. There is no unique modeling strategy in the economic literature, for a discussion of the approaches see Haufler and Schjelderup (2000). Nevertheless our results would not qualitatively change if we assumed concealment cost to be tax deductible.

j to the affiliate in country i. If $t_i > t_j$ the transfer price is understated and profits are shifted to the affiliate in country j. Moreover, we modeled the corporate tax to be a pure profit tax and therefore labor demand is not distorted by corporate taxation under SA (see equation (3.5)).

3.2.2 Wage Bargaining

In the following, we investigate the effects of corporate taxation on wage bargaining between the MNE and a national labor union in a standard right-to-manage bargaining model. Despite the growing importance of MNEs in the last two decades, labor unions did not adjust to this new development but to a large extend remained organized at the subnational level. Transnational union cooperation is restricted to few individual examples (Gordon and Turner (2000)). Therefore, we model the interaction between a MNE and national labor unions. One may show that this fragmentation of workers into local unions is inefficient from a workers' perspective since each union exerts an externality on foreign workers' wages.[2]

The workers' collective utility is assumed not to depend on the wage and employment level at the foreign affiliate and, therefore, local trade unions follow the objective to maximize local wage rents and local employment. The MNE, in contrast, is assumed to be led by a central management that acts as an entity in the bargaining process. Therefore, the MNE is assumed to maximize overall after-tax profit.[3] Formally, the

[2]There are two classic arguments for the merger of labor unions in an industry context. First, an industry-wide labor union is able to bargain for higher wages since its threat-point payoffs are larger. Second, decentralized unions in oligopolistic markets do not internalize the positive impact of their wage rate increases on other firms employment situation (Davidson (1988)). Note that these arguments refer to a setting in which decentralized labor unions bargain with different corporations for workers' wages. In our setting decentralized labor unions bargain with one MNE over workers' wages and the source of inefficiency is therefore different from previous work.

[3]One unique implication of centralized corporate wage bargaining is that wages bargained in one country depend on profit earned at foreign affiliates. Since Budd et al. (2005) find empirical support for this kind of international rent sharing between multinational subsidiaries, we consider our modeling

MNE and the local labor union solve the following problem by choosing the optimal wage level w_i

$$\max_{w_i}[\Pi(w_a, w_b)]^{1-\delta}[(w_i - \overline{w})L_i]^{\delta}, \quad i \in \{a, b\} \tag{3.6}$$

subject to $L_i < N$ and $w_i > \overline{w}$; $\Pi(w_a, w_b)$ represents the corporation's profit, w_i is the remuneration level bargained[4], $\overline{w}$ symbolizes the reservation (or minimum) wage, δ the union's bargaining power and N describes the overall national work force, all three assumed to be equal across the two countries. Last, $L_i(w_i)$ defines the MNE's labor demand function in country i. In equilibrium (along the Pareto frontier with respect to contracts between the union and the MNE if we explicitly modeled the bargaining game), it holds $\partial U_i/\partial w_i > 0$ whereas $U_i = [(w_i - \overline{w})L_i]$ represents union i's utility. The reasoning is very simple. Since the corporate profit is declining in the wage rate, the MNE always desires lower remuneration. If the union also preferred a lower wage, the bargaining parties could improve their joint surplus by lowering the wage to zero. Thus, it holds

$$\frac{\partial U_i}{\partial w_i} = L_i + (w_i - \overline{w})\frac{\partial L_i}{\partial w_i} = L_i\left(1 + \frac{(w_i - \overline{w})}{L_i}\frac{\partial L_i}{\partial w_i}\right) = L_i(1 + \epsilon_i) > 0 \tag{3.7}$$

with ϵ_i is symbolizing the labor demand sensitivity with respect to the multinationals' workers wage *rent*. Taking logs and differentiating equation (3.6) with respect to w_i, $i \in \{a, b\}$, gives the following first order conditions

$$\Phi_a = \frac{\delta}{L_a}\frac{\partial L_a}{\partial w_a} + \frac{\delta}{w_a - \overline{w}} + \frac{1-\delta}{\Pi}\frac{\partial \Pi}{\partial w_a} = 0, \tag{3.8}$$

$$\Phi_b = \frac{\delta}{L_b}\frac{\partial L_b}{\partial w_b} + \frac{\delta}{w_b - \overline{w}} + \frac{1-\delta}{\Pi}\frac{\partial \Pi}{\partial w_b} = 0. \tag{3.9}$$

To derive the corporate tax effect on the bargained wage level, we apply the implicit function theorem to equations (3.8) and (3.9).

$$\frac{dw_i}{dt_i} = \frac{-\partial\Phi_i/\partial t_i \cdot \partial\Phi_j/\partial w_j + \partial\Phi_j/\partial t_i \cdot \partial\Phi_i/\partial w_j}{\partial\Phi_i/\partial w_i \cdot \partial\Phi_j/\partial w_j - \partial\Phi_i/\partial w_j \cdot \partial\Phi_j/\partial w_i} > 0 \tag{3.10}$$

$$\frac{dw_i}{dt_j} = \frac{-\partial\Phi_i/\partial t_j \cdot \partial\Phi_j/\partial w_j + \partial\Phi_j/\partial t_j \cdot \partial\Phi_i/\partial w_j}{\partial\Phi_i/\partial w_i \cdot \partial\Phi_j/\partial w_j - \partial\Phi_i/\partial w_j \cdot \partial\Phi_j/\partial w_i} < 0 \tag{3.11}$$

strategy to be valid.

[4]The assumption of a linear objective function is for analytical and expository convenience. Our results do not change if we assumed the union's utility to be a concave function of the wage level w_i.

with $i, j \in \{a, b\}$ and $i \neq j$. This directly leads to the following proposition.

Proposition 3.1. *Under SA, the local corporate tax rate has a positive (negative) effect on the wages bargained at the local (foreign) affiliate.*

Proof: For the objective function (3.6) to be concave, the second derivative with respect to the wage rate must be negative $\partial\Phi_i/\partial w_i < 0$ and $\partial\Phi_j/\partial w_j < 0$, with $i \in \{a, b\}$. Moreover, it can be shown that $\partial\Phi_i/\partial w_j = \partial\Phi_j/\partial w_i = -(1-\delta)/\Pi^2 \cdot \partial\Pi/\partial w_i \cdot \partial\Pi/\partial w_j < 0$ for $i \in \{a, b\}$ and $i \neq j$. Since our analysis focuses on stable equilibria only, the determinant of the equation system is assumed to be positive, $\partial\Phi_i/\partial w_i \cdot \partial\Phi_j/\partial w_j - \partial\Phi_i/\partial w_j \cdot \partial\Phi_j/\partial w_i > 0$ for $i \in \{a, b\}$ and $i \neq j$.[5] Thus, the signs of equations (3.10) and (3.11) depend on the sign of the numerator, explicitly on $\partial\Phi_i/\partial t_i$ and $\partial\Phi_i/\partial t_j$. Taking into account that it follows from equations (3.1) and (3.5) that

$$\frac{\partial L_i}{\partial w_i} = \frac{1}{F''(L_i)}, \quad \frac{\partial L_i}{\partial w_j} = 0, \quad \frac{\partial \Pi}{\partial w_i} = -(1-t_i)L_i \tag{3.12}$$

$$\frac{\partial L_i}{\partial t_i} = \frac{\partial L_i}{\partial t_j} = \frac{\partial^2 L_i}{\partial w_i \partial t_i} = \frac{\partial^2 L_i}{\partial w_i \partial t_j} = 0, \quad \frac{\partial^2 \Pi}{\partial w_i \partial t_i} = L_i, \quad \frac{\partial^2 \Pi}{\partial w_i \partial t_j} = 0 \tag{3.13}$$

for $i, j \in \{a, b\}$ and $i \neq j$, we find

$$\frac{\partial \Phi_i}{\partial t_i} = \frac{(1-\delta)L_i(1-t_j)\Pi_{Tj}}{\Pi^2} > 0 \tag{3.14}$$

$$\frac{\partial \Phi_i}{\partial t_j} = -\frac{(1-\delta)L_i(1-t_i)\Pi_{Tj}}{\Pi^2} < 0 \tag{3.15}$$

with $i, j \in \{a, b\}$, $i \neq j$. Hence, $\partial w_i/\partial t_i > 0$ and $\partial w_i/\partial t_j < 0$ ■

A rise in the domestic corporate tax rate exerts two effects on the local wage bargaining game. First, a higher tax rate enlarges the MNE's tax bill and therefore leads to a decline of the MNE's after-tax profit. This induces lower wages being bargained at the domestic affiliate. Second, an increase in the corporate tax rate lowers the MNE's profit sensitivity to local workers' wages. As payroll costs are deductible from the corporate

[5] See for example Hammond et al. (2005).

tax base, a corporate tax rise increases the value of this deduction and therefore makes corporate profits less vulnerable to enlarged payroll cost. This effect tends to raise the wage level bargained at home. According to equation (3.14) the latter effect prevails and a tax increase raises wage level bargained at the domestic affiliate.

In contrast, a corporate tax increase leads to a reduction in the wage rate bargained at the foreign country. Since payroll costs are only deductible from the domestic corporate tax base, tax increases do not exhibit any effect on the profit sensitivity with respect to *foreign* wages. The foreign wage bargaining process is only affected by the reduction in after-tax profits. Thus, the wage level of the foreign affiliate's workers decline.[6] Concluding, it can be said that increases in the domestic corporate tax lead to a 'redistribution' of wage income from the foreign affiliate's workers towards the domestic workers.

3.2.3 Tax Competition

At the first stage, we investigate a tax competition game between the countries' governments which are assumed to levy a corporate income tax on the MNE's profits. Each government maximizes a social welfare function comprising tax revenues multiplied by the marginal cost of public funds (ρ) and the residents' wage income. For simplicity reasons, we assume the MNE to be owned by a third party not being resident in countries a and b.[7] Under SA all profits earned are subject to corporate taxation in the country where they accrue and the social welfare function is defined

$$SW_i = \rho t_i \widetilde{\Pi}_{Ti} + (\widetilde{w}_i - \overline{w})\widetilde{L}_i + \overline{w}N \tag{3.16}$$

[6]It shall be pointed out that the strategic responses to wage changes in the other country amplify the described wage effects. As shown above, a rise in the corporation tax increases the domestic wage rate. This wage increase lowers the MNE's after-tax profit and hence reduces the wage rate bargained at the foreign location. Equivalently, the corporate tax increase directly reduces the wage rate bargained at the foreign country, which induces domestic wages to increase.

[7]This assumption will not qualitatively change our results.

with $\widetilde{L}_i, \widetilde{w}_i, \widetilde{w}_j,\ \widetilde{p}_i,\ \widetilde{p}_j$ and $\widetilde{\Pi}_{Ti} = \widetilde{\Pi}_{Ti}(\widetilde{L}_i, \widetilde{w}_i, \widetilde{p}_i, \widetilde{p}_j)$ representing the optimal values chosen at the second and third stage according to equations (3.4), (3.5) and (3.8) for $i, j \in \{a, b\}$ and $i \neq j$. Each government is assumed to maximize the social welfare function given by equation (3.16) not taking into account the effects of its tax policy on the foreign country's social welfare. Therefore it holds

$$\frac{\partial SW_i(t_a, t_b)}{\partial t_i} = 0 \tag{3.17}$$

The MNE's affiliates are structurally identical across countries, additionally the workforce potential N and the reservation wage $\overline{w}$ are presumed to be equal in a and b. Therefore, we focus on the symmetric Nash equilibrium with equal tax rates $\widetilde{t} = t_a = t_b$. Equilibrium tax revenue in country i can be derived

$$SW_i(\tilde{t}, \tilde{t}) =: SW(\tilde{t}) \tag{3.18}$$

Our analysis investigates whether the countries choose inefficiently high or low tax rates in equilibrium. Therefore we determine the impact of a coordinated increase in the common tax rate $\tilde{t}$ on the social welfare of the countries. Differentiating (3.18) yields

$$\frac{dSW(\widetilde{t})}{d\widetilde{t}} = \frac{\partial SW_i(t_a, t_b)}{\partial t_i}\Big|_{t_a=t_b=t} + \frac{\partial SW_i(t_a, t_b)}{\partial t_j}\Big|_{t_a=t_b=t} \tag{3.19}$$

whereas $\partial SW_i/\partial t_i = 0$ according to equation (3.17) and $\partial SW_i/\partial t_j$ represents the fiscal externality on the other country's welfare, with $i, j \in \{a, b\}$ and $i \neq j$.

$$\frac{\partial SW_i}{\partial t_j} = \rho t_i \left\{ \frac{\partial \widetilde{\Pi}_{Ti}}{\partial \widetilde{p}_i}\frac{\partial \widetilde{p}_i}{\partial t_j} + \frac{\partial \widetilde{\Pi}_{Ti}}{\partial \widetilde{p}_j}\frac{\partial \widetilde{p}_j}{\partial t_j} + \frac{\partial \widetilde{\Pi}_{Ti}}{\partial \widetilde{L}_i}\left(\frac{\partial \widetilde{L}_i}{\partial t_j} + \frac{\partial \widetilde{L}_i}{\partial \widetilde{w}_i}\frac{\partial \widetilde{w}_i}{\partial t_j}\right) + \frac{\partial \widetilde{\Pi}_{Ti}}{\partial \widetilde{w}_i}\frac{\partial \widetilde{w}_i}{\partial t_j} \right\} + \widetilde{L}_i\frac{\partial \widetilde{w}_i}{\partial t_j} + (\widetilde{w}_i - \overline{w})\left(\frac{\partial \widetilde{L}_i}{\partial t_j} + \frac{\partial \widetilde{L}_i}{\partial \widetilde{w}_i}\frac{\partial \widetilde{w}_i}{\partial t_j}\right) \tag{3.20}$$

for $j, i \in \{a, b\}$ and $i \neq j$. Since we investigate a symmetric equilibrium of the tax competition game, we evaluate equation (3.20) for equal corporate tax rates $t_a = t_b = \widetilde{t}$. It follows from equations (3.4) and (3.5)

$$\frac{\partial \widetilde{L}_i}{\partial t_j}\Big|_{t_a=t_b=t} = 0,\ \frac{\partial \widetilde{p}_i}{\partial t_j}\Big|_{t_a=t_b=t} = -\frac{\partial \widetilde{p}_j}{\partial t_j}\Big|_{t_a=t_b=t} = \frac{1}{\theta''(1)} > 0,\ \frac{\partial \widetilde{\Pi}_{Ti}}{\partial L_i} = F'(L_i) - w_i = 0 \tag{3.21}$$

for $i, j \in \{a, b\}$ and $i \neq j$. Moreover, under symmetry it holds that $L_a = L_b = \widetilde{L}$, $w_a = w_b = \widetilde{w}$, $p_a = p_b = 1$ and $\epsilon_a = \epsilon_b = \widetilde{\epsilon}$. Consequently, equation (3.20) can be simplified to

$$\frac{\partial SW_i}{\partial t_j}\Big|_{t_a=t_b=t} = \frac{2\rho\,\widetilde{t}}{\theta''(1)} + \left\{1 + \widetilde{\epsilon} - \rho\,\widetilde{t}\right\}\widetilde{L}\cdot\frac{\partial \widetilde{w}_i}{\partial t_j}\Big|_{t_a=t_b=t} \tag{3.22}$$

This leads to the following proposition.

Proposition 3.2. *Suppose the tax competition game under SA attains a symmetric equilibrium $t_a = t_b = \widetilde{t}$; then the governments may either set too high or too low corporate tax rates depending on the relative size of a positive profit shifting externality and an ambiguous wage income externality.*

Proof: It follows from equations (3.11) and (3.21) that $1/\theta''(1) > 0$ and $\widetilde{L}\cdot\partial\widetilde{w}_i/\partial t_j < 0$. Moreover, it must hold that $1 + \widetilde{\epsilon} > 0$ as was demonstrated in section 2.2. Therefore, the profit shifting externality $2\rho\,\widetilde{t}/\theta''(1)$ is positive while the wage income externality $\left\{1 + \epsilon - \rho\,\widetilde{t}\right\}\widetilde{L}\cdot\partial\widetilde{w}_i/\partial t_j$ carries an ambiguous sign. ■

We derive ambiguous fiscal externalities under SA. The first term on the right hand side of equation (3.22) represents the well-known profit shifting externality derived under SA. The fiscal externality is established by the following mechanism: If one country raises its corporate tax rate, the MNE has an incentive to shift profits to the foreign jurisdiction thereby increasing the foreign tax base. This imposes a positive fiscal externality on the other country and motivates a race-to-the-bottom in corporate taxes.

Our model's contribution is the derivation of an ambiguous wage income externality established by the endogenous determination of wages in a bargaining process. Formally the effect is represented by the second term on the right hand side of equation (3.22). In the previous section we proved that raising the corporate tax rate lowers the wages bargained at the foreign location. First, the decline in the foreign wage rate reduces the foreign location's payroll cost and thereby raises the MNE's after-tax profit and the foreign tax base. This imposes a positive fiscal externality on the foreign

country. Second, the reduction in foreign workers' remuneration leads to a direct fall in workers' utility from wage income and imposes a negative fiscal externality on the foreign country.[8] The sign of the wage income externality depends on the relative size of these countervailing effects. Equation (3.22) reveals that the income externality and in consequence the sum of externalities will tend to be negative if the marginal cost of public funds ρ and the absolute value of the labor demand elasticity with respect to the wage rent are low.

3.3 Empirical Test of Tax Effects on Workers' Wages

The purpose of this section is to test the theoretical predictions of Proposition 1. Therefore, we will investigate how the statutory corporate tax rate at the affiliate and parent location impacts on the average workers' wage rate.

3.3.1 Empirical Estimation Methodology

Proposition 1 suggests the following equation to be estimated

$$\log\ W_{it} = \alpha_1 + \alpha_2 \ln\ Tax_{it} + \alpha_3 Inttax_{it} + \alpha_4 \ln\ TaxF_{it} + \alpha_5 X_{it} + \alpha_6 XF_{it} + \phi_i + \epsilon_{it}$$

Since the corporate wage rate exhibits a rather skewed distribution, we employ the logarithm of the average wage rate at the subsidiary level as endogeneous variable. The central explanatory variable is the corporate tax at the affiliate and parent location (Tax_{it} and $TaxF_{it}$) which enters the equation in log-form. The variable ϕ_i symbolizes a full set of affiliate fixed effects. These allow for unobserved and time-invariant heterogeneity between the subsidiaries and hence may capture heterogeneity due to

[8] The induced changes in workers' wages lead to adjustments in the MNE's labor demand behavior in the opposite direction. The MNE reacts to a decline in the bargained wage level with increased labor demand and vice versa. Nevertheless, since $\epsilon > -1$ this does not overcompensate the direct wage effects.

differences in firm technology and workers' skill level. We also include a full set of year effects that control for unobserved heterogeneity over time common to all subsidiaries like skill biased technological change (see also Budd et al. (2005)). Moreover, we include a set of time varying control variables, like the corporate capital intensity and the value added per employee, national GDP per capita and a national earnings-index for the manufacturing industry. We additionally include a full set of time-industry effects.

While the effect of the foreign corporate tax on domestic workers' wages is driven by after-tax profit adjustments only, the impact of corporate taxes on domestic workers' wages can be split in a negative profit level effect and a positive profit sensitivity effect (see Section 3.2). To separate the latter two effects we interact the log domestic corporate tax rate with the MNE's log employment. This isolates the profit sensitivity and the profit income effect since marginally increasing the affiliate employment raises the corporate tax effect on the MNE's profit sensitivity with respect to domestic wages $\partial^3\Pi/\partial w_i \partial t_i \partial L_i = 1$ but does not have any effect on the profit sensitivity with respect to the corporation tax $\partial^2\Pi/\partial t_i \partial L_i = F'(L_i) - w_i = 0$. Hence, we would presume the interaction effect to be positive and hence to provide direct evidence for the existence of the profit sensitivity effect.

3.3.2 Data Description and Sample Statistics

Our empirical analysis employs the AMADEUS data base which is compiled by Bureau van Dijck and contains detailed accounting and firm structure information for 1.6 million corporations in 38 countries. The data is available from 1995 to 2005, but unbalanced in structure. Since our analysis centers around corporate tax effects on multinational firms, we restrict our sample to subsidiaries which are directly and ultimately owned by a foreign parent company.[9] Additionally, for an affiliate to be

[9]The Amadeus data contains information on a corporation's direct and ultimate investment in other firms. For a corporation to be identified as parent company, it has to hold at least 50 percent in a respective affiliate directly and ultimately. Since the ownership information is missing for a

included in the data set it has to be ultimately owned by an industrial corporation and has to employ more than 50 employees.[10]

Otherwise, we include companies based on the availability of the essential information needed for our analysis (wages, corporate tax rate at affiliate and parent location). Additionally, affiliate observations could only be used in the regressions if the link to the global ultimate owner as well as basic information on this parent corporation was available with AMADEUS. Last, we had to restrict the sample to corporate groups with unconsolidated accounting information.

The ownership information in our data refers to the last reported date which is the year 2005 for most corporations in our data set. Thus, ownership has a cross sectional dimension only. In line with previous work based on the same data, we are not too concerned about this assumption. To the extend that we are potentially including a few affiliates which were not affiliated in earlier years, we are introducing measurement error that biases our results towards zero (Budd et al. (2005), Navaretti et al. (2003)).

Matching parent companies to foreign affiliates leaves an unbalanced panel with 1213 affiliates and 564 parent corporations over 10 years. Table 1 exhibits the country distribution. The distribution looks broadly in line with basic patterns of FDI in Europe. Most of the global ultimate owners are concentrated in western European countries like France, Germany and Belgium. In contrast, many subsidiaries are located in the European South (Spain and Italy) as well as in new EU member states like the Czech Republic and Poland.[11]

substantial number of observations and the existing ownership information points out that less than 5% of affiliates are not directly owned by their global ultimate owner, we assume affiliates with missing information on direct ownership to be directly owned by the global ultimate owner. We exercised some sensitivity checks with respect to this assumption which proved to lead to similar results as the ones presented in this section.

[10] Both assumptions are not qualitatively decisive for our results.

[11] The firm distribution shows an under-sampling of British global ultimate owners and the absence of Finish firms. This is ascribed to a lack of reporting requirements for these corporations (see Budd et al. (2005)).

The data contains 7045 affiliate-year observations. Thus, the accounting information is available for 5.5 years on average. Table 2 summarizes basic sample statistics. The average wage rate at the affiliate level is measured to be 46,899 US Dollar. The wage rate is constructed dividing the corporate wage bill by the number of employees which is standard in the literature on international profit sharing (e.g. Budd et al. (2005), Hildreth and Oswald (1997)).[12] Since there is a considerable spread in the wage variable, we hedge against results that are driven by outliers in the endogenous wage component by excluding observations in the first and 99th percentile of the wage distribution.[13]

In line with the profit sharing literature on multinational firms (see for example Budd et al. (2005)), we include the value added per capita at the affiliate and parent location as a measure for corporate profits. The variable will serve as control in the empirical analysis. However, since the information is missing for nearly half the observations, the inclusion leads to a drastic reduction in sample size. The measure for value added is substantially lower at the affiliate than at the parent-firm level which might partly be explained by a significantly higher capital-to-labor ratio at the parent level.

Moreover, the average corporate tax rate at the parent location is slightly higher than the corporate tax rate at the affiliate location which is line with the common perception that headquarters are mainly located in western European high-tax countries while production also takes place through affiliates in Eastern and Southern European countries with lower corporate tax rates.

3.3.3 Results

The results for the fixed-effects model are presented in Table 3. Specification (1) is our baseline estimation and regresses the log wage level on the statutory corporate tax rate

[12] Unfortunately, AMADEUS does provide a skill indicator for a corporation's workforce.

[13] We thus only include corporations with an average wage rate above 5,700 US-Dollar and below 141,072 US-Dollar. However, our results are not sensitive to this data exclusion.

at the subsidiary and parent location. In line with our theoretical analysis the data points to a positive correlation between the statutory corporate tax and the domestic wage level. Increasing the corporate tax rate by 10% thus enlargens workers' wages by 2%. In contrast, the tax at the parent location exerts a significantly negative impact on the average wage rate. A 10% rise in corporate tax rates at the parent location reduces wages bargained by 1%. The specification includes affiliate fixed effects, year and industry fixed effects and time-varying country characteristics like the GDP per capita and a manufacturing earning's index.

In specification (2) we include an interaction term between the statutory corporate tax rate and the number of employees. As described above, the tax sensitivity effect should be captured by the interaction since it positively depends on the number of employees while the profit effect is independent of employment numbers. The result is in line with our theoretical predictions since the interaction term carries a positive sign and is statistically significant while the coefficient for the domestic corporate tax rate turns negative. Hence, increases in the domestic corporate tax lower workers wages since after-tax profits decline. But higher corporate taxes also raise the value of deducting wage costs from the tax base. The larger the number of employees the larger the gains from raising these wages.

Specification (3) additionally controls for the value added per worker at the affiliate and parent location. We find a statistically significant and positive effect of both variables on workers' wages which is in line with the results presented by Budd et al. (2005) on rent sharing in international firms. Moreover, the capital-labor ratio at the affiliate level is found to increase the wage rate. Since a higher capital stock per worker should raise labor productivity, the effect carries the expected sign.

Concluding, we provide qualitative evidence for corporate tax effects on workers' wages that is broadly in line with our theoretical model. Thus, the corporate tax rate at foreign parent companies has a negative and significant impact on workers wages, while we find evidence for a negative profit level effect and a positive profit sensitivity effect

of the domestic corporate tax rate.[14]

3.4 Extensions

In the extension, we investigate within our theoretical framework how wage bargaining between MNEs and subnational labor unions is affected by a switch from SA to FA. Although SA principles apply for the taxation of MNEs at the international level, several subnational corporate tax systems follow formula apportionment principles. Moreover, the EU Commission proposed to switch from SA to FA within EU borders, and, hence, the topic is at the policy agenda. Under FA the MNE's profits are consolidated and apportioned to the affiliates according to a formula based on relative payroll cost, relative capital investment and/or relative sales. For simplicity, we concentrate on apportionment according to the relative payroll share. The MNE's tax burden in country $i \in \{a, b\}$ calculates $T_i = t_i \beta_i \left[\Pi_{Ta} + \Pi_{Tb}\right]$, with β_i being the fraction of the consolidated tax base apportioned to country i, which is assumed to comprise the MNE's relative payroll share $\beta_i = w_i L_i / (w_a L_a + w_b L_b)$.

As is commonly known, the MNE has no incentive to shift profits under a FA system; therefore the corporation sets the transfer price equal to the true price ($p_i = 1$) for $i \in \{a, b\}$. The MNE's labor demand in country i is determined by the following first

[14]Note, that these results contradict a recent paper by Devereux et al. (2007) who find that increases in the corporate tax rate lower domestic wages. The differing findings are most likely attributable to differences in the study design. Devereux et al. (2007) employ data on *national* firms mostly and observe relatively few observations from Scandinavian and Continental European countries which are characterized by high union bargaining power, while our theoretical model applies to MNEs in unionized labor markets only. The theoretical results do not apply to national firms. Moreover, Devereux et al. (2007) include the effective corporate tax rate as explanatory variable in their estimations, while our theory predicts effects of the *statutory* corporate tax rate on wages bargained.

order condition

$$F'(L_i) \quad = \quad w_i + \frac{(t_i - t_j)}{(1-\overline{t})} \frac{\beta_j w_i}{\sum_i w_i L_i} \left[\Pi_{Ta} + \Pi_{Tb}\right] \tag{3.23}$$

with $\overline{t}$ being defined as the MNE's average tax rate $\overline{t} = t_a\beta_a + t_b\beta_b$ and $i, j \in \{a, b\}$ and $i \neq j$. The first term on the right hand side of equation (3.23) reflects the MNE's labor demand L_i to decline in the workers' wage rate w_i. The second term represents the FA effect stating that the MNE's labor demand is biased towards the low-tax country. The intuition can be described as follows: under FA the consolidated corporate tax base is apportioned according to the affiliates' relative payroll shares, thus the MNE has an incentive to employ an over-proportional number of workers at the low-tax location since this increases its relative payroll share and the profit taxed in the low-tax country and reduces the overall corporate tax burden.

At the second stage the MNE and local labor unions bargain over workers' wages. Analogously to our analysis under SA, the bargaining parties maximize the objective function given by equation (3.6) with respect to the wage rate w_i. We exercise a comparative static analysis to determine the corporate tax effect on bargained wages in equilibrium. Since we will focus on a symmetric equilibrium at the first stage of the tax competition game, we will derive the marginal tax effects on workers' wages for symmetric tax rates.

Proposition 3.3. *Suppose the tax competition game at the first stage attains an equilibrium with $t_a = t_b = \hat{t}$. Then, under FA the local corporate tax rate is likely to exert a negative (positive) effect on local (foreign) workers' remuneration.*

Proof: Appendix A

In the following, we will explain why the corporation tax is likely to exert a negative effect on domestic wages while the effect on foreign workers' wages is likely to be positive.

The corporate tax effect on domestic wages constitutes from three sub-effects: First, a rise in the local tax tends to decrease local labor demand since the MNE has an incentive

to shift employment to the foreign affiliate. This tends to reduce the bargained wage level of domestic workers. Second, increasing the corporate tax rate raises the MNE's tax burden and leads to a decline in the MNE's after-tax profit which also tends to lower bargained wages. Third, increasing the domestic corporate tax exerts an ambiguous effect on the profit sensitivity with respect to domestic wages. On the one hand, payroll cost are deductible from the tax base and hence, raising the corporate tax rate reduces the MNE's profit sensitivity with respect to the domestic wage level in absolute terms. On the other hand, increasing the local corporate tax rate raises the profit sensitivity in absolute terms since higher wages induce an enlarged amount of the consolidated tax base to be apportioned to the home country and then to be taxed at the increased local corporate tax rate. Since we are not able to determine the sign of the relevant effect analytically, we simulate the model for a Cobb Douglas production function of the form $F(L, G) = G^{1-\alpha}L^{\alpha}$, with G being a fixed production factor. We set G and the outside wage $\overline{w}$ equal to 1 and simulate the model for different parameter values of α and δ. The result is presented in figure 1. The dotted area symbolizes combinations of α and δ for which the impact of the corporate tax on domestic wages is negative.[15] Thus, unless the union bargaining power and the labor share in corporate production are very low, the corporate tax exerts a negative effect on bargained wages. Note, that at least for European countries union bargaining power is estimated to be well beyond 30% (Dumont et al. (2006)) and the labor share in production is not minor in most industries. Thus, for the EU, our model predicts a negative impact of corporate taxes on domestically bargained wages.

In contrast, increasing the domestic corporate tax rate is likely to raise foreign workers' wages. Again, the effect comprises three sub-effects. First, a rise in the local corporate tax rate increases foreign labor demand and therefore tends to increase the workers' wage level bargained at the foreign location. Second, domestic corporate tax increases impact on the wage bargaining process since they lower the MNE's after-tax profit and, hence, tend to reduce bargained foreign wages. Third, domestic tax increases affect the

[15] We exercised sensitivity checks with respect to the parameter values for G and $\overline{w}$, and found Graphic 1 to be reasonably robust against variations in these parameters.

profit sensitivity to changes in the foreign wage rate. On the one hand, payroll cost are deductible from the corporate tax base and therefore reduce the MNE's consolidated profit. Domestic corporate tax increases raise the value of this deduction. Additionally, increasing the local corporate tax rate makes foreign wage increases less costly since higher foreign wages raise the foreign relative payroll share and the corporate profit that is taxed at the constant tax abroad. Both effects tend in the direction of higher foreign wages. Again we simulate the effect making use of the above described assumptions. The conditions for foreign wages to increase in the domestic corporate tax rate turn out to be equally captured by figure 1. For $\alpha - \delta$-combinations in the dotted area the effect is positive, which is a plausible assumption with regard to European countries.

At the first stage, we consider a tax competition game under FA. The social welfare function is defined

$$SW_i = \rho t_i \hat{\beta}_i \left[\hat{\Pi}_{Ta} + \hat{\Pi}_{Tb}\right] + (\hat{w}_i - \overline{w})\hat{L}_i + \overline{w}N \qquad i \in \{a, b\} \tag{3.24}$$

whereas the hat symbol indicates the optimal values chosen at the second and third stage of the game. Analogously to SA, social welfare is assumed to comprise corporate tax revenues and residents' wage income. The corporate tax base under FA is determined by the relative payroll share β_i, which represents the fraction of the consolidated profits apportioned to country i. Since both countries maximize their social welfare, it holds $\partial SW_i(t_a, t_b)/\partial t_i = 0$. The countries are assumed to be identical, therefore it is reasonable to focus on the symmetric Nash equilibrium of the tax competition game. Let $\hat{t} = t_a = t_b$ be the equilibrium tax rate. Equilibrium social welfare is given by

$$SW_i(\hat{t}, \hat{t}) =: SW(\hat{t}). \tag{3.25}$$

To investigate whether the countries choose inefficiently high or low tax rates in equilibrium, we have to determine the impact of a coordinated increase in the common tax rate $\hat{t}$ on the tax revenue of the countries. Differentiating equation (3.25) yields

$$\frac{dSW(\hat{t})}{d\hat{t}} = \frac{\partial SW_i(t_a, t_b)}{\partial t_i}\Big|_{t_a=t_b=\hat{t}} + \frac{\partial SW_i(t_a, t_b)}{\partial t_j}\Big|_{t_a=t_b=\hat{t}} \qquad i, j \in \{a, b\},\ i \neq j \tag{3.26}$$

whereas $\partial SW_i/\partial t_i = 0$. The cross effect $\partial SW_i/\partial t_j$ reflects the fiscal externalities.

$$\frac{\partial SW_i}{\partial t_j} = t_i \rho \left\{ \hat{\beta}_i \sum_{k=a,b} \left[\frac{\partial \hat{\Pi}_T}{\partial \hat{w}_k} \frac{\partial \hat{w}_k}{\partial t_j} + \frac{\partial \hat{\Pi}_T}{\partial \hat{L}_k} \frac{\partial \hat{L}_k}{\partial t_j} \right] + \hat{\Pi}_T \frac{\partial \hat{\beta}_i}{\partial t_j} \right\} + (1+\hat{\epsilon}) \hat{L}_i \frac{\partial \hat{w}_i}{\partial t_j}$$
$$+ (\hat{w}_i - \overline{w}) \frac{\partial \hat{L}_i}{\partial t_j} \qquad i,j \in \{a,b\},\ i \neq j \qquad (3.27)$$

with $\hat{\Pi}_T = \left[\hat{\Pi}_{Ta} + \hat{\Pi}_{Tb} \right]$ and $\hat{\epsilon} = \partial \hat{L}_i / \partial \hat{w}_i \cdot (\hat{w}_i - \overline{w})/\hat{L}_i$. Evaluating equation (3.27) at the symmetric equilibium leads to the following proposition.

Proposition 3.4. *Suppose the tax competition game under FA attains a symmetric equilibrium $t_a = t_b = \hat{t}$ and it holds that $\partial w_i/\partial t_j > 0$; then countries set inefficiently small corporate tax rates due to a positive FA externality and a positive wage income externality.*

Proof: Appendix B

Two fiscal externalities are derived under FA. First, if a country raises its corporate tax rate it induces the MNE to shift labor demand to the foreign country thereby increasing the relative payroll share of the foreign affiliate and the fraction of consolidated profit taxed at the foreign country. Moreover, the increase in the corporate tax rate tends to lower the local bargained wage rate and simultaneously increases the wage level bargained at the foreign affiliate. Therefore the wage adjustments further enlarges the relative payroll share in the foreign country. This implies that a larger fraction of the MNE's consolidated profit is apportioned to the foreign country which constitutes a positive fiscal externality. Second, we observe a positive wage income externality. Raising the corporate tax rate leads to an increase in the bargained wages of the foreign affiliate and thereby raises foreign residents' utility from wage income. The wage income externality is additionally enforced, since a marginal rise in the domestic corporate tax rate induces the MNE to employ an increased number of workers at the foreign location. Since additional labor demand increases the aggregated foreign utility from labor income, the wage income externality is fostered.

3.5 Discussion and Conclusion

The theoretical analysis introduces union wage bargaining in a standard tax competition framework with multinational corporations. Under SA we derive a positive (negative) corporate tax effect on the local (foreign) wage level. The main insight emerging from a tax competition game is that endogenously determining wages in imperfectly competitive labor markets leads to a new fiscal externality under SA. Besides the well-known profit shifting externality we derive a wage income externality which may lead to inefficiently large or small corporate tax rates. Moreover, we test the predicted effects of corporate taxes on domestic and foreign workers' wages with European firm data and find results in line with our theoretical predictions.

Under FA, corporate tax effects on workers' wages are fundamentally altered. Here, tax increases are likely to lower (enlarge) workers' remuneration bargained at the domestic (foreign) affiliate. A tax competition game establishes two fiscal externalities. The well-known FA externality is augmented by a wage income externality. Both externalities are positive and motivate a race-to-the-bottom in corporate tax rates.

Our model's policy implications include that a switch from an international SA system to FA might imply fundamental changes in the rent sharing of multinational corporations. While under the current SA system, countries with relatively high corporate tax rates receive higher rents, the picture turns under FA. In the literature on tax competition, FA is often seen as a means to reduce international tax competition and dampen the race-to-the-bottom in corporate tax rates caused by a positive profit shifting externality. Our model suggests the opposite to be true. We derive a wage income externality which might lead to a race-to-the top under SA but is unambiguously positive under FA implying that under this system tax competition is fueled.

3.6 Appendix

Appendix A

A comparative static analysis derives the marginal tax effects on domestic and foreign wages which are determined by

$$\frac{\partial w_i}{\partial t_i} = \frac{-\partial\Phi_i/\partial t_i \cdot \partial\Phi_j/\partial w_j + \partial\Phi_j/\partial t_i \cdot \partial\Phi_i/\partial w_j}{\partial\Phi_i/\partial w_i \cdot \partial\Phi_j/\partial w_j - \partial\Phi_i/\partial w_j \cdot \partial\Phi_j/\partial w_i} \tag{3.28}$$

$$\frac{\partial w_i}{\partial t_j} = \frac{-\partial\Phi_i/\partial t_j \cdot \partial\Phi_j/\partial w_j + \partial\Phi_j/\partial t_j \cdot \partial\Phi_i/\partial w_j}{\partial\Phi_i/\partial w_i \cdot \partial\Phi_j/\partial w_j - \partial\Phi_i/\partial w_j \cdot \partial\Phi_j/\partial w_i} \tag{3.29}$$

$i, j \in \{a, b\}$ and $i \neq j$. For the objective function to be concave, it holds that $\partial\Phi_i/\partial w_i = \partial\Phi_j/\partial w_j < 0$. Additionally, it can be shown that $\partial\Phi_i/\partial w_j = \partial\Phi_j/\partial w_i = -(1-\delta)/\Pi^2 \cdot \partial\Pi/\partial w_i \cdot \partial\Pi/\partial w_j < 0$, as $\partial L_i/\partial w_i\partial w_j = \partial L_i/\partial w_j = \partial\Pi/\partial w_i\partial w_j = 0$ and $\partial\Pi/\partial w_i < 0$. Since our analysis focuses on stable equilibriums, the determinant of the equation system (3.8) and (3.9) is assumed to be positive, $\partial\Phi_i/\partial w_i \cdot \partial\Phi_j/\partial w_j - \partial\Phi_i/\partial w_j \cdot \partial\Phi_j/\partial w_i > 0$. Thus, the signs of equations (3.28) and (3.29) are determined by $\partial\Phi_i/\partial t_i$ and $\partial\Phi_i/\partial t_j$.

$$\frac{\partial\Phi_i}{\partial t_i} = \frac{\delta}{L_i}\frac{\partial^2 L_i}{\partial w_i \partial t_i} - \frac{\delta}{L^2}\frac{\partial L_i}{\partial w_i}\frac{\partial L_i}{\partial t_i} + \frac{(1-\delta)}{\Pi}\frac{\partial^2\Pi}{\partial w_i\partial t_i} - \frac{1-\delta}{\Pi^2}\frac{\partial\Pi}{\partial w_i}\frac{\partial\Pi}{\partial t_i} \tag{3.30}$$

$$\frac{\partial\Phi_i}{\partial t_j} = \frac{\delta}{L_i}\frac{\partial^2 L_i}{\partial w_i \partial t_j} - \frac{\delta}{L^2}\frac{\partial L_i}{\partial w_i}\frac{\partial L_i}{\partial t_j} + \frac{(1-\delta)}{\Pi}\frac{\partial^2\Pi}{\partial w_i\partial t_j} - \frac{1-\delta}{\Pi^2}\frac{\partial\Pi}{\partial w_i}\frac{\partial\Pi}{\partial t_j} \tag{3.31}$$

Differentiating equation (3.23) and applying the symmetry assumption yields the following second order conditions with respect to the MNE's optimal labor demand

$$\frac{\partial L_i}{\partial w_i} = \frac{1}{F''(\hat{L})} < 0, \tag{3.32}$$

$$\frac{\partial L_i}{\partial w_j} = \frac{\partial L_i}{\partial w_j \partial t_j} = 0 \tag{3.33}$$

$$\frac{\partial^2 L_i}{\partial w_i \partial t_i} = -\frac{\partial^2 L_i}{\partial w_i \partial t_j} = -\frac{[F''(\hat{L})\hat{L}^2 + 2\hat{\Pi}_T]}{4(1-\hat{t})F''(\hat{L})^2\hat{L}^2} \tag{3.34}$$

$$\frac{\partial L_i}{\partial t_i} = -\frac{\partial L_i}{\partial t_j} = \frac{\hat{\Pi}_T}{2(1-\hat{t})F''(\hat{L})\hat{L}} < 0 \tag{3.35}$$

for $i, j \in \{a, b\}$ and $i \neq j$. While we unambiguously show that the partial derivatives of equation (3.33) are zero and equation (3.35) takes on negative values, the sign

of equation (3.34) is ambiguous and depends on the sign of $F''(\hat{L})\hat{L}^2 + 2\hat{\Pi}_T$. For a Cobb Douglas function of the form $F(L_i) = L_i^{\alpha} G_i^{1-\alpha}$ $\alpha \in [0,1]$, with G being a fixed production factor, we show that $F''(\hat{L})\hat{L}^2 + 2\hat{\Pi}_T > 0$ holds. The MNE's labor demand is determined by (3.23), therefore it follows $\hat{L} = \left(\alpha \hat{G}^{1-\alpha}/\hat{w}\right)^{\frac{1}{1-\alpha}}$. Under symmetry ($t_a = t_b = \hat{t}$) it holds that $L_a = L_b = \hat{L}$, $w_a = w_b = \hat{w}$, $\Pi_{Ta} = \Pi_{Tb} = \hat{\Pi}_T$. Thus we can modify the term $F''(\hat{L})\hat{L}^2 + 2\hat{\Pi}_T = \alpha(\alpha-1)\hat{L}^{\alpha}\hat{G}^{1-\alpha} + 2\left[\hat{L}^{\alpha}\hat{G}^{1-\alpha} - \hat{w}\hat{L}\right] = 2 - \alpha > 0$. To determine the sign of equations (3.30) and (3.31), we additionally differentiate the MNE's after-tax profit with respect to the wage level and the corporate tax rate

$$\frac{\partial \Pi}{\partial w_i} = -(1-\hat{t})\hat{L} < 0, \quad \frac{\partial \Pi}{\partial t_i} = \frac{\partial \Pi}{\partial t_j} = -\hat{\Pi}_T < 0 \tag{3.36}$$

$$\frac{\partial^2 \Pi}{\partial w_i \partial t_i} = \frac{1}{2}\left[\hat{L} - \frac{\hat{\Pi}_T}{\hat{w}} - \frac{\hat{\Pi}_T}{F''(\hat{L})\hat{L}}\right], \quad \frac{\partial^2 \Pi}{\partial w_i \partial t_j} = \frac{1}{2}\left[\hat{L} + \frac{\hat{\Pi}_T}{\hat{w}} + \frac{\hat{\Pi}_T}{F''(\hat{L})\hat{L}}\right] \tag{3.37}$$

Plugging in these second order effects in equation (3.30) and (3.31) gives

$$\begin{aligned}\frac{\partial \Phi_i}{\partial t_i} = \frac{\delta}{L_i}\frac{\partial^2 L_i}{\partial w_i \partial t_j} - \frac{\delta}{L^2}\frac{\partial L_i}{\partial w_i}\frac{\partial L_i}{\partial t_j} + \frac{(1-\delta)}{\Pi(w_i)}\frac{\partial^2 \Pi}{\partial w_i \partial t_j} - \frac{1-\delta}{\Pi^2}\frac{\partial \Pi}{\partial w_i}\frac{\partial \Pi}{\partial t_j} = \\ = \frac{[F''(\hat{L})\hat{L}^2 + 4\delta\hat{\Pi}_T]}{4(1-\hat{t})F''(\hat{L})^2\hat{L}^3} + \frac{1-\delta}{4(1-\hat{t})\hat{w}}\end{aligned} \tag{3.38}$$

$$\begin{aligned}\frac{\partial \Phi_i}{\partial t_j} = \frac{\delta}{L_i}\frac{\partial L_i}{\partial w_i \partial t_i} - \frac{\delta}{L^2}\frac{\partial L_i}{\partial w_i}\frac{\partial L_i}{\partial t_i} + \frac{(1-\delta)}{\Pi(w_i)}\frac{\partial \Pi}{\partial w_i \partial t_i} - \frac{1-\delta}{\Pi^2}\frac{\partial \Pi}{\partial w_i}\frac{\partial \Pi}{\partial t_i} = \\ = -\frac{[F''(\hat{L})\hat{L}^2 + 4\delta\hat{\Pi}_T]}{4(1-\hat{t})F''(\hat{L})^2\hat{L}^3} - \frac{1-\delta}{4(1-\hat{t})\hat{w}}\end{aligned} \tag{3.39}$$

Appendix B

The fiscal externality of corporate taxation in jurisdiction j on the social welfare in jurisdiction i, with $i, j \in \{a, b\}$ and $i \neq j$, reads

$$\frac{\partial SW_i}{\partial t_j}\Big|_{t_a=t_a=\hat{t}} = \rho\hat{t} \cdot 2\hat{\Pi}_T \frac{\partial \hat{\beta}_i}{\partial t_j}\Big|_{t_a=t_a=\hat{t}} + (1+\hat{\epsilon})\hat{L}\frac{\partial \hat{w}_i}{\partial t_j}\Big|_{t_a=t_a=\hat{t}} + (\hat{w} - \overline{w})\frac{\partial \hat{L}_i}{\partial t_j}\Big|_{t_a=t_a=\hat{t}} \tag{3.40}$$

In a symmetric Nash equilibrium the FA externality can be written

$$\begin{aligned}\frac{\partial \hat{\beta}_i}{\partial t_j}\Big|_{t_a=t_a=\hat{t}} &= \left[\frac{\partial \hat{\beta}_i}{\partial \hat{w}_i} + \frac{\partial \hat{\beta}_i}{\partial \hat{L}_i}\frac{\partial \hat{L}_i}{\partial \hat{w}_i}\right]\frac{\partial \hat{w}_i}{\partial t_j} + \left[\frac{\partial \hat{\beta}_i}{\partial \hat{w}_j} + \frac{\partial \hat{\beta}_i}{\partial \hat{L}_j}\frac{\partial \hat{L}_j}{\partial \hat{w}_j}\right]\frac{\partial \hat{w}_j}{\partial t_j} \\ &= \frac{1}{4\hat{w}}\left[1 + \frac{\partial \hat{L}_i}{\partial \hat{w}_i}\frac{\hat{w}}{\hat{L}}\right]\frac{\partial \hat{w}_i}{\partial t_j} - \frac{1}{4\hat{w}}\left[1 + \frac{\partial \hat{L}_j}{\partial \hat{w}_j}\frac{\hat{w}}{\hat{L}}\right]\frac{\partial \hat{w}_j}{\partial t_j} > 0\end{aligned} \tag{3.41}$$

As for standard convex labor demand functions the elasticity of labor demand with respect to the wage rate is smaller than 1 in absolute terms, it follows that equation (3.41) is unambiguously positive. Note that under the symmetry assumption cross effects of the foreign wage rate on the local labor demand are zero. The change in the local corporate tax rate does not exhibit any effect on the MNE's total payroll cost since under symmetry $\partial w_j/\partial t_i = -\partial w_i/\partial t_i$. Additionally employing equation (3.23) for the symmetry case delivers $F'(L_i) = w_i$ and we prove

$$\sum_k \left[\frac{\partial \left[\Pi_{Ta} + \Pi_{Tb}\right]}{\partial \hat{w}_k} \frac{\partial \hat{w}_k}{\partial t_j} + \frac{\partial \left[\Pi_{Ta} + \Pi_{Tb}\right]}{\partial \hat{L}_k} \frac{\partial \hat{L}_k}{\partial t_j} \right] = 0, \qquad j,k \in \{a,b\} \tag{3.42}$$

According to equation (3.35) and our result in proposition 3 we can show that the wage income externality is unambiguously positive

$$(1+\hat{\epsilon}) L_i \frac{\partial \hat{w}_i}{\partial t_j} + (\hat{w} - \overline{w}) \frac{\partial \hat{L}_i}{\partial t_j} > 0 \tag{3.43}$$

Note: Throughout * will indicate significance on the 10% level, ** significance on the 5% level and *** significance on the 1% level.

Table 1: Country Statistic

	Affiliate	*Parent*
Austria	33	12
Germany	70	96
Belgium	61	80
Czech Republic	53	1
Denmark	57	43
Estonia	30	0
Spain	161	45
France	222	105
United Kingdom	254	2
Hungary	8	0
Ireland	4	4
Italy	85	61
Luxembourg	5	9
Netherlands	51	14
Poland	80	2
Portugal	15	8
Sweden	46	79
Slovakia	14	0
Sum	1213	564

Table 2: Descriptive Statistics

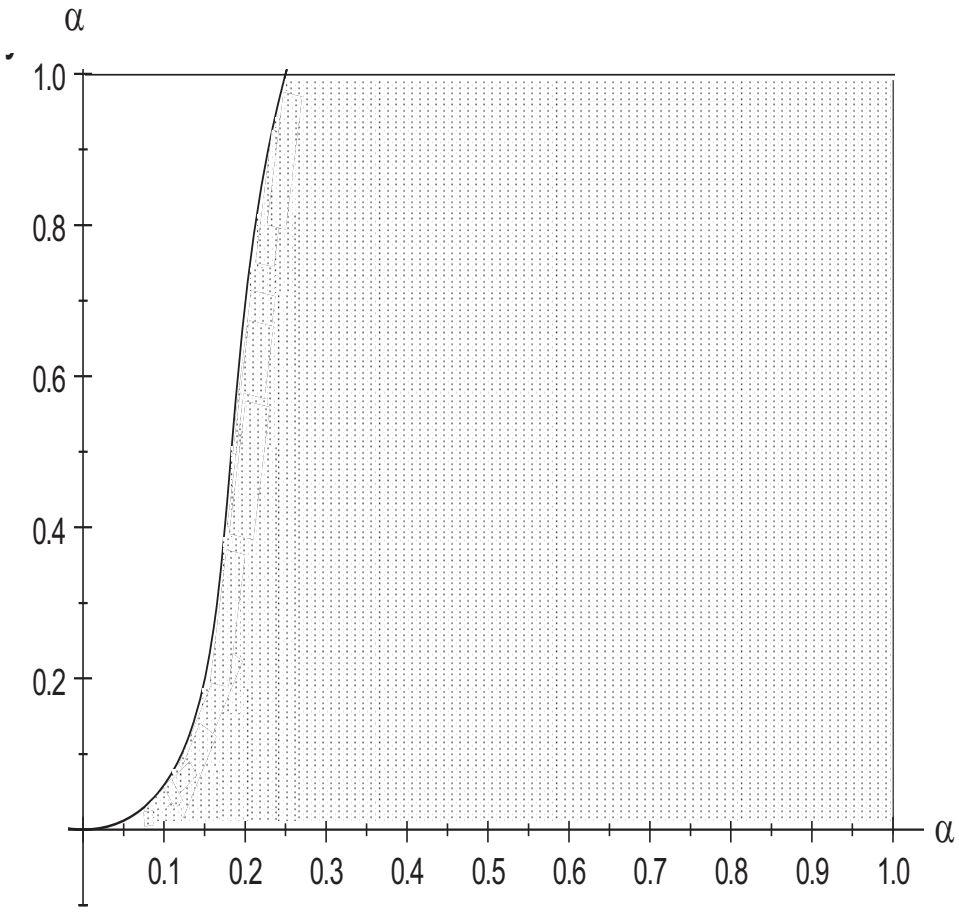
Variable	*Mean*	*Standard Deviation*
Wage Rate, Affiliate	46.8986	26.0519
Employment, Affiliate	246.1318	852.9569
Value Added Per Capita, Affiliate [(sales - material cost)/employment]	171.7227	480.3587
Value Added Per Capita, Parent [(sales - material cost)/employment]	8796.218	39487.92
Statutory Tax Rate, Affiliate	0.3454	0.0534
Statutory Tax Rate, Parent	0.3704	0.0667
Capital Labor Ratio, Affiliate [fixed assets / employment]	1334.85	25083.48
Capital Labor Ratio, Parent [fixed assets / employment]	13618.62	48480.65
GDP per Capita, Affiliate	24907.94	4770.872
GDP per Capita, Parent	26428.75	3934.035

Table 3: Fixed Effect Regression, End. Variable: Log Wage Rate

Variable	*(1)*	*(2)*	*(3)*
Log Statutory Tax Rate Affiliate	0.1980***	−1.0002***	−1.0003***
	(0.0440)	(0.0638)	(0.1572)
Log Statutory Tax Rate Parent	−0.0998**	−0.1456***	−0.2371***
	(0.0457)	(0.0432)	(0.1064)
Log Statutory Tax Rate Affiliate * Log Employment		0.2092***	0.1986***
		(0.0082)	(0.0237)
Log GDP per Capita Affiliate	0.1975	0.1567	−0.0231
	(0.1256)	(0.1189)	(0.2883)
Log GDP per Capita Parent	0.4780***	0.5394***	0.1100
	(0.1600)	(0.1514)	(0.4246)
Log Earnings Affiliate	0.8879***	0.9665***	0.8750***
	(0.0788)	(0.0746)	(0.2255)
Log Earnings Parent	0.4567***	0.6063***	0.5755
	(0.1857)	(0.1758)	(0.5011)
Value Added per Capita Affiliate /1000			0.2144***
			(0.0484)
Value Added per Capita Parent/1000			0.0222***
			(0.0062)
Capital Intensity Affiliate			0.0869***
			(0.0123)
Capital Intensity Parent			−0.0075
			(0.0125)
Year, Year-Industry	√	√	√
Number of Observations	6821	6821	1338
Number of Groups	1166	1166	343
R-squared within	0.5110	0.5625	0.6386
R-squared between	0.0862	0.0335	0.0656
R-squared overall	0.1612	0.0885	0.1052

Impact of domestic corporate tax on wages

On the horizontal axis we depict all values of α, the vertical axis measures δ.
The shaded area depicts those combinations of α and δ for which an increase in the domestic corporate tax rate has a negative effect on domestic wages, but a positive effect on foreign wages.



Chapter 4

Employment Distortions under Formula Apportionment: Evidence from the Population of German Firms

4.1 Introduction

Reform options for corporate taxation of multi-jurisdictional firms have been on policy makers' agenda for some time. Over the last decade, economic integration has fostered the number and importance of multinational entities (MNEs) and hence the topic finds increasing public and political attention. Traditionally, corporate taxation of multinationally operating firms follows separate accounting (SA) principles, that is, profits are taxed in the country where they accrue. However, under this current system MNEs are well known to shift profit from high-tax locations to tax havens to achieve a reduction in their overall tax burden. Since countries compete for the shifty tax base, this gives rise to inefficiencies in the international tax scheme.

In 2001, the European Commission therefore proposed to abolish the existing SA system within the borders of the European Union and to introduce an alternative taxation system called formula apportionment (FA). The idea behind FA is that the corporate tax base of a MNE is consolidated at the group level and is afterwards apportioned to the affiliates on basis of a formula that shall measure the relative corporate activity. The main advantage of FA is that profit consolidation at the group level abolishes the incentives to engage in profit shifting activities. However, it is well known that the system may introduce new distortions, mainly investment distortions induced by the inclusion of input factors in the apportionment formula. Although FA has not been implemented at the international level yet, sub-national corporate taxation in the US, Canada and Germany has followed FA principles for decades.

While the profit shifting externality under SA is well-reported (see Devereux (2006)), empirical evidence on distortions under FA is thin. The small number of papers that investigates the impact of policy choices on real investment under FA (e.g. Weiner (1994), Klassen and Shackelford (1998), Goolsbee and Maydew (2000)) is moreover strongly inspired by the FA system implemented in the US, where states happen to choose both, the corporate tax rate and the apportionment formula, autonomously. Thus, the literature mainly centers around the question if US states may improve

their economic development by reducing the corporate tax rate or rather by changing the factor weights in their apportionment formula. Evidence in this field is far from being conclusive. While some authors derive significant effects of tax rate changes on investment and employment levels (e.g. Lightner (1999)), others are not able to find a stable relation and claim the apportionment formula to be the decisive policy means under FA (e.g. Goolsbee and Maydew (2000)).

The focus of the cited studies may, however, be inappropriate to provide policy recommendations with respect to the European Commission's proposal. Following the legislation of existing FA unions apart from the US, the European Commission plans to delegate the decision on the apportionment formula to a central layer while the single member countries may autonomously choose their corporate tax rates only (European Commission (2002)). Thus, it is seems most relevant to quantify distortions caused by an autonomous corporate *tax rate* choice under FA. Since the assessment criterion for multinational corporate taxation schemes is usually seen in the size of policy externalities exerted on foreign jurisdictions (see e.g. Nielsen et al. (2001)), this calls for empirical work to quantify corporate tax effects on foreign jurisdictions' investment and pre-tax profits in a FA system.

The present paper tries to fill this gap. We obtain data on the population of German firms that are liable to the German local business tax. The tax is raised at the municipality level and prescribes firms that operate affiliates in more than one community to consolidate their pre-tax profit at the national level and to apportion it according to the relative payroll share. Since our dataset allows us to identify all affiliates within a corporate group that are consolidated under FA regulations, we can, in contrast to previous studies, not only test the impact of the local corporate tax rate on the affiliate's investment and employment level, but may also determine the impact of corporate taxes at other group affiliates on the input choice. The latter effect represents the fiscal externality under FA and captures the inefficiencies introduced by this tax scheme. Precisely, since theoretical models show that the investment decision under FA depends on the tax rate *differential* between a jurisdiction and foreign group locations, we will

investigate the investment dependency on a tax difference measure.

Since apportionment under the German local business tax system takes place according to the relative payroll share, we expect the (major) distortions to fall on the payroll choice of the multi-regional firm. We employ a simple theoretical model to receive guidance for the specification of the estimation equation and eventually regress the affiliate payroll to capital ratio on the tax rate differential between the subsidiary tax and the average tax rate of other group entities. Intuitively, a rise in the corporate tax rate differential should decrease the affiliate's payroll to capital ratio since the multi-regional firm has an incentive to shift payroll expenditure to affiliates with a low corporate tax rate. Our results confirm this presumption as we find a stable and significantly negative effect of the tax rate difference on the payroll to capital ratio.

Thus, our paper is the first one to provide rigorous evidence on fiscal externalities under FA. Moreover, to the best of our knowledge, we are the first to provide evidence on corporate tax distortions under FA within the EU. Since the existing empirical evidence is restricted to the US and Canada (e.g. Mintz and Smart (2004)), policy recommendations with respect to the European Commission's proposal should largely gain from the investigation of FA systems *within* EU borders.

This chapter is structured as follows. In section 2, we will give a short introduction to the German local business tax, section 3 presents a simple theoretical model that shall motivate our estimation specification. In section 4, we present the estimation methodology and provide information on the data base. The estimation results are found in section 5, section 6 concludes.

4.2 German Local Business Taxation

The German federation currently comprises 12,544 municipalities. Each community may autonomously choose the local corporate business tax, while the tax base definition

is set at the national level. In our dataset, the average firm faces a local business tax rate of 16.25%, whereas the rate varies between 0% and 45%.[1] The considerable cross-sectional and longitudinal variation is usually accredited to the fact that the local business tax is the only major revenue instrument at communities' discretion and therefore is often adjusted to local budget needs.

Liable to the business tax are individual enterprises, non-incorporated and incorporated firms. The former two groups benefit from tax allowance of 24,500 Euros[2] and reduced taxes for the preceding pre-tax profits up to 72,500 Euros.[3] The allowances do not apply to incorporated firms. Hence, non-incorporated businesses face a progressive tax scheme, while incorporated groups are taxed according to a linear scheme.

The calculation of the German local business tax applies a rather special system that shall be sketched shortly. Starting point for the tax base calculation is the (corporate) income tax base for taxes paid at the national level. This measure is adjusted by certain positions. For example, (50% of) interest payments on long-term debt are added to the local business tax base while the tax base is shorted by a share of the corporate property value. To calculate the corporate tax liability, the adjusted tax base is multiplied by first, a percentage value called 'Steuermesszahl' (SMZ), which takes on values between 1% and 5%, and second, by the municipality's business tax rate, which varies between 0 and 900 business tax points for our sample years. The progressivity in the tax scheme for non-incorporated firms is thus reflected by the SMZ values. While for incorporated groups a SMZ value of 5% applies throughout, non-incorporated groups observe lower SMZ-values for income under the threshold of 72,500 Euros. Note, that the maximum business tax points can be recalculated in a 'standard' percentage tax value by multiplying the tax points by the maximum SMZ value of 5%; for example 325 tax points correspond to a (maximum) tax rate of 16.25%.

[1]Note, in 2002 a minimum local business tax of 1% was introduced. However, since our data set comprises earlier years this does not affect our analysis.

[2]Until January 1, 2002: 48,000 Deutsche Mark (DM)

[3]Until January 1, 2002: 144,000 DM

If a corporation operates affiliates in more than one community, a FA system applies. Thus, income of the multi-regional firm is consolidated at the national level and is apportioned to the single entities according to the relative payroll share. In seldom cases, apportionment takes place according to different factors if the payroll share does not reflect the actual business activity of a corporate group in a proper way.

In the following section, we will present the theoretical model that builds the basis of our empirical estimation strategy and will derive the main hypotheses.

4.3 Theory

We consider a standard model of corporate taxation under FA (similar models can be found in Gordon and Wilson (1986) and Nielsen et al. (2002) among others). The model comprises two symmetric countries a and b which host one affiliate of a representative MNE. The MNE produces a homogeneous good using labor L_i and capital K_i as input factors, with $i \in \{a, b\}$. We assume perfect competition on the product market whereas the price of the good is normalized to 1. A fixed production factor gives rise to positive profit which is taxed at rate t_i with $i \in \{a, b\}$. Workers receive a wage rate w_i which is fixed from the MNE's perspective and which we normalize to 1 for all jurisdictions.[4] The capital costs are denoted by the interest rate r and are assumed to be partially deductible from the corporate tax base, whereas the deduction parameter is given by γ and is assumed to be equal across jurisdictions.[5] The MNE's profit function reads

$$\Pi = \sum_i \left[\left(1 - \overline{t}\right) \left(F(K_i, L_i) - L_i - \gamma r K_i\right) - (1 - \gamma) r K_i \right], \quad i \in \{a, b\} \tag{4.1}$$

[4]This reflects the notion of a common labor market for all jurisdictions, that is, workers are mobile across borders which is well justified with respect to German municipalities. Moreover, a single firm is assumed not to be able to alter equilibrium wages by changing its individual labor demand.

[5]Note, that this corresponds to the German legislation since the deductibility of capital costs from the corporate tax base is chosen centrally at the national level while each jurisdiction may autonomously decide on the corporate tax rate parameter.

whereas $\overline{t}$ describes the MNE's average corporate tax

$$\overline{t} = t_a \frac{L_a}{L_a + L_b} + t_b \frac{L_b}{L_a + L_b} \tag{4.2}$$

Thus, corporate profit comprises output minus factor costs and is taxed according to a weighted average of the corporate tax rates in jurisdictions a and b in which the MNE observes business activity. This applies since under FA every unit of income earned in the corporate group is consolidated at the national level and is then apportioned to the single jurisdictions according to relative payroll share and taxed at the local statutory corporate tax rates. The MNE maximizes (4.1) by choosing its optimal labor demand L_i and the optimal capital stock K_i. This leads to the following first-order conditions

$$\frac{\partial F(L_i, K_i)}{\partial L_i} = 1 + \frac{(t_i - t_j)}{(1 - \overline{t})} \frac{L_j}{(L_a + L_b)^2} \left(\Pi_{Pa} + \Pi_{Pb}\right), \quad i, j \in \{a, b\}, i \neq j \tag{4.3}$$

$$\frac{\partial F(L_i, K_i)}{\partial K_i} = \frac{(1 - \overline{t}\gamma) r}{1 - \overline{t}} \tag{4.4}$$

whereas $\Pi_{Pi} = (F(K_i, L_i) - L_i - \gamma r K_i)$, for $i \in \{a, b\}$, represents the MNE's tax base in jurisdiction i. According to equation (4.3) the MNE's labor demand is distorted by corporate profit taxes. If $t_i > t_j$, the MNE has an incentive to reduce its labor demand in country i since it thus lowers the share of consolidated profit which is apportioned to i and taxed at the high corporate tax rate. If $t_i < t_j$ the MNE has an incentive to distort labor demand in favor of country i since this increases the fraction of the consolidated tax base that is taxed in country i at the relatively low tax rate t_i.[6] Optimal capital demand which is given by equation (4.4) is equally distorted by corporate taxation since capital costs are assumed to be only partially deductible from the corporate tax base. In case of full deductibility ($\gamma = 1$), the corporate tax becomes a pure profit tax and capital demand is undistorted by corporate taxation.

Thus, the corporate tax rate of the foreign location t_j influences local input factor choice through two channels. Assuming that $t_i > t_j$ an increase in t_j will reduce the

[6]Note that we could easily introduce a complementarity effect between input factors at the two locations in the spirit of Nielsen et al. (2001) and Becker and Riedel (2007). However, it can be shown that under FA the complementarity effect of corporate taxes abroad on home country input demand is always dominated by the formula effect described in this paragraph.

tax rate differential $t_i - t_j$ and will thus tend to increase labor demand in jurisdiction i according to equation (4.3). Second, if the foreign location t_j increases its corporate tax rate, this raises the average corporate tax for all affiliates in the multi-regional group and therefore lowers investment at all subsidiary locations. These two mechanisms constitute the basic fiscal externalities under FA, since they reflect an effect of foreign tax policy on local investment and the corporate tax base (which is not present in the benchmark case of tax coordination). While the former effect is usually referred to as formula externality, the latter is known as investment externality (Nielsen et al. (2001), Soerensen (2004)). Our analysis will mainly focus on the formula externality.

To obtain guidance for the specification of the estimation equation, let us assume a Cobb-Douglas production function of the following form

$$F(L_i, K_i) = L_i^{\alpha} K_i^{\beta} G_i^{1-\alpha-\beta}, \tag{4.5}$$

where G_i represents a fixed production factor. Dividing equation (4.3) by equation (4.4) and accounting for the Cobb Douglas technology one obtains

$$\frac{L_i}{K_i} = \frac{\alpha}{\beta} \cdot \frac{(1-\overline{t}\gamma)r}{(1-\overline{t}) + (t_i - t_j)\frac{L_j}{(L_a+L_b)^2}(\Pi_{Pa} + \Pi_{Pb})} \tag{4.6}$$

This expression is a modified version of the well-known relation between labor and capital demand and the relative factor price in the Cobb Douglas case. Taking the log of equation (4.6), we arrive at

$$\log \frac{L_i}{K_i} = \log \alpha - \log \beta + \log \frac{(1-\overline{t}\gamma)r}{(1-\overline{t})} - \log\left(1 + \kappa(t_i - t_j)\right) \tag{4.7}$$

$$\approx \log \alpha - \log \beta + \log \frac{(1-\overline{t}\gamma)r}{(1-\overline{t})} - \kappa(t_i - t_j) \tag{4.8}$$

with

$$\kappa = \frac{1}{(1-\overline{t})} \frac{L_j}{(L_a + L_b)^2} (\Pi_{Pa} + \Pi_{Pb}) \tag{4.9}$$

Thus, equation (4.8) suggests to regress the labor to capital ratio on the tax rate *difference* between a considered affiliate and other subsidiaries belonging to the same corporate group as well as on a measure for the average corporate tax rate of the multi-regional firm. As mentioned above, labor demand is distorted downwards by increases

in the tax rate differential between the home and foreign jurisdiction. As we assumed labor and capital to be complements (by the Cobb Douglas specification), the reduced labor demand at the home jurisdiction will translate in a reduced capital demand. However, the effect on capital is smaller than the initial labor adjustment. Thus, the labor to capital ratio will drop.

Moreover, taxes are predicted to affect the labor to capital ratio through the term $(1-\overline{t}\gamma)r/(1-\overline{t})$. Increases in the local tax rates t_a and t_b raise the multi-regional firm's average tax and thereby raise $(1-\overline{t}\gamma)r/(1-\overline{t})$. Thus, raising the tax rate at either group location, will tend to increase the labor to capital ratio. The result is driven by the partial deductibility of capital costs from the corporate tax base. Partial deductibility implies that increases in the corporate tax rate distort the multi-regional's capital demand downwards which tends to increase the labor to capital ratio. Since under FA, profit is effectively taxed at an average tax rate, this mechanism holds for increases in either of the group's affiliate taxes. Note, that if we assumed full deductibility of the capital costs from the corporate tax base ($\gamma = 1$), it holds that $(1-\overline{t}\gamma)r/(1-\overline{t}) = r$. Hence, in this case the term will reflect corporate capital costs only. The relative importance of labor and capital in the production process is represented by the parameters α and β and may well vary across industries. We will therefore account for industry effects in our estimation strategy.

The well-known problem with the equation derived above is that the size of the formula distortion may depend on the endogenous variables L_i and K_i. It is hence not possible to derive a closed-form solution for labor demand in location i. Theoretical papers in the FA literature therefore assume symmetric tax competition equilibria throughout to avoid this complication. The analysis then centers around the investigation of marginal deviations of the corporate tax rate difference from the symmetric equilibrium. Adjustments of κ driven by changes in the endogenous variable thus play no role in the analysis anymore. In the empirical model that follows we will also neglect the indirect impact of the tax rate differential on the κ term. Although this might be a rather strong assumption with respect to our empirical analysis, it nevertheless enables us

to receive some guidance on the model specification. Since the average tax difference between the locations is small (as will be shown in the sample statistics presented in Table 1), we are confident that our specification is not invalid.

It shall moreover be pointed out that equation (4.8) employs labor demand over capital investment as dependent variable. Our data set does not comprise information on employment but includes the affiliate's payroll costs only. Hence, the dependent variable used in the analysis will be payroll over capital investment. If we were willing to assume that wages are fixed, the implications derived in the analysis above will not be altered by this modification in the dependent variable. This may however not be true. Riedel (2006), for example, shows in a union bargaining model that under FA wages in the home country are likely to fall in the national corporate tax rate, while foreign wages are likely to increase. These wage effects point in the same directions as the formula externality, and are thus likely to amplify the estimation for the formula effect.[7] This does not have to be true, however, with respect to the capital investment effects. Precisely, it can be shown that increases in the home jurisdiction's corporate tax rate lower capital investment, but simultaneously lower wages bargained, that is the overall effect on the payroll capital ratio is ambiguous. In turn, increases in foreign affiliates' corporate tax rates also lower the affiliate's capital investment, but tend to increase the wage level bargained, henceforth the payroll to capital ratio is predicted to increase.

[7]Precisely, the formula effect states that increases in the tax rate differential between the affiliate and foreign group locations will reduce the affiliate's labor demand and henceforth the payroll to capital ratio. The wage effects prescribe that increases in the home jurisdiction's tax as well as decreases in foreign jurisdictions' taxes (that correspond to an increase in the tax rate differential between the home jurisdiction and foreign group locations) will reduce the wage level bargained in the home jurisdiction. Thus, the two effects point in the same direction.

4.4 Estimation Methodology

Following the discussion in the previous chapter, we estimate a model of the following form

$$\log\ w_{i,t} = \beta_0 + \beta_1(t_{i,t} - \overline{t_{i,t}}) + \beta_2\hat{t}_{i,t} + \beta_3 x_{i,t} + \beta_4\overline{x_{i,t}} + \phi_i + \epsilon_{i,t} \tag{4.10}$$

whereas $w_{i,t}$ denotes the ratio of payroll cost to capital employed by multi-regional plant i at time t. Since the distribution of payroll expenses is substantially skewed to the right, we employ the log of payroll cost as endogeneous variable. The central explanatory variable of the analysis comprises the difference between the corporate tax rate at the considered jurisdiction i and the tax rate at foreign affiliates $t_{i,t} - \overline{t_{i,t}}$. Moreover, we include a tax measure $\hat{t}_{i,t}$ that shall capture the group's average corporate tax. Since our data comprises two time periods, the estimation approach controls for affiliate fixed effects that capture unobserved time-constant plant-characteristics like the industry specific capital labor ratio. Moreover, we control for time-varying locational and industry characteristics at the home and foreign location $x_{i,t}$ and $\overline{x_{i,t}}$. The time-varying locational characteristics thereby comprise the local unemployment rate, the number of inhabitants and the number of employees.

One major advantage of our study compared to previous work lies in the possibility to connect affiliates of the same corporate group. This enables us to determine the impact of the corporate tax rate at foreign locations on the payroll to capital ratio as suggested by the theoretical model. However, the inclusion of information on subsidiaries in other jurisdictions also raises the need to find a proper weighting scheme for cases in which a corporate group consists of more than two entities. Theoretically, the average corporate tax rate reflects the tax burden on profit at foreign subsidiaries. Since the actual tax payment depends on the apportionment shares after consolidation and hence on the relative distribution of the payroll shares, the calculation of the average corporate tax rate at foreign affiliates should employ relative payroll weights. However, this may give rise to endogeneity problems since tax rate changes induce an adjustment of the payroll share that is employed as a weighting scheme.

Nevertheless it shall be noted that the direction of the distortion is not clear. To illustrate that, consider a corporate tax increase at one of the foreign affiliates. The optimal payroll adjustment would imply to lower the relative payroll share at this affiliate. Thus, the average tax increase is understated and the coefficient estimate for the effect of the average corporate tax rate on the local payroll costs tends to be too high. In contrast, if the corporate tax rate was lowered, the opposite picture emerges. Decreases in the corporate tax imply that the relative payroll expenditures at this affiliate are enlarged. This tends to overstate the reduction in the average foreign affiliate tax and thus leads to an underestimation of the effect of foreign corporate taxes on the local payroll share. The distortions thus point in different directions and may even cancel out each other, whereas this clearly does not have to be the case.

We hedge against this endogeneity concern by two strategies. First, we will employ an unweighted corporate tax measure. This will introduce measurement error to our average corporate tax variable. However, as long as this measurement error is unsystematic, it will just bias our results towards zero. If we can derive statistically significant effects, we might interpret them as a lower bound to the actual relation between the corporate taxes and the payroll to capital ratio. For the measurement error introduced to be unsystematic the corporate tax rates at foreign affiliate locations have to be uncorrelated with the affiliates' size. One might have some concerns with respect to this assumption, since larger communities tend to charge higher local business rates and also host relatively large corporations. This could possibly introduce systematic measurement error that may bias the estimations in both directions. We will therefore run specifications that rely on average tax measures which are calculated on the basis of the lagged payroll shares in the previous period and moreover will experiment with specifications in which we instrument for the average tax rate using the average tax of the previous period. Note, that all specifications will also control for other time-varying characteristics at foreign affiliate locations. For consistency reasons, the calculation methods (unweighted, payroll weighted) for the control characteristics will follow the calculation method for the tax rate variable.

4.5 Data Set and Sample Statistics

We test our theoretical hypotheses using a unique dataset provided by the German Federal Statistical Office. The data contains tax reports for the whole population of German corporations that are subject to local business taxation. The data is gathered directly from the German tax offices and is available for the years 1998 and 2001.

German corporations are obliged to file a detailed tax return for the calculation of their business tax liabilities every year. In each cross section, we observe 3 million corporations with respect to their location, capital investment, payroll cost, industry, multi-regional status (multi-regional vs. uni-regional firms), legal form (incorporated vs. non-incorporated firms), and taxable profit. Note, that the data set unfortunately does not include the number of employees, but only the payroll costs variable. Hence, we will estimate corporate tax effects on the payroll to capital ratio.

Most of the variables contained in the business tax database were quality checked by the tax offices and the German Federal Statistical Office since individual tax payments were calculated on basis of this data. The only exception is the information on the corporate input factors, i.e. capital investment and payroll expenses. Therefore, we ran plausibility checks on the data and excluded affiliates in the 1st and 99th percentile of the payroll and capital investment distribution from our empirical analysis.[8] Since our theory analyzes corporate tax effects on multi-jurisdictional firms, we restrict the regressions to multi-regional groups that on average observed a positive profit in the two sample years. The latter restriction is justified since the distortions we are interested in critically depend on positive multi-regional firm profits.

The dataset contains $130,672$ multi-regional corporations with 3.1 affiliates on average. While 42% of the affiliates in our data belong to a group that consists of two affiliates only, there are some groups with a substantial number of corporate facilities, the largest one comprising more than 1,000 entities. However, 95% of the corporate groups consist

[8]Note, however that this exclusion is not decisive for our qualitative and quantitative results.

of less than 50 affiliates. Hence, we will restrict our focus to firms with less than 50 entities for computational reasons.[9]

Furthermore, we augment our data by municipality characteristics at the firm location. Besides the corporate tax rate, we add the number of inhabitants, the number of employees and the local unemployment rate. The data for the community characteristics is thereby also gathered from the Federal Statistical Offices (mostly from the REGIO-STAT data base). The average corporate tax rate for the multi-regional firms in our data set is measured to be 325 local business tax points which translates in a percentage tax rate of approximately 16.25%. The other community variables summarized in Table 1 exhibit a pronounced heterogeneity across German municipalities. For example, population size varies between 5 inhabitants in the community of Wiedenborstel (state of Schleswig-Holstein) and 3.5 million inhabitants in the city of Berlin. Moreover, the economic situation of the municipalities differs and is proxied by the unemployment rate in our empirical analysis. While some communities observe low unemployment rates of around 1%, others are faced with more than 50% of the work force without job.

Moreover, we add Gauss-Krueger coordinates to our data and could thereby calculate the average distance between a group's affiliates. We obtain as a side result that the unweighted mean of the distance between the corporate subsidiaries amounts to 91.14 kilometer. If the distance between affiliates was weighted by the affiliates' payroll or capital shares the average distance reduces to 77.34 and 77.52 kilometers respectively. Unsurprisingly, the average distance between the corporate affiliates increases in the affiliate number. While corporate groups with two subsidiaries are located 65.23 kilometers apart on average, the (unweighted) average distance between corporate groups with five subsidiaries is 100.94 kilometers and the (unweighted) average distance for

[9]The main reason is that with larger firms it is time consuming to calculate an appropriate average corporate tax rate for the foreign affiliates.

groups with 10 to 50 subsidiaries is calculated to be 132.39 kilometers.[10]

Table 1 contains the basic sample statistics. The average corporate tax base of a multi-regional firm is estimated to be 660, 270 DM (around 340, 000 Euros). Corporate payroll expenses and capital invested amount to 54 million DM and 68 million DM respectively. The payroll to capital ratio is calculated with an average of 2889 which is excessivly large. However, a more detailed look at the data reveals that this mean calculation is driven by substantial outliers since the median of the distribution is 1.82 and the $95th$ percentile of the distribution is calculated with 34.82. We will therefore run sensitivity checks on our analysis excluding the upper percentiles from the estimation which will turn out to have no effect on our qualitative and quantitative results. Note moreover, that 48% of the multi-regional affiliates in our data belong to incorporated groups. Additionally, we obtain detailed information on the industry of a corporate group which we cluster to industry groups basically according to the NACE code and obtain 20 categories that broadly correspond to the NACE two-digit level.

Last, since our estimation strategy comprises a fixed effect approach that relies on the panel structure of the employed data, we should comment on the fact that the panel dimension in our dataset is rather small. Precisely, around 20% of the observations are linkable between the years. This roots in the fact that the identificator variable in the data is the multi-regional firm's tax account number which happens to be identical for all affiliates in a corporate group and is determined by the location of the corporate headquarter. This number may potentially change over time in the course of tax office restructuring or in case of headquarter moves to different municipalities (or in large cities even by a move to another quarter). We thus presume that the availablity of a panel dimension with a certain observation is randomly determined by tax office restructurings and corporate location changes and does not follow any underlying sys-

[10]The 'average distances' are calculated as the average distance of one affiliate to all other members of a corporate group for which the FA regulation applies.

temtatic.[11] Moreover, we aggregate the data at the community level and hence treat all entities in a community as one single affiliate.

The following section will provide the estimation results for the empirical strategy laid out above.

4.6 Results

The basic estimation results can be found in Table 2.[12] The endogenous variable is the payroll to capital ratio. We focus on the formula externality first and include the tax rate differential between the corporate affiliate and other members of the corporate group. The average tax rate at other members' location is thereby calculated as an unweighted average. Moreover we include a set of control variables comprising the legal status of the corporation as well as a set of industry-year dummies, affiliate fixed effects and time varying control characteristics at the subsidiary location that include inhabitants, employment and the local unemployment rate. The control variables on employment and inhabitants thereby enter in log-form, however, this is neither qualitatively nor quantitatively relevant for our results. Specification (1) indicates that the tax rate differential between the considered subsidiary and the rest of the corporate group exerts a significantly negative impact on the payroll to capital ratio. This is in line with our theoretical presumptions since the theory predicts that an increase in the corporate tax rate difference reduces labor demand at the affiliate which only partly translates in reduced capital investment through a complementarity relation. The other control variables broadly exhibit the expected signs. Non-incorporated firms tend to have a significantly higher payroll to capital ratio than incorporated firms (the latter

[11] Note, that we cannot determine the headquarter within a corporate group since the original tax account number was removed due to confidentiality requirements.

[12] Note that we report the calculation scheme for the average corporate tax rate of foreign affiliates at the bottom of the estimation tables. 'UW' thereby denotes that the average corporate tax rate was calculated as an unweighted measure. 'PW' denotes that we used payroll weights for the calculation.

constitute the base category) which corresponds to the common notion that the production process of non-incorporated firms is more labor-intensive than the production process of incorporated firms.[13] With respect to the location controls for the municipality characteristics of the own as well as of other group members' locations ('OGM' = Other Group Members), only employment at the home jurisdictions exerts a statistically significant effect. The positive coefficient indicates that corporate labor intensity is higher in communities with a large labor market. Specification (2) additionally includes a full set of state-year dummies that shall capture shocks over time to one of the 16 German states. The results do not change by much, however, the impact of the tax rate differential on the payroll to capital ratio slightly drops in size and significance as does the coefficient estimate for the number of local employees.

As we pointed out in section 2, non-incorporated and individual enterprises are granted tax allowances for pre-tax profits below 72,500 Euros. The tax regulation for this group of firms thus exhibits a convex scheme. In contrast, the tax scheme for incorporated firms is linear. This implies an underestimation of the relation between the tax rate differential and the payroll to capital ratio if we included non-incorporated firms in our regressions. To avoid this problem, we rerun our estimations accounting for incorporated firms only. In line with our presumption, the estimated coefficient for the tax rate difference increases in absolute size, now suggesting a semi-elasticity of -0.0008. Specification (3) thereby controls for industry-year dummies only, while Specification (4) also accounts for state-year dummies. To get an idea for the quantitative size of this estimate, we might consider a rise in the corporate tax rate by 1 percentage point that corresponds to an increase in the local business tax by 20 points. This will induce a decline of the payroll to capital ratio by 1.6%.

The estimation results so far were based on the calculation of an unweighted average of the tax rate at foreign locations. As pointed out above, from a theoretical point of

[13] Note, that we observe some changes in the legal status of corporate groups that we can track over the time period. This explains why the dummy variables on the legal status do not drop out despite the inclusion of firm fixed effects.

view a more appropriate measure might be the calculation of a payroll weighted average corporate tax rate. The results are presented in Table 3 and comprise estimates for the group of incorporated firms. The estimation exhibits the same pattern as the specification based on the unweighted average tax although the coefficients for the tax rate difference effect on the payroll to capital ratio are now slightly larger in absolute terms and estimated to be -0.0010. One may interpret this result to be in line with our presumption that the point estimate for the tax difference variable shall be lower if the tax difference was calculated based on an unweighted average tax measure since this introduces measurement error that biases the coefficient estimate towards zero. However, as described in the 'Methodology' section, we cannot fully exclude that both coefficient estimates, the estimate for the unweighted as well as for the payroll weighted average tax, are systematically biased. We will address this later by IV estimations.

But beforehand, we account for the corporate tax effects on capital investment derived in our model. Since our theory predicts the corporate tax at the home jurisdiction to distort capital investment downwards, we presume the payroll to capital ratio to rise with corporate tax increases. In Table 4, we augment our estimation model by the inclusion of the home jurisdiction's corporate tax rate. In Specification (1), we employ data on all multi-regional firms irrespective of their legal status; the tax rate differential is calculated on basis of an unweighted average of the foreign affiliate taxes. The control variables include industry-year effects and time-varying community characteristics. The tax rate differential remains to exert a negative and statistically significant impact on the payroll to capital ratio whereas it slightly increases in absolute size compared to the estimation results presented in Table 2. The coefficient estimate for the local corporate tax rate in turn exhibits a positive effect on the payroll to capital ratio as expected from our theoretical model. The estimates for the control variables show the same pattern as before. Specification (2) reestimates the relation additionally controlling for state-year effect. The coefficient estimates on the tax rate variable gain in absolute size without loosing their statistical significance.

Specification (3) presents estimations for the sub-group of incorporated firms. The

specification resembles Specification (1) for the group of all firms. In line with the presumption, the coefficient estimate for the tax rate difference variable is now slightly larger in absolute terms. Interestingly, the effect of local corporate taxes on the payroll to capital ratio, in contrast, looses in size compared to estimates including all multi-regional firms and does not exhibit statistical significance. There are basically two explanations for this phenomenon. First, corporate tax increases deter capital investment by non-incorporated firms more than capital investment by incorporated firms. Second, in a union wage bargaining setting, increases in the corporate tax rate lead to a reduction of wages bargained at the local affiliates, as was pointed out by Riedel (2006). This would tend to lower the payroll sum and therefore point in the opposite direction than the capital effect described in our theoretical model. If one assumes that the wage setting process in incorporated, and hence often large, multi-regional corporations is to a larger extent characterized by union wage bargaining than in non-incorporated firms, this might explain the difference in the estimated coefficients. Specification (4) additionally accounts for state-year effects and shows qualitatively and quantitatively equal results to Specification (3). All of the estimations presented so far in this table relied on a foreign corporate tax measure which was calculated as an unweighted average. In Specification (5), we use a payroll weighting scheme to calculate the foreign affiliates' average corporate tax rate. Clearly, the results do neither qualitatively nor quantitatively change.

As we discussed above, including a weighted or unweighted average tax rate calculation in our regression model may introduce endogeneity or measurement problems that may drive the effects presented in the last paragraphs. We address that by exploiting the panel structure of our data. Using observations on all firms for which we have data in both years and which did not change the composition of their group affiliates over the sample period, we determine the average corporate tax rate in 2001 based on the relative payroll shares in 1998. The lagged values shall hedge us against endogeneity problems with respect to the payroll weights. The estimation results are found in Specifications (1) to (3) in Table 5. Specification (1) presents estimation results for the

sub-group of incorporated firms and includes three tax measures: the payroll weighted tax rate difference between the subsidiary and foreign locations, the corporate tax rate at the subsidiary location and a the payroll weighted average corporate tax rate at the foreign affiliate location. The latter variable was ignored so far in our estimations although our theoretical model clearly predicted a positive impact of the foreign average tax on the payroll to capital ratio. In line with the previous estimation results, we find the corporate tax at the home jurisdiction to exert a significantly positive effect on the payroll to capital ratio. The coefficient estimate for the tax rate difference carries a negative sign, as expected, although it does not fully gain statistical significance. The coefficient for the average corporate tax rate at foreign affiliates, however, exhibits a negative sign (which contradicts our theoretical presumptions) but is far from being statistically significant (t-ratio: -0.73). Thus, we may value this as evidence that our data does not point to a negative investment externality in the sense that increasing the foreign corporate tax lowers investment at a group's affiliates under FA. In Specification (2), we thus only include the home jurisdiction's corporate tax rate and the tax difference variable. Both coefficient estimates on the tax variables loose in absolute size, the coefficient estimate on the tax difference variable still does not gain statistical significance. In Specification (3), we reestimate the model for all multi-regional firms. Here, the coefficient estimates gain statistical significance, whereas the semi-elasticity for the tax-difference term is estimated with -0.0405 and the semi-elasticity for the corporate tax rate at the home jurisdiction is estimated to be 0.0818. Thus, the estimates based on the lagged payroll weights confirm the qualitative estimates derived from the fixed effects model above, but suggest quantitatively smaller effects.[14]

In a last step, we employ an instrumental variable approach to account for possible endogeneity concerns. We thereby instrument for the average corporate tax rate (and other average jurisdictional characteristics) in 2001 using the average corporate tax value in 1998. Specification (4) displays the estimation results for the group of incorporated firms, while Specification (5) displays the results for the estimation accounting

[14]Note, that the calculation of the other control variables in the analysis equally employs the relative payroll weights from the year 1998.

for all multi-regional corporations irrespective of their legal status. Both estimations derive results in line with our basic hypotheses. That is, the tax rate difference exerts a significantly negative effect on the local payroll to capital ratio, while the home jurisdiction's corporate tax is shown to have a positive impact. The estimation for the subgroup of incorporated firms for example suggests that an increase in the local business tax by 1 percentage point (20 local business tax points) reduces the payroll to capital ratio by 1.6%, an estimate which is in line with the fixed effect specifications based on unweighted average tax rate calculations (see Table 2).

4.7 Conclusion

We may conclude that we find evidence for a quantitatively relevant distortion of the payroll to capital ratio by corporate taxation under the German FA system. This gives rise to a positive fiscal externality that translates into inefficiently low corporate taxes under FA. In turn, we cannot find evidence for a negative investment externality. Thus, the results indicate, that firms possess substantial flexibility in adjusting their payroll to capital ratio to changes in the tax rate differentials between their corporate subsidiaries at the intensive margin.

With respect to the European Commission's proposal to introduce FA within the European Union, our results suggest that some caution is warranted since the investment distortions under FA may be substantial. Our results indicate that a 1 percentage point increase in the corporate tax rate reduces the payroll to capital ratio by 1.6% which points to a strong adjustment of payroll expenditure according to which income in the German FA system is apportioned.

4.8 Appendix

Note: Throughout * will indicate significance on the 10% level, ** significance on the 5% level and *** significance on the 1% level.

Table 1: Descriptive Statistics for Multiregional Firms

Variables (in DM)	**Average**	**Standard Error**
Corporate Tax Base /1,000	660.27	16,121
Payroll Cost / 1,000	54,805	7,470,045
Capital Invested / 1,000	67,940	10,0329,111
Payroll to Capital Ratio	2889.0	$161,433.7$
Local Corporate Tax (in %)	16.25	1.640
Local Corporate Tax (in 'Hebesatz' points)	325	0.032
Tax Difference (Unweighted, in 'Hebesatz' points)	$1.94 \cdot 10^{-08}$	54.71
Tax Difference (Capital Weighted, in 'Hebesatz' points)	-3.73	57.76
Inhabitants	6740.48	403.90
Employees	2368.55	174.28
Unemployment Rate	0.1162	0.070

Table 2: End. Var.: Log Payroll to Capital Ratio				
	All Firms		*Incorp. Firms*	
Variable	*(1)*	*(2)*	*(3)*	*(4)*
Tax Rate Difference × 100	-0.0505^{***}	-0.0442^{*}	-0.0806^{**}	-0.0843^{**}
	(0.0259)	(0.0259)	(0.0401)	(0.0403)
Individual Enterprise	0.2015	0.2056		
	(0.1761)	(0.1761)		
Non-Incorporated Firm	0.5070^{***}	0.5165^{***}		
	(0.1425)	(0.1425)		
Inhabitants	0.0292	-0.0612	-0.2496^{*}	-0.2773^{**}
	(0.0921)	(0.0953)	(0.1373)	(0.1429)
Employment	0.1086^{***}	0.0727^{*}	0.1914^{***}	0.1897^{**}
	(0.0408)	(0.0418)	(0.0634)	(0.0648)
Unemployment Rate	0.0784	0.2016	-0.4353	-0.6869
	(0.2391)	(0.2636)	(0.3846)	(0.4361)
Inhabitants OGM	0.0278	0.0447	0.0561	0.0626
	(0.0302)	(0.0304)	(0.0439)	(0.0443)
Employment OGM	-0.0064	-0.0174	-0.0178	-0.0221
	(0.0252)	(0.0253)	(0.0370)	(0.0372)
Unemployment OGM	-0.3222	-0.1888	-0.8854^{**}	-1.0091^{**}
	(0.2670)	(0.2794)	(0.4216)	(0.4363)
Year / Industry-Year Dummies	√	√	√	√
State-Year Dummies		√		√
Weight	UW	UW	UW	UW
Number of Observations	342,827	342,827	150,217	150,217
Number of Groups	286,272	286,272	127,824	127,824
R Squared	0.96	0.97	0.97	0.97

Table 3: End. Var.: Log Payroll to Capital Ratio

	Incorp. Firms	
Variable	*(1)*	*(2)*
Tax Rate Difference × 100	-0.1074^{***}	-0.1037^{**}
	(0.0351)	(0.0335)
Inhabitants	-0.2452^{*}	-0.2691^{**}
	(0.1350)	(0.1404)
Employment	0.1995^{***}	0.1932^{***}
	(0.0617)	(0.0631)
Unemployment Rate	−0.5003	−0.6253
	(0.3741)	(0.4235)
Inhabitants OGM	0.0506	0.0588
	(0.0424)	(0.0427)
Employment OGM	−0.0186	−0.0239
	(0.0359)	(0.0361)
Unemployment OGM	-0.8060^{**}	-0.8602^{**}
	(0.4117)	(0.4269)
Year / Industry - Year Dummies	√	√
State - Year Dummies		√
Weight	PW	PW
Number of Observations	148,042	148,042
Number of Groups	126,131	126,131
R Squared	0.97	0.97

Table 4: End. Variable: Log Payroll to Capital Ratio

	All Firms		*Incorp. Firms*		
Variable	*1*	*2*	*3*	*4*	*5*
Tax Diff. × 100	-0.1145^{***}	-0.1267^{***}	-0.1258^{**}	-0.1394^{***}	-0.14182^{***}
	(0.0361)	(0.0367)	(0.0559)	(0.0482)	(0.0490)
Corp. Tax Rate × 100	0.1202^{**}	0.1591^{***}	0.0843	0.0914	0.0981
	(0.0471)	(0.0502)	(0.0729)	(0.0672)	(0.0720)
Individual Enterprise	0.1996	0.2036			
	(0.1761)	(0.1761)			
Non-inc. Firms	0.5039^{***}	0.5130^{***}			
	(0.1425)	(0.1425)			
Inhabitants	0.0362	−0.0529	-0.2425^{*}	-0.2328^{*}	-0.2606^{*}
	(0.0921)	(0.0954)	(0.1374)	(0.1352)	(0.1405)
Employment	0.1104^{***}	0.0726^{*}	0.1925^{**}	0.1981^{***}	0.1903^{***}
	(0.0408)	(0.0417)	(0.0634)	(0.0617)	(0.0631)
Unemployment Rate	0.0297	0.1756	−0.4774	−0.5029	−0.6286
	(0.2399)	(0.2638)	(0.3863)	(0.3749)	(0.4250)
Inhabitant OMG	0.0142	0.0288	0.0469	0.0770^{*}	0.0855^{**}
	(0.0306)	(0.0308)	(0.0446)	(0.0396)	(0.0398)
Employment OMG	−0.0028	−0.0141	−0.0156	−0.0538	-0.0591^{*}
	(0.0252)	(0.0254)	(0.0370)	(0.0331)	(0.0333)
Unemployment OMG	−0.4017	−0.2565	-0.9539^{**}	-1.1068^{***}	-1.1735^{***}
	(0.2688)	(0.2803)	(0.4257)	(0.3751)	(0.3867)
Year /Industry - Year Dummies	√	√	√	√	√
State - Year Dummy		√		√	√
Weight	UW	UW	UW	UW	PW
Number of Obs.	342, 827	342, 827	150, 217	148, 009	148.009
Number of Firms	286, 272	286, 272	126, 328	126, 128	126, 128
R Squared	0.97	0.97	0.97	0.97	0.97

Table 5: End. Variable: Log Payroll to Capital Ratio

	Weight 98			*IV Estimation*	
Variable	*1*	*2*	*3*	*4*	*5*
Tax Diff. × 100	−0.1061	−0.0543	−0.0405*	−0.0776*	−0.0614**
	(0.0798)	(0.0363)	(0.0239)	(0.0457)	(0.0294)
Corp.Tax Rate × 100	0.1274*	0.0816*	0.0818***	0.1132*	0.1113***
	(0.0785)	(0.0470)	(0.0305)	(0.0658)	(0.0419)
Average Tax × 100	−0.0629				
	(0.0864)				
Individual Enterprise			−0.8565***		−0.8558***
			(0.0171)		(0.0171)
Non Inc. Firms			−0.6166***		−0.6161***
			(0.0197)		(0.0196)
Inhabitants	0.0367	0.0349	0.0239	0.0330	0.0212
	(0.0343)	(0.0343)	(0.0218)	(0.0347)	(0.0220)
Employment	0.0359	0.0369	0.0598***	0.0385	0.0617***
	(0.0261)	(0.0261)	(0.0163)	(0.0261)	(0.0164)
Unemployment Rate	0.6526*	0.6336*	0.1535	0.5606	0.1050
	(0.3687)	(0.3677)	(0.2396)	(0.3689)	(0.2399)
Inhabitants OMG	0.1157***	0.1116***	0.0834***	0.1052***	0.0747***
	(0.0374)	(0.0370)	(0.0233)	(0.0384)	(0.0242)
Employment OMG	−0.0225	−0.0213	0.0186	−0.0215	0.0211
	(0.0296)	(0.0295)	(0.0184)	(0.0297)	(0.0185)
Weighted Unempl. OMG	−1.1805***	−1.182***	−0.8068***	−1.0939***	−0.7390***
	(0.2686)	(0.2686)	(0.1852)	(0.2686)	(0.1850)
Year + State + Industry Dummies	√	√	√	√	√
Number of Obs.	24,878	24,878	57,779	24,877	57,775
Adj. R Squared	0.1791	0.1791	0.1834	0.1790	0.1835

Chapter 5

Corporate Taxation and Complementarities within Multinational Firms

5.1 Introduction

In the public opinion, multinational enterprises (MNE) are considered to be accelerators of globalization. From a fiscal point of view, MNEs are supposed to be those companies that adjust their tax base elastically to corporate tax increases - by re-allocating either production or profits abroad. There is extensive evidence that profits are shifted across borders in response to tax rate differentials (e.g. Hines and Rice (1994) and Clausing (2003)). Moreover, a large number of studies shows that multinational investment decreases in the national corporate tax rate (see e.g. Devereux (2006) for a survey). While most authors implicitly interpreted the latter results as evidence for production relocation to foreign subsidiaries, the link has never been tested explicitly to the best of our knowledge.

The last years have seen a number of studies that investigate whether increased foreign capital investment of MNEs replaces domestic investment. The rather surprising result that emerges from these papers, is that foreign investment does not reduce domestic investment, it rather boosts it (see e.g. Desai et al. (2004), Egger and Pfaffermayer (2003)). Therefore, increasing capital, employment and sales abroad is suggested to trigger enhanced activity at home. In technical terms, foreign and domestic activities are not substitutes, they are complements.

This observation may have important consequences for optimal tax policy considerations, as we theoretically demonstrate in Becker and Riedel (2007b). If domestic and foreign asset stocks are complements, not substitutes, domestic taxes may exert a negative externalities on the foreign stock of assets and consequently on the foreign corporate tax base. This effect obviously runs counter to the well-established positive externality due to profit shifting. In simple words, domestic taxes increase foreign tax revenue because reported foreign profits increase due to shifting activities, and they reduce foreign tax revenue because foreign activity is deterred due to complementarity effects. Which of the two externalities prevails is an open, i.e. an empirical question.

The purpose of this paper is two-fold. Firstly, we use a large firm-level data set in order to empirically measure the tax effects on capital stocks within a multinational firm. Our results show that there is a strong and economically significant negative effect of domestic taxes on foreign assets. Secondly, we try to quantify the externalities caused by the intra-firm complementarities and profit shifting behavior. Here, our results indicate that the profit shifting effect dominates. However, the complementarity effect is shown to compensate a substantial part of the profit shifting externality on foreign affiliates' pre-tax profit (around 30%). If one takes into account that increased multinational activity may raise national welfare through other channels (for example, through a reduction in the national unremployment rate), the welfare effects caused by complementarity relations within MNEs may be even larger. Our findings thus imply that distortions caused by corporate taxation of MNEs might be less severe than usually considered and that defensive measures like the introduction of a multinational corporate taxation scheme following Formula Apportionment principles as proposed by the European Commission (see European Commission (2001)) may not be justified.

The literature on the causal relationship between foreign and domestic investment starts with Feldstein (1995) who provides evidence using aggregate investment data and claims that investment abroad reduces domestic investment 'dollar for dollar'. Desai et al. (2005a) confirm this result with respect to aggregate values but they also find that US multinationals increase their domestic capital stock in response to investment abroad. In Desai et al. (2005b), they use firm-level data of US multinationals and show that foreign investment in plant, property and equipment (PPE) is associated with higher domestic PPE investment. Similarly, Egger and Pfaffermayer (2003) find that foreign investment increases domestic investment in tangible assets and does not decrease investment in intangibles. Castellani et al. (2004) and Jaeckle (2006) show that going abroad increases domestic productivity and competitiveness. Lipsey (1995) analyzes a cross-section of American multinational firms, reporting a mild positive correlation between foreign production and domestic employment levels. Stevens and Lipsey (1992) analyze the investment behavior of seven multinational firms, concluding

that investments in different locations substitute for each other due to costly external financing. The absence of compelling instruments that satisfy the necessary exclusion restrictions complicate the interpretation of this evidence, a problem that likewise appears in studies of aggregate FDI and domestic investment. Devereux and Freeman (1995) come to a different conclusion in their study of bilateral flows of aggregate investment funds between seven OECD countries, finding no evidence of tax-induced substitution between domestic and foreign investment. Desai et al. (2006) ask whether investment in tax havens diverts activity from non-havens and find that non-haven activity rises in response to tax haven investment activity.

To the best of our knowledge, there are no empirical studies analyzing complementarity effects from a public finance point of view. There are only a few theoretical contributions. Nielsen et al. (2004) show that production in the multinational firm's affiliate and headquarter can be complementary in the presence of a firm-wide public good (e.g. a brand, patent, etc.). They build a model in which taxes have negative fiscal externalities and suggest that complementary production structures may give rise to overtaxation. In Becker & Riedel (2007), we show that overtaxtion is no likely result if capital market externalities on the interest rate are accounted for. However, the presence of MNEs lowers the degree of tax competition, and equilibrium tax rates are higher the higher the fraction of multinationals.

The remainder of this chapter is organized as follows. In the next section, two hypotheses are developed and the estimation methodology is set out. Section 3 presents the data, gives some descriptive statistics and reports the results. In section 4, we consider several extensions of the analysis. Section 5 discusses some implications and concludes.

5.2 Hypotheses and Estimation Methodology

In this section, we derive two theoretical hypotheses (5.2.1) and outline the basic estimation methodology to identify the proposed effects (5.2.2).

5.2.1 Hypotheses

Consider the following illustrative model. There are two countries, called the domestic and the foreign country, in a large world capital market. The domestic country hosts the headquarters of a representative MNE, the foreign country the affiliate. The MNE produces output in both locations using capital K as the only production input. Capital is provided by the world capital market at an interest rate of r. For the headquarters level, output reads $F^h\left(K^h\right)$ where h denotes the headquarters. For the affiliate level, output is given by $F^a\left(K^h, K^a\right)$, the superscript a denotes the affiliate. The affiliate's output depends on the affiliate's capital stock and the headquarter endowment with capital.

What is the intuition of this assumption? The affiliate's output may depend on the headquarters capital stock if research and development (R&D) is carried out at the headquarter, and affiliate investment becomes more profitable and/or productive if R&D is successful. Moreover, if an increased headquarters capital stock increases the quality of the product for which affiliate output is a complement, the profitability (i.e. the marginal productivity) of the affiliate capital stock is increased. Alternatively, a third story would consider the affiliate as a pure distribution center which has some fixed cost but very low marginal cost for distributing one extra unit of output. If the headquarters' capital stock and output increases, the value of the capital at the subsidiary rises, too.

Thus, the after-tax profits of the MNE is given by

$$\begin{aligned}\Pi &= F^h\left(K^h\right)\left(1-\tau^h\right) + F^a\left(K^h, K^a\right)(1-\tau) - r\left(K^h + K^a\right) \\ &\quad + \left(\tau^h - \tau\right)s - C\left(s\right) \end{aligned} \tag{5.1}$$

whereas τ^h and τ denote the corporate tax rates at country h and country a respectively. For simplicity reasons, we assume that capital cost are not deductible from the corporate tax base which corresponds to full equity finance of the investment projects.

Moreover, the MNE may shift profits between the headquarters and its affiliate. The

amount of profit shifted from the headquarters to the affiliate is thereby denoted with s, whereas $s > 0$ ($s < 0$) if profit is shifted from the headquarters to the affiliate (from the affiliate to the headquarters). To derive an interior solution, we assume that profit shifting causes convex concealment cost of $C(s)$ with $\partial C/\partial s = sign(\tau^h - \tau)$ and $\partial^2 C/\partial s^2 > 0$ (see e.g. Haufler and Schjelderup, 2000). Optimal profit shifting activities are determined by the first order condition $C_s = \tau^h - \tau$. Optimal investment implies

$$K^h \quad : \qquad F_h^h + F_h^a \frac{1-\tau}{1-\tau^h} = \frac{r}{1-\tau^h} \tag{5.2}$$

$$K^a \quad : \qquad F_a^a = \frac{r}{1-\tau} \tag{5.3}$$

with $F_h^h = \partial F^h/\partial K^h$, $F_h^a = \partial F^a/\partial K^h$, $F_a^a = \partial F^a/\partial K^a$. Equations (5.2) and (5.3) determine the capital demand functions for K^h and K^a.

As laid out above, we are interested in the corporate tax effects on the own and foreign capital stock. From equations (5.2) and (5.3) it follows that the marginal effect of a corporate tax increase at the parent firm on headquarters and subsidiary investment reads

$$\frac{dK^h}{d\tau^h} = \frac{F_{aa}^a}{(1-\tau^h)F_{hh}^h F_{aa}^a + (1-\tau)(F_{hh}^a F_{aa}^a - F_{ha}^a F_{ah}^a)} \cdot F_h^h \tag{5.4}$$

$$\frac{dK^a}{d\tau^h} = -\frac{F_{ah}^a}{(1-\tau^h)F_{hh}^h F_{aa}^a + (1-\tau)(F_{hh}^a F_{aa}^a - F_{ha}^a F_{ah}^a)} \cdot F_h^h \tag{5.5}$$

We assume that $F_{hh}^a F_{aa}^a - F_{ha}^a F_{ah}^a > 0$ holds, which ensures concavity of the production function F^a in K^h and K^a. Moreover, we presume $F_{ah}^a > 0$ which corresponds to a complementary relationship between capital investment at the affiliate and subsidiary level. It follows then directly that $dK^h/d\tau^h < 0$, and $dK^a/d\tau^h < 0$. Intuitively, increases in the headquarter tax rate enhance the local capital cost and reduce investment at the headquarter location. If production at the affiliate and headquarters level are complements as suggested by the empirical work cited in the introduction, the investment reduction at the headquarters location translates in a drop of investment

at the affiliate. Note that, in the absence of any interdependencies, i.e. $F^a_{ah}, F^a_{ha} = 0$, tax effects are given by $dK^h/d\tau^h = r/\left[F^h_{hh}\left(1-\tau^h\right)^2\right]$ and $dK^a/d\tau^h = 0$. Note that expression (5.4) and (5.5) are derived assuming constant interest rates.[1] Hypothesis 1 directly follows

Hypothesis 5.1 *Consider the investment at the headquarter and affiliate location to be complements. Then a corporate tax increase at the headquarter location reduces capital investment at the subsidiary level.*

If hypothesis 1 is true, then domestic taxes have a negative externality on the foreign country's tax revenue. Let $T_i = \tau_i \cdot B_i$, $i \in \{h, a\}$, denote the tax revenue in the domestic and the foreign country, whereas B_i describes the local tax base which is given by the representative multinational's pre-tax profit $B^h = F(K^h) - s$ and $B^a = F(K^a, K^h) + s$. The effect of the domestic country's tax rate increase on the foreign country's tax revenue is given by $dT_a/d\tau^h = \tau \cdot dB_a/d\tau^h$ with

$$\frac{dB_a}{d\tau^h} = \frac{\partial F^a}{\partial K^a}\frac{\partial K^a}{\partial \tau^h} + \frac{\partial F^a}{\partial K^h}\frac{\partial K^h}{\partial \tau^h} + \frac{\partial s}{\partial \tau^h} \tag{5.6}$$

In the absence of these complementarities, the externality caused by corporate taxation would comprise solely the profit shifting effect $\frac{\partial s}{\partial \tau^h} > 0$. This is the externality usually associated with national tax policy in the presence of multinational entities: If the parent company faces a higher tax rate, then profit is shifted to the affiliate country which increases the corporate tax base of the affiliate location.

However, in the presence of complementarities in production, $\partial K^a/\partial \tau^h > 0$ and $\partial F^a/\partial K^h > 0$, the positive profit shifting externality may be compensated by a negative externality of the headquarters tax on the affiliate's capital stock. The rationale of this result is that a corporate tax increase at the headquarters location does not only

[1] It seems that the assumption of constant interest rates is justified in the framework of our empirical purpose. The sample under consideration mainly consists of MNEs located in European countries which may be considered small from world capital point of view. However, interest rate effects will be discussed where necessary.

induce the shifting of paper profit to the subsidiary, but additionally reduces headquarters capital investment that translates into a lower investment level at the subsidiary location in the presence of intra-firm complementarities. In sum, the externality of corporate taxation may be positive or negative. In terms of tax competition, that implies that equilibrium tax rates may be inefficiently low or high. This is captured by the following hypothesis

Hypothesis 5.2 *The positive fiscal externality due to profit shifting opportunities of MNEs is (partially) compensated by the negative fiscal externality due to production complementarities.*

It is worth discussing briefly how hypothesis 2 relates to the standard literature on multinational profit shifting in the presence of tax differentials between countries. Especially, we could ask if hypothesis 2 implies that studies measuring the impact of tax differentials on profit shifting are misled. From our point of view, the answer is no, because these studies usually choose as dependent variable the profitability of each affiliate as reported by the multinational firm, where profitability means the ratio of reported profits over assets. By dividing profits through assets, this approach abstracts from all effects on assets. We argue that these studies correctly measure the profit shifting activity *per unit of capital*. Estimations of the total amount shifted by multinational firms, though, will be biased if the complementarity externality is not taken into account. Our results imply that low-tax countries profit far less than expected from high tax environments in other countries.

Moreover, it shall be pointed out that the same relation between the corporate tax rate and foreign multinational investment can be derived by funding restrictions in the sense that the MNE may not receive the financing for all profitable investment projects within its group. If new investment projects are partly financed from retained profit, then a corporate tax reduction at the headquarters location increases the headquarters' after-tax profit and thus the funds available for project finance within the corporate group. This may equally raise the capital stock invested at the foreign affiliates. In

the following, we will not be interested in the identification of channels through which capital taxes abroad reduce capital investment at the affiliates, but will simply try to provide evidence that a negative causal relationship exists.

5.2.2 Estimation Methodology

The purpose of the empirical section is to test for the hypotheses derived above. We first determine the effect of corporate taxes at the headquarters location on foreign subsidiaries' capital stock. This is captured by the following estimation equation

$$\log\ k_{i,t} = \beta_0 + \beta_1\ \tau_{i,t} + \beta_2 \tau_{hi,t} + \beta_3 x_{i,t} + \beta_4 x_{hi,t} + \phi_i + \epsilon_{i,t} \tag{5.7}$$

whereas $k_{i,t}$ denotes the fixed assets of affiliate i at time t. Since the distribution of fixed assets is rather skewed, we employ the logarithm as endogeneous variable. To determine the cross effect of headquarters taxes on foreign subsidiaries' investment, we include the corporate tax rate at the headquarter location $\tau_{hi,t}$ as explanatory variable. Additionally, the estimation approach controls for affiliate fixed effects ϕ_i that capture unobserved time-constant plant-characteristics, and for time-varying locational and industry characteristics $x_{i,t}$, as well as time-varying characteristics of the parent country $x_{hi,t}$.

The aim of the analysis is to capture the effect of parent country taxes on subsidiary investment accounting for other possible investment determinants. The theory predicts that subsidiaries with parents in high-tax countries invest less than subsidiaries with parents in low-tax countries. Therefore, we expect β_2 to be negative. In some specifications, we include country-year fixed effects which fully capture the impact of tax rate and other policy variable changes at the subsidiary's location. Hence, we are able to implicitly compare capital investment of subsidiaries in the same country that only differ in their parent's location and thus in the parent country's tax policy. Note that if tax rate changes have effects on the interest rate, these effects will be equal for all firms and will therefore be absorbed by the country-year fixed effects, too.[2]

[2]Of course, we are also interested in the sign and the size of β_1 which measures the effect of the

As a robustness test to our analysis, we will rerun the estimations using not the national tax rate, but the affiliate's actual tax payments as explanatory variable. Since there might be some reverse causality concerns with respect to the impact of actual tax payments on the corporate capital stock, we estimate equation (5.7) employing a first-difference approach which follows Arellano and Bond (1991). First-differencing controls for affiliate fixed effects, and if there is no serial correlation, the lagged tax payments is not correlated with the differenced error term and is therefore a valid instrument for the current tax payments. Lack of serial correlation provides a moment restriction, so that equation (5.8) can be estimated using the general methods of moments restriction. In comparison to conventional instrumental variables estimators, this moment restriction provides additional instruments so that this GMM estimator is more efficient. To test the validity of these instruments we use a Sargan/Hansen test (Sargan, 1958, Hansen, 1982) of overidentifying restrictions. Because the model is estimated in first-differences, the equation will be characterized by the presence of first-order serial correlation. But the validity of the GMM estimator relies on the absence of second-order serial correlation. The tests for second-order serial correlation by Arellano and Bond (1991) will be reported at the bottom of the result tables.[3]

In a second step, we will quantify the impact of corporate taxes on the multinational's pre-tax profit. If complementarities in asset stocks are accounted for, there are two effects which compensate each other. Firstly, higher tax rates at the parent's location increase the reported profits of the subsidiary due to profit shifting activities. Secondly, higher parent location tax rates reduce the subsidiary's stock of capital and thereby

subsidiary's location tax rate on the subsidiary's asset stock size. Note, though, that we cannot fully exclude that other unobserved policy changes drive the result in the regressions in which we include the national corporate tax rate as explanatory variable since the national corporate rate affects all (profitable) corporations in a given country in the same way and hence, a 'control group' to the analysis within the same country is missing. However, we address this problem in an extension section by regressing the capital stock on the actual corporate tax payments.

[3]We have chosen the lags of the instruments on the basis of the serial correlation test and the Sargan Hansen test.

reduces the subsidiary's profits. The estimated equation is given by

$$\Delta \log\ b_{i,t} = \alpha_1 \Delta\ Diff_{i,t} + \alpha_2 \Delta \log\ k_{i,t} + \alpha_3 \Delta x_{i,t} + \alpha_4 \Delta x_{hi,t} + \Delta \epsilon_{i,t} \tag{5.8}$$

The coefficient α_1 measures the impact of the corporate tax rate *difference* $Diff_{i,t}$ between the headquarter and the affiliate country on the reported pre-tax profits $b_{i,t}$. In contrast, α_2 captures the effect via the asset stock size $k_{i,t}$ which may be affected by the parent tax rate; $x_{i,t}$ and $x_{hi,t}$ are control variables as defined above.

In contrast to the profit shifting channel, the impact of the firm's assets on profit's may be mismeasured due to reverse causality problems: high profits may equally trigger high capital investment. Therefore, we estimate the effect of an asset increase on profits by employing the first-difference approach by Arellano and Bond (1991) shortly described above. Note, that Δ denotes the first difference of a variable. First-differencing controls for affiliate fixed effects, and if there is no serial correlation, lagged fixed assets are not correlated with the differenced error term and are therefore valid instruments for the current fixed assets. Following equation (5.7) we additionally include the corporate tax rates at the affiliate and parent location as instruments for affiliate fixed assets. To test the validity of these instruments we again use a Sargan test of overidentifying restrictions.[4]

5.3 Data, Descriptive Statistics and Results

In this section, we describe the data base (5.3.1), give some descriptive statistics (5.3.2) and report the result of the estimation approach outlined above (5.3.3).

[4]Note moreover, that the standard errors of the GMM model presented in the Result Section are robust one-step errors. Simulation studies have shown that the efficiency gain from using the two-step procedure is very modest even in the presence of considerable heteroscedasticity (Arellano and Bond (1991)).

5.3.1 Data Set

Our empirical analysis relies on the AMADEUS data base which is compiled by Bureau van Dijck and contains detailed accounting and firm structure information for 1.6 million corporations in 38 countries. The data is available from 1995 to 2005, but unbalanced in structure. Since our analysis centers around corporate tax effects on multinational firms, we restrict our sample to subsidiaries which are directly and ultimately owned by a foreign parent company.[5] Additionally, for an affiliate to be included in the data set it has to be ultimately owned by an industrial corporation and has to employ more than 10 workers (see for example Navaretti et al. (2003)).

Apart from this, we include companies based on the availability of the essential information needed for our analysis (fixed assets, corporate tax rate at affiliate and parent location). Additionally, affiliate observations will only be used in the regressions if the link to the global ultimate owner as well as basic information on this parent corporation is available with AMADEUS. Last, we have to restrict the sample to corporate groups with unconsolidated accounting information.

The ownership information in our data refers to the last reported date which is the year 2005 for most corporations in our data set. Thus, ownership has a cross sectional dimension only. In line with previous work based on the same data, we are not too concerned about this assumption. To the extent that we are potentially including a few affiliates which were not affiliated in earlier years, we are introducing measurement error that biases our results towards zero (Budd et al. (2005), Navaretti et al. (2003)).

Matching parent companies to foreign affiliates gives an unbalanced panel with 5429 affiliates and 2049 parent corporations over 10 years. Table 1 exhibits the country distribution which is basically consistent with patterns of multinational firms in Europe. Most of the global ultimate owners are concentrated in Western European countries

[5]The AMADEUS data contains information on a corporation's direct investment in other firms. For a corporation to be identified as parent company, it has to own 100% of the subsidiary directly and ultimately.

like France, Germany and Belgium. In contrast, many subsidiaries are located in the European South (Spain and Italy) as well as in new EU member states like the Czech Republic and Poland.

Since our analysis investigates corporate tax effects on capital investment and pre-tax profit, we merge the firm data with data on the statutory corporate tax rates for EU 25 countries as well as other country characteristics like GDP per capita, GDP growth rate, the population size and an earnings index for the manufacturing industry. The corporate tax rates are thereby taken from the European Commission (European Commission (2006)), while the information on GDP per capita and population size is obtained from the OECD (OECD (2007)).

5.3.2 Sample Statistics

The data contains 34237 affiliate-year observations. Thus, the accounting information is available for 6.3 years on average. Table 2 summarizes basic sample statistics. The average amount of fixed assets at the affiliate level is measured to be 36 million US Dollar. Moreover, the average employment level amounts to 250 employees while the corporations earn a pre-tax profit of 3 million US dollar on average. The average corporate tax rate at the parent location is measured with 0.35 and is, hence, slightly higher than the corporate tax rate at the affiliate location which is 0.33. This observation is line with the common perception that headquarters are mainly located in western European high-tax countries while production also takes place through affiliates in Eastern and Southern European countries with lower corporate tax rates. Additionally, we will run sensitivity checks on our regressions using the actual corporate tax payments instead of the national tax rate as explanatory variable. We calculate this measure by dividing actual corporate tax payments by corporate total asset. Total assets are used because this information is available for more parent corporations than pre-tax profit or fixed assets and hence, we hedge us against loosing too many observations. The average tax payment per total assets amounts to 0.04 at the affiliate level and 0.02 at

the headquarter location. Interestingly, (assuming equal productivity) the headquarter thus carries a lower tax burden than the subsidiaries.

5.3.3 Estimation Results

Our central aim is to determine the effect of the corporate tax rate at the affiliate and parent level on the volume of affiliate's fixed assets. This shall capture the complementarity effect described in our theoretical analysis. In a second step, we will determine the corporate tax effect on *pre-tax profits* distinguishing the complementarity effect from the profit-shifting effect.

Table 3 contains fixed-effect estimations of the corporate fixed assets on the statutory corporate tax rate at the affiliate and parent location. In Specification (1), we include a full set of year and affiliate dummies to control for time-constant affiliate characteristics and shocks common to all affiliates over time. We find a significantly negative effect of both, the domestic and the foreign statutory tax rate, on fixed assets. The semi-elasticities are calculated with -0.6903 and -0.3874 respectively. Specification (2) reestimates the relationship including a set of variables controlling for time-varying country characteristics at the affiliate and parent location. We account for GDP per capita, population size, the growth rate of GDP per capita and earnings in the manufacturing industry. Multinational firms tend to locate high investment levels in countries with high populations, while a large population at the parent country deters investment. This is in line with the basic proximity concentration trade-off known from trade-theory models. The service of large markets via exports is associated with high transport costs. That increases the attractiveness of FDI compared to exports. Moreover, a high GDP growth and high earnings in manufacturing tend to increase multinational capital investment, whereas we find also weak evidence that high levels of these controls in the parent country tend to increase the fixed asset stock at the affiliate.[6] Although GDP per capita at the affiliate exhibits an unexpected negative

[6]All control variables despite the GDP growth rate enter the estimation equation in log form. This

sign, this can be explained by the additional inclusion of earnings in the manufacturing index as a proxy for the (change) in national income as well. Without the inclusion of manufacturing earnings, GDP per capita captures the positive income effect on capital investment.

The inclusion of the additional country controls substantially increases the estimated coefficients for the statutory tax at the affiliate as well as at the parent country. Specifications (3) and (4) additionally include a set of industry year dummies and a set of year - Eastern Europe dummies accounting for possible differences in shocks to Western and Eastern Europe over time. Industry is thereby specified at the NACE 1-digit level. The estimated taxation coefficients are robust to these inclusions and remain large and statistically significant. The semi-elasticities estimated in Specification (4) are -0.6903 for the tax at the affiliate country and -0.3874 for the tax at the parent country. Last, in Specification (5) we add country-year effects which absorb all country-specific shocks to the subsidiary and also capture the corporate tax effect on local investment (hence, there is no coefficient estimate reported for this effect). For this specification, the estimated coefficient slightly drops in size but remains statistically significant at the 1% level. In Table 4, we re-estimate the model including the corporate tax effects in log-form. The coefficient estimates are qualitatively and quantitatively similar to the results for the semi-logarithmic form. Controlling for country-year effects, Specification (5) suggests that a 10% increase in the parent tax rate reduces investment at the affiliate level by 1.9%.

Thus, we can conclude that there is quite robust evidence for a negative and significant impact of home country taxes on host country activity.[7] This generates a

specification is chosen since it seems to fit the data slightly better than an inclusion in levels. Note, however, that the estimated corporate tax coefficient are neither qualitatively nor quantitatively sensitive to the specification of the controls.

[7]Note again, that the purpose of our study is not to provide evidence on the exact channel through which parent taxes impact on affiliate investment. However, evidence that our data is broadly consistent with the theory presented above, we regressed fixed assets at the parent location on corporate taxes at the parent country. The results are displayed in Table 5. As presumed the effect is signifi-

potentially important externality of domestic tax policy on the foreign country's tax revenue. Therefore, this finding may have implications for tax efficiency in the presence of multinational corporations and is thus related to another hotly debated question: inefficiencies caused by cross-border profit-shifting. It is straight-forward to ask how these two externalities are related to each other. While tax rate increases exert a positive externality on the other country's tax revenue via the profit shifting channel, complementarities generate a negative externality. Our aim is to quantitatively weigh these two effects against each other.

Therefore, we investigate the causal effect of domestic and foreign corporate taxes on corporate pre-tax profit, thereby differentiating the profit shifting and the complementarity effect. One unique feature of profit shifting activity is that the shifting volume is determined by the *tax differential* defined as domestic statutory corporate tax minus parent statutory corporate tax rate. Thus, we can capture the profit shifting effect by including the tax rate differential in the estimation equation for corporate pre-tax profit. In contrast, the complementarity effect is driven by the impact of foreign corporate taxes on domestic input factor choice which in turn affects domestic corporate pre-tax profit. Hence, we include fixed assets in the estimation equation. Following our analysis so far we estimate a GMM model where we instrument for fixed assets using the domestic and foreign statutory corporate tax rates. Moreover the third to fifth lag of the fixed assets variable are included among others to instrument for the change in fixed assets.[8]

cantly negative. Note, however, that the number of parent firms for which the information of fixed asset investment is available falls short from the overall number of parents in our study. Moreover, since fixed assets variable for the parent location exhibits substantial variation, the estimations presented in Table 5 exclude the 5th and 95th percentile of the fixed asset variable. Note furthermore, that the effect of corporate taxes at the parent location on affiliate fixed assets reported in Table 3 is quantitatively substantial and may not exclusively explained by complementarities in fixed assets at the parent and subsidiary location. Instead, limiting financing may also play a significant role in explaining the results. We leave a detailed analysis to future research.

[8]The lags of instruments were chosen based on the test on second order autocorrelation and the Sargan/Hansen test.

Table 6 presents several model specifications. Specification (1) controls for GDP per capita and population at the affiliate and parent country and year dummies. The tax rate differential enters with a negative sign, as expected, the semi-elasticity is estimated with -0.7189. Thus, a larger difference between the statutory tax rate at the affiliate level and statutory taxes at the parent location reduces the MNE's pre-tax profit. This observation is in line with profit shifting behavior. The coefficient estimate on fixed assets indicates that a 1% increase in fixed assets raises pre-tax profit by 0.42% on average. The following estimations (2) to (4) additionally control for industry-year dummies and the GDP growth rate as well as the earnings in manufacturing. Especially, the inclusion of the additional country control variables lead to a slight drop in the absolute size of both coefficients, the estimated coefficient for the fixed asset investment as well as the coefficient for the difference in statutory tax rates.

These estimates enable us to quantify the profit shifting effect against the complementarity effect. How do pre-tax profit change with increases in the corporate tax rate? According to the theory and estimation set up presented above, the effect can be written as

$$\frac{d\hat{b}_i}{d\tau_{hi}} = -\frac{\partial \hat{b}_i}{\partial(\tau_i - \tau_{ih})} + \frac{\partial \hat{b}_i}{\partial(k_i)} \frac{\partial k_i}{\partial(\tau_{hi})} = \left[-\hat{\alpha}_1 + \hat{\beta}_2 \cdot \hat{\alpha}_2\right] b_i \tag{5.9}$$

for the semi-logarithmic estimation of the corporate tax impact on capital investment. $\hat{\alpha}_1$, $\hat{\beta}_2$, $\hat{\alpha}_2$ thereby indicate the estimated coefficients. Drawing on the coefficient estimates in Table 3, Specification (5) ($\hat{\beta}_2$) and Table 6, Specification (4) ($\hat{\alpha}_1$ and $\hat{\alpha}_2$), we find that accounting for the complementarity effect reduces the semi-elasticity of reported profits from $\frac{d\hat{b}_i}{d\tau_{hi}} \frac{1}{\hat{b}_i} = 0.67$ to 0.53, a reduction of 21% of its value.[9] If we consider the log-log specification in contrast to the semi-logarithmic model and evaluate the estimated effects at the sample average of the corporate tax rate at the parent country, we find a slightly larger drop of 24%.[10] Therefore, if an empirical profit-shifting study concluded that a ten percentage point increase in the parent company's statutory tax rate increased reported profits by 6.7%, we would have to add that this is true in terms

[9] $0.6688 + (-0.4632) \cdot 0.3015 = 0.5291$

[10] $0.6688 + (-0.1885) \cdot 0.3015/0.35 = 0.5064$

of per capital unit; since the asset stock at the subsidiary's location is reduced by the tax rate increase, the overall reported profit only increases by somewhat more than three forth of this effect, which approximately amounts to 5%.

5.4 Extensions

5.4.1 Effective Corporate Tax Rate

Our results in the previous section provide evidence that the statutory corporate tax rate at the headquarter location exerts a negative impact on investment at the affiliate level. Although our theory section does not distinguish between the statutory corporate tax and the effective corporate tax rate, it is obvious that the complementarity effect hinges on the effective corporate tax rate for which the statutory rate was used as proxy above. As a sensitivity check we therefore reestimate the causal impact of headquarters' taxes on affiliate employment using the actual corporate tax payment per unit of total assets at the headquarters' location as explanatory variable. Since the inclusion of actual corporate tax payment in the capital investment equation may be prone to endogeneity problems, we again employ the Arellano and Bond (1991) approach estimating a first-differenced equation with lagged corporate taxation levels as instruments for the change in tax payment. The results can be found in Table 7. The first equation controls for time fixed effects while the second specification additionally includes industry-year dummies.[11] Both estimations provide evidence in line with our results and indicate that an increase in the corporate tax burden at the headquarters location translates in significantly lower investment levels at the affiliates.

[11]Both specifications employ the second lag of effective average tax payments as instruments.

5.4.2 Investment Effects of Profit Shifting

Our simple model presented in the theory section abstracted from corporate tax effects on multinational capital investment that is driven by profit shifting considerations. Part of the literature suggests that profit shifting is facilitated with increasing size of corporate investment at the affiliate location. This reflects the notion that enlarged investment activity corresponds to an increased intra-firm trade connection between the affiliates which makes it easier to shift profit between the locations (see e.g. Grubert and Slemrod (1998), who introduce the term of "avoidance-adjusted cost of capital"). The modeling strategy would for example presume that profit can be shifted per unit of capital at the affiliate location (see Eggert and Schjelderup (2005) and Riedel and Runkel (2007)) and hence multinational after-tax profit could be summarized as

$$\begin{aligned} \Pi &= F^h\left(K^h\right)\left(1-\tau^h\right) + F^a\left(K^h, K^a\right)(1-\tau) - r\left(K^h + K^a\right) \\ &\quad + \left[\left(\tau^h - \tau\right)s - C\left(s\right)\right]K^a \end{aligned} \tag{5.10}$$

Thus, optimal investment at the affiliate location is given by

$$F_a^a = \frac{r - \left[(\tau^h - \tau)s - C\right]}{1-\tau} \tag{5.11}$$

It holds that $(\tau^h - \tau)s - C > 0$ since the multinational would otherwise not engage in paper profit shifting. This implies that positive profit shifting activities lead to increased investment at the affiliate level whereas the investment is higher the larger the amount shifted. Assuming shifting costs to be constant across multinational firms located in different countries, profit shifting activity increases in the gross shifting gains which are given by the *absolute* tax rate difference between two locations. Therefore, the theoretical extension would predict that the affiliate capital stock raises in the absolute tax difference to the home country.

Calculating the effect of headquarter taxes on the affiliates' capital investment gives

$$\begin{aligned}\frac{dK^a}{d\tau^h} &= -\frac{F^a_{ah}}{(1-\tau^h)\,F^h_{hh}F^a_{aa}+(1-\tau)\,(F^a_{hh}F^a_{aa}-F^a_{ha}F^a_{ah})}\cdot F^h_h \\ &\quad -\frac{\left(1-\tau^h\right)F^h_{hh}+(1-\tau)\,F^a_{hh}}{(1-\tau^h)\,F^h_{hh}F^a_{aa}+(1-\tau)\,(F^a_{hh}F^a_{aa}-F^a_{ha}F^a_{ah})}\cdot\frac{s}{1-t}\end{aligned} \tag{5.12}$$

The first term on the right hand side corresponds to equation (5.4). The second term reflects the impact of profit shifting on investment behavior. For a better understanding, assume for the moment that there are no complementarities, $F^a_{ah} = F^a_{ha} = 0$. The expression then becomes:

$$\frac{dK^a}{d\tau^h} = -\frac{1}{F^a_{aa}}\cdot\frac{s}{1-t} \tag{5.13}$$

It is obvious that the effect of the parent location's tax rate carries the same sign as the profit shifting term s. If the parent location's tax rate is higher than the subsidiary location's, $\tau^h > \tau$, then increasing τ^h leads to an increase in the subsidiary's stock of capital. The intuition for the result is very simple. An increase in τ^h leads to an increase in the tax differential between parent and subsidiary firm. This increases the incentive to shift profits and to lower the avoidance-adjusted cost of capital by enlarging the subsidiary's stock of capital.

To test for these capital effects, we include the absolute tax rate differential between the headquarter and the corporate subsidiary in the fixed effect estimation described by equation 5.7. The results are presented in Table 8. In line with the theoretical prediction, the absolute tax rate difference exerts a significantly positive impact on affiliate investment and is robust against the inclusion of industry-year and country-year dummies. The estimated coefficient for the absolute corporate tax rate difference in Specification (3) presents a semi-elasticity of 0.4567.

The size of the effects of headquarters' taxes on affiliate investment thus depends on the relation of corporate taxes. If the headquarters' tax falls short from the tax rate at the affiliate location, the complementarity and profit shifting investment effect point in the same direction. Increases in the corporate tax rate at the headquarters location lead to a substantial drop in affiliates' assets. In turn, if the headquarters' tax

exceeds the corporate tax at the affiliate location, then an increase in the headquarter tax reduces affiliate investment through the complementarity effect but may, however, increase corporate investment due to profit shifting induced considerations. According to Specification (3) in Table 8, we find that the effect of corporate taxes at the parent location on fixed assets at the affiliate is represented by a semi-elasticity of -1.2278 $(= -0.7711 - 0.4567)$ if $\tau^h < \tau$. In turn, if the headquarters country is the high-tax country and $\tau^h > \tau$ holds, then the complementarity investment effect and the profit shifting investment effect point in different directions. This translates in an estimated semi-elasticity of -0.3144 $(= -0.7711 + 0.4567)$. This implies that if (equilibrium) tax rates feature $\tau^h < \tau$, then the described investment effects dampen the profit shifting effect by 55% $(0.6688 - 0.3015 \cdot 1.2278 = 0.2986)$. In contrast, if (equilibrium) tax rates feature $\tau^h > \tau$ then the share of the profit shifting effect compensated amounts to 14% only $(0.6688 - 0.3015 \cdot 0.3144 = 0.5740)$.

In this context it is interesting to note that in our sample 52% of the affiliates have their direct parent corporation in country with a higher statutory corporate tax rate while 48% are owned by parent corporations that pay a lower statutory tax rate on average.

5.4.3 Employment Effects

It is a standard notion of the economic literature (and in the public debate) that the adjustment of capital investment in the wake of corporate tax changes is likely to go hand in hand with employment effects in the same direction. The basic argument can be demonstrated by a simple extension of our theoretical model presented in section 2. For simplicity reasons and without loss of generality, we assume that production at the headquarters' location employs capital as the only input factor while production at the subsidiary level additionally relies on the use of labor input L^a. The wage level in country a is given by w^a and assumed to be exogenous from the MNE's perspective.

This motivates the following after-tax profit function

$$\begin{aligned}\Pi &= F^h\left(K^h\right)\left(1-\tau^h\right)+F^a\left(K^h,K^a,L^a\right)(1-\tau)-w^aL^a-r\left(K^h+K^a\right)\\ &\quad+\left(\tau^h-\tau\right)s-C\left(s\right)\end{aligned} \tag{5.14}$$

First order conditions with respect to K^h, K^a and s replicate the equations given in section 2, apart from the fact that the production function F^a is now dependent on labor input L^a. By assuming that the determinant of this equation system D is positive, the marginal effect of headquarters' taxes on employment at the affiliate location is given by

$$\frac{dL^a}{d\tau^h}=-\frac{(1-\tau)}{D}\cdot\left[\frac{\partial F^h}{\partial K^h}\cdot\frac{\partial^2F^a}{\partial K^a\partial K^h}\cdot\frac{\partial^2F^a}{\partial L^a\partial K^a}-\frac{\partial F^h}{\partial K^h}\cdot\frac{\partial^2F^a}{\partial(K^a)^2}\cdot\frac{\partial^2F^a}{\partial L^a\partial K^h}\right] \tag{5.15}$$

Assuming the cross effects to be positive for capital investment at the headquarters and affiliate location as well as as for labor and capital input ($\partial^2F^a/\partial K^a\partial K^h>0$, $\partial^2F^a/\partial L^a\partial K^a>0$, $\partial^2F^a/\partial L^a\partial K^h>0$), it is obvious that equation (5.15) exhibits a negative sign, that is, production at the subsidiary level falls in the headquarters' tax. The intuition behind this result is that increases in the corporate tax liability at the headquarters location reduce the headquarters' capital stock which translates in reduced investment *and* employment levels at the affiliate.

Therefore, we reestimate the above equations using the number of employees instead of fixed assets as endogeneous variable. Since employment numbers are equally skewed to the right as fixed asset investment, we employ the logarithm of employees as endogeneous variable. Table 9 shows the results of estimations of affiliate employment numbers on the statutory corporate tax rates at the affiliate and headquarters country.

The estimation results replicate those for the fixed asset equations. Thus, a rise in the statutory tax rate at the affiliate level as well as at the parent level leads to a reduction in employment numbers. Specifications (1) and (2) thereby account for various time-varying country characteristics as well as year dummies and industry year effects. In Specification (3) we add a full set of country-year dummies and still find the corporate

tax at the parent location to exert a significantly negative impact on the number of employees. The semi-elasticity is thereby estimated with -0.2659.

How does that change our results for the corporate tax effects on pre-tax profit? Accounting for employment input in the profit equation, in line with the basic intuition, we find that employment as well as fixed assets have a statistically significant impact on the profit level. According to the estimate, a 10% increase in fixed assets raises pre-tax profit by 4.4%; similarly, increasing employment by 10% raises pre-tax profit by 4.1%. Since, the estimated coefficients on the input factors labor and fixed assets add up to $0.81 < 1$, the technology exhibits decreasing returns to scale. Note, that we again employ a dynamic GMM approach to handle endogeneity problems. It should moreover be pointed out, that the estimated coefficient on the statutory tax rate difference increases in absolute size and gains statistical significance. If we accounted for complementarity effects through both input factor channels, we now find (based on the estimation results in Table 3, Specification 5, Table 9, Specification 3, Table 10, Specification 2) that the complementarity effect offsets 34% of the profit shifting externality on foreign pre-tax profit ($= 0.9259 - 0.4469 \cdot 0.4632 - 0.4033 \cdot 0.2659$).

Note moreover, that our argumentation so far restricted national welfare to be represented by corporate tax revenues. However, this may be to restrictive since for example wage earnings may constitute part of overall national welfare. Thus, if we accounted for further welfare components, corporate tax increases at the headquarters' location that translate in reductions of affiliate employment, decrease national wage income and thereby national welfare and may additionally enlarge government spending for unemployment benefits and welfare aid if the dismissed workers will not be employed by national firms that pay lower wages. Accounting for these effects surely goes beyond the scope of our paper. However, we show that corporate taxes exert a negative externality on the investment and employment levels of foreign multinational affiliates and that this effect may compensate a substantial part of the well-studied positive profit shifting externality.

5.5 Discussion and Conclusions

In this paper, we used a large firm-level data set to test for tax policy effects in the presence of complementarities within multinational enterprises. Our results show that tax increases at the parent location negatively affect the subsidiary's stock of capital. Consequently, domestic tax policy imposes a negative externality on the foreign country's tax revenue. In a second step we quantified this externality and contrasted it with the well-established positive externality due to profit shifting. We found that the shifting externality is considerably compensated by up to 34%. We concluded that low-tax countries do not profit as much from tax rate increases in high-tax countries than is usually assumed.

What does this mean for the current policy debate? The EU debates about replacing the current taxation scheme for MNEs based on separate accounting principles by a scheme of profit consolidation and formula apportionment (European Commission (2001)). The main argument brought forward by supporters of this move are inefficiencies caused by profit shifting activities of multinational firms under the current system. However, the debate has neglected so far that tax policy also exerts a negative impact on foreign affiliates capital stock which points in the opposite direction than the positive profit shifting externality and hence brings the corporate tax system closer to the efficient solution. In other words, if a foreign country reduces its tax rate the home country is hurt by multinational profit that is shifted out of its borders, but benefits by increased investment and employment levels of MNEs located in the tax-reducing country. Therefore, our analysis casts some doubt on the necessity to abolish the existing corporate tax scheme for a FA solution that is prone to inefficiencies and administrative difficulties.

5.6 Appendix

Note: Throughout * will indicate significance on the 10% level, ** significance on the 5% level and *** significance on the 1% level.

Table 1: Country Statistic

	Affiliate	*Parent*
Austria	61	42
Belgium	416	146
Cyprus	0	2
Czech Republic	181	0
Germany	292	311
Denmark	232	136
Estonia	91	6
Spain	785	82
Finland	196	79
France	730	209
United Kingdom	834	317
Greece	49	4
Hungary	104	2
Ireland	208	58
Italy	379	144
Lithuania	26	2
Luxembourg	27	28
Latvia	39	1
Netherlands	352	219
Poland	302	6
Portugal	78	17
Sweden	306	233
Slovenia	2	2
Slovakia	39	0
Sum	5,429	2,049

Table 2: Descriptive Statistics			
Variable	*Number of Observations*	*Mean*	*Standard Deviation*
Affiliate			
Fixed Assets	34,237	36,254.54	428,470.50
Employment	25,433	250.33	857.16
Profit Loss Before Tax	32,299	3,400.60	54,808.74
Statutory Tax Rate	34,237	0.3300	0.0710
Average Tax Payment	21,343	0.0379	0.0459
GDP per Capita	31,386	24,396.27	5,763.54
Parent Company			
Statutory Tax Rate	34,237	0.3515	0.0777
Average Tax Payment	10,392	0.0180	0.0245
GDP per Capita	32,143	27,022.56	4,737.58

Table 3: Fixed Effect Estimation, End. Variable: Log Fixed Assets

Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
Statutory Tax Rate, Affiliate	-0.6903^{***}	-1.1138^{***}	-1.1496^{***}	-0.7971^{***}	
	0.2024	(0.2334)	(0.2371)	(0.2527)	
Statutory Tax Rate, Parent	-0.3874^{**}	-0.6337^{**}	-0.6383^{***}	-0.6245^{***}	-0.4632^{***}
	(0.1615)	(0.2074)	(0.2090)	(0.2112)	(0.2142)
GDP per Capita, Affiliate		-0.6094^{**}	-0.6521^{**}	-1.4252^{***}	
		(0.2812)	(0.2841)	(0.3455)	
GDP per Capita, Parent		0.5287^{*}	0.6528^{***}	0.5186	0.3665
		(0.3252)	(0.3277)	(0.3290)	(0.3363)
Population, Affiliate		4.9737^{***}	4.9246^{***}	7.8969^{***}	
		(0.7787)	(0.7862)	(0.8642)	
Population, Parent		-0.5319^{***}	-1.3602	-1.0686	-0.9196
		(1.0742)	(1.0800)	(1.1018)	(1.1343)
GDP Growth, Affiliate		1.8278^{***}	1.7136^{***}	1.3708^{***}	
		(0.4093)	(0.4132)	(0.4394)	
GDP Growth, Parent		0.6063	0.3852	0.4059	0.4547
		(0.4515)	(0.4549)	(0.4553)	(0.4663)
Earnings Manufacturing, Affiliate		1.2860^{***}	1.3755^{***}	1.1449^{***}	-0.2531
		(0.1197)	(0.1203)	(0.2635)	(0.9952)
Earnings Manufacturing, Parent		0.6063	0.2640	0.4615	0.6195
		(0.4515)	(0.3727)	(0.3982)	(0.4053)
Year Dummies	√	√	√	√	√
Year-Industry Dummies			√	√	√
Year-Eastern Europe Dummies				√	√
Year-Country Dummies					√
Number of Observations	34,237	29,928	29,292	29,292	29,292
Number of Firms	5429	5,157	5,043	5,043	5,043
R-squared	0.90	0.91	0.91	0.91	0.91

Table 4: Fixed Effect Estimation, End. Variable: Log Fixed Assets

Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
Log Statutory Tax Rate, Affiliate	-0.3735^{***}	-0.5038^{***}	-0.5048^{***}	-0.3740^{***}	
	0.0670	(0.0799)	(0.0807)	(0.0906)	
Log Statutory Tax Rate, Parent	-0.1348^{**}	-0.2688^{***}	-0.2702^{***}	-0.2592^{***}	-0.1885^{**}
	(0.0689)	(0.0907)	(0.0913)	(0.0925)	(0.0939)
GDP per Capita, Affiliate		-0.6564^{**}	-0.7067^{***}	-1.3880^{***}	
		(0.2764)	(0.2794)	(0.3415)	
GDP per Capita, Parent		0.5090	0.6307^{**}	0.5020	0.3389
		(0.3238)	(0.3263)	(0.3277)	(0.3351)
Population, Affiliate		4.9737^{***}	5.5568^{***}	8.1747^{***}	
		(0.7787)	(0.8016)	(0.8703)	
Population, Parent		-0.4695	-1.2842	-1.0341	-0.8262
		(1.0758)	(1.0817)	(1.1028)	(1.1352)
GDP Growth, Affiliate		1.7605^{***}	1.6497^{***}	1.3582^{***}	
		(0.4096)	(0.4134)	(0.4394)	
GDP Growth, Parent		0.5891	0.3718	0.4047	0.4690
		(0.4511)	(0.4545)	(0.4551)	(0.4660)
Earnings Manufacturing, Affiliate		1.2860^{***}	1.3611^{***}	1.1477^{***}	0.6120
		(0.1196)	(0.1201)	(0.2633)	(0.4082)
Earnings Manufacturing, Parent		0.2228	0.2892	0.4713	0.6195
		(0.3719)	(0.3744)	(0.4005)	(0.4053)
Year Dummies	√	√	√	√	√
Year-Industry Dummies			√	√	√
Year-Eastern Europe Dummies				√	√
Year-Country Dummies					√
Number of Observations	34,237	29,928	29,292	29,292	29,292
Number of Firms	5429	5,157	5,043	5,043	5,043
R-squared	0.90	0.91	0.91	0.91	0.91

Table 5: End. Variable: Log Fixed Assets Parent Subsidiary		
Variable	*(1)*	*(2)*
Log Corporate Tax, Parent	-0.2396^{***}	-0.2556^{***}
	(0.0848)	(0.0946)
Population, Parent		1.5711
		(1.0812)
GDP per Capita, Parent		-0.0808
		(0.3407)
Year Dummies	$\surd$	$\surd$
Year-Industry Dummies	$\surd$	$\surd$
Number of Observations	$9,260$	$8,420$
Number of Firms	$1,275$	$1,262$
R^2	0.94	0.95

Table 6: Endogeneous Variable: Log Profit Before Tax				
Variable	*(1)*	*(2)*	*(3)*	*(4)*
Log Profit/Loss Before Tax, Lag1	0.1934^{***}	0.2299^{***}	0.1742^{***}	0.2207^{***}
	(0.0688)	(0.0712)	(0.0707)	(0.0740)
Tax Rate Differential	-0.7189^{**}	-0.6455^{*}	-0.7316^{**}	-0.6688^{*}
	(0.3434)	(0.3648)	(0.3542)	(0.3786)
Log Fixed Assets	0.4178^{***}	0.3342^{**}	0.3912^{***}	0.3015^{**}
	(0.1419)	(0.1490)	(0.1432)	(0.1503)
GDP per Capita, Affiliate	1.6901^{***}	-2.2670	0.9580	-2.1576
	(0.3063)	(2.3276)	(0.6059)	(2.4166)
GDP per Capita, Parent	-0.6320^{*}	2.7974	0.6471	3.3277
	(0.3316)	(2.1964)	(0.7331)	(2.2538)
Population, Affiliate	-3.1975^{*}	1.5058	-3.2930^{*}	1.2461
	(1.7875)	(3.8639)	(1.7913)	(3.9950)
Population, Parent	-0.5169	-0.0857	-0.1864	-0.11278
	(2.8615)	4.9902	(2.8514)	(5.1257)
GDP per Capita Growth, Affiliate		3.9304^{*}		4.0450^{*}
		(2.1527)		(2.2173)
GDP per Capita Growth, Parent		-2.6185		-3.3005
		(2.5160)		(2.5985)
Earnings, Affiliate		1.8665		1.4639
		(2.4429)		(2.5916)
Earnings, Parent		-2.9354		-3.7479
		3.3751		(3.4695)
Year Dummies	$\surd$	$\surd$	$\surd$	$\surd$
Year-Industry Dummies			$\surd$	$\surd$
Number of Observations	10,785	10,513	10,593	10,321
Number of Firms	2935	2,895	2874	2,834
Test for 2^{nd} Order Autocorrelation (z-Value)	0.608	0.886	0.349	0.641
Sargan Test (p-Value)	0.253	0.469	0.228	0.513

Table 7: Endogeneous Variable: Log Fixed Assets		
Variable	*(1)*	*(2)*
Log Fixed Assets, Lag1	0.4003^{***}	0.3448^{***}
	(0.1015)	(0.0975)
Log Average Tax Payment, Affiliate	-0.0681^{***}	-0.0660^{***}
	(0.0217)	(0.0212)
Log Average Tax Payment, Parent	-0.0301^{**}	-0.03450^{**}
	(0.0154)	(0.0162)
Year Dummies	$\surd$	$\surd$
Year-Industry Dummies		$\surd$
Number of Observations	3252	3208
Number of Firms	1157	1140
Test for Second Order Autocorrelation (z-Value)	0.75	0.74
Sargan Test (p-Value)	0.20	0.36

Table 8: Fixed Effect Estimation, End. Variable: log Fixed Assets

Variable	*(1)*	*(2)*	*(3)*
Statutory Tax Rate, Affiliate	-1.2092^{***}	-1.2392^{***}	
	(0.2351)	(0.2385)	
Statutory Tax Rate, Parent	-1.1219^{***}	-1.1525^{***}	-0.7711^{***}
	(0.2537)	(0.2577)	(0.2899)
Absolute Difference Statutory Taxes	0.6744^{***}	0.7014^{***}	0.4567^{*}
	(0.2018)	(0.2051)	(0.2589)
GDP per Capita, Affiliate	-0.6789^{**}	-0.7273^{***}	
	(0.2819)	(0.2848)	
GDP per Capita, Parent	0.5442^{*}	0.6668^{**}	0.3968
	(0.3252)	(0.3277)	(0.3360)
Population, Affiliate	5.1771^{***}	5.1261^{***}	
	(0.7809)	(0.7882)	
Population Parent	-0.6534	-0.7002	
	(1.0746)	(1.1141)	
Earnings Manufacturing, Affiliate	1.2835^{***}	1.3562^{***}	
	(0.1200)	(0.1204)	
Earnings, Manufacturing, Parent	0.2742	0.3484	0.4738
	(0.3710)	(0.3734)	(0.3792)
Growth Rate Per Capita, Affiliate	1.8295^{***}	1.7149^{***}	
	(0.4093)	(0.4131)	
Growth Rate Per Capita, Parent	0.6037	0.3854	0.4394
	(0.4514)	(0.4548)	(0.4656)
Year Dummies	$\surd$	$\surd$	$\surd$
Year-Industry Dummies		$\surd$	$\surd$
Year-Country Dummies			$\surd$
Number of Observations	29,928	29,292	29,292
Number of Firms	5,157	5,043	5,043
R-squared	0.91	0.91	0.91

Table 9: Endogeneous Variable: Log Employees			
Variable	*(1)*	*(2)*	*(3)*
Statutory Tax Rate, Affiliate	-0.7350^{***}	-0.7474^{***}	
	(0.1049)	(0.1058)	
Statutory Tax Rate, Parent	-0.3916^{***}	-0.4575^{***}	-0.2659^{***}
	(0.1049)	(0.1053)	(0.1033)
Log GDP per Capita, Affiliate	0.8999^{***}	0.8847^{***}	0.2700^{***}
	(0.1561)	(0.1566)	(0.1082)
Log GDP per Capita, Parent	-0.0994	0.1376	0.4329^{***}
	(0.1604)	(0.1610)	(0.1270)
Log Population, Affiliate	-1.299^{***}	-1.4231^{***}	
	(0.4133)	(0.4134)	
Log Population, Parent	-0.4082	-1.1033^{**}	-1.3595^{***}
	(0.5318)	(0.5328)	(0.5313)
Growth Rate GDP per Capita, Affiliate	0.5465^{***}	0.4124^{***}	
	(0.2225)	(0.2229)	
Growth Rate GDP per Capita, Parent	-0.9916^{***}	-0.9831^{***}	0.4917^{**}
	(0.2187)	(0.2188)	(0.2179)
Log Earnings, Affiliate	-0.1804^{***}	-0.1054^{*}	
	(0.0564)	(0.0562)	
Log Earnings, Parent	0.8317^{***}	0.7838^{***}	0.7908^{**}
	(0.1899)	(0.1902)	(0.1944)
Year Dummies	√	√	√
Year-Industry Dummies		√	√
Year-Country Dummies			√
Year-Eastern Parent Dummies			√
Number of Observations	24,734	24,255	24,255
Number of Firms	4,637	4,548	4,548
R^2	0.94	0.94	0.94

Table 10: GMM Estimation, End. Variable: Log Profit before Tax		
Variable	*(1)*	*(2)*
Log Profit before Tax, Lag1	0.1887*	0.1726
	(0.1157)	(0.1192)
Log Fixed Assets	0.4407**	0.4469**
	(0.1969)	(0.1991)
Log Employees	0.4066**	0.4033**
	(0.2038)	(0.2081)
Tax Difference	−0.8872**	−0.9259**
	(0.3926)	(0.4075)
Log GDP per Capita, Affiliate	−0.2699	−0.1256
	(1.0346)	(1.0483)
Log GDP per Capita, Parent	0.6753	0.6272
	(0.9395)	(0.9593)
Log Earnings, Affiliate	−0.7284	−0.8678
	(0.9586)	(0.9598)
Log Earnings, Parent	−2.3869	−2.4956**
	(1.2728)	(1.2903)
Log Growth Rate GDP per Capita, Affiliate	2.0409**	1.8659**
	(0.9339)	(0.9283)
Log GDP per Capita, Parent	0.0729	−0.1651
	(0.8435)	(0.8458)
Log Population, Affiliate	3.0330	3.1563
	(2.9758)	(3.0319)
Log Population, Parent	1.7496	1.9942
	(3.6877)	(3.7122)
Year Dummies	√	√
Year Dummies, Eastern Europe	√	√
Year-Industry Dummies		√
Number of Observations	8,363	8,206
Number of Firms	2,343	2,295
Test for Second Order Autocorrelation (z-Value)	0.91	0.66
Sargan Test (p-Value)	0.37	0.57

Chapter 6

Corporate Taxes, Profit Shifting and the Organization of Multinational Firms

6.1 Introduction

Some historians trace the existence of multinational enterprises (MNEs) back to banking under the Knights Templar in 1135. However, for centuries it had been only a few individual firms that pursued an international organization. The corporate expansion to foreign countries became popular in the 19th century when European firms founded sales offices in their colonies to serve the local markets. MNEs gained real economic significance some decades ago when growing trade integration between countries led to the emergence of new markets and the fracture of production processes according to comparative advantages. The last years, however, did not only observe a rise in the number of multinational corporations, but also witnessed an increased complexity in the structure of internationally operating firms. Foremost, the number of foreign affiliates has steeply increased since the 1970s (e.g. Markusen (2002)).

In the last years MNEs have moreover expanded the functions of foreign affiliates. Subsidiaries abroad are no longer used as production centers only, but also serve as research and development (R&D) units and product design centers. Several multinationals, like the pharmaceutical producers Pfizer and Bristol-Myers Squibb and the software company Microsoft, have transferred a considerable part of their R&D investments away from their home countries to Ireland. Others founded trademark holding companies abroad that own and administer the group's trademarks and licences. A famous example is the British mobile phone company Vodafone whose intangible properties are held by an Irish subsidiary. Furthermore, not only general group functions have become increasingly mobile across borders but the headquarters themselves seem to be on the move. Had the headquarters locations traditionally remained untouched for a long time, this seems to end now. The oil company Shell, founded in London in 1833, relocated its headquarters from Great Britain to the Netherlands in 2004. In January 2007, the US food company Kraft announced to relocate its European headquarters from Austria and Great Britain to Switzerland.

One common feature of the relocation examples mentioned above is that real economic

activity has been shifted to countries with a low corporate tax rate in comparison to other EU25 locations. There may be various explanations for this development, the easiest being that the rents generated by the relocated investment shall be taxed at a low statutory tax rate. With respect to the relocation of headquarters activity, Huizinga and Voget (2006) also stress double taxation rules and withholding taxes to have an influence on the location choice. Since both the Netherlands and Switzerland have generous taxation rules for holding companies, this may partly explain the headquarters relocations mentioned in the last paragraph.

Our paper offers an alternative explanation which refers to the fact that MNEs relocate central (potentially headquarters-) functions to low-tax countries to optimize their strategies of profit shifting. We will show that the amount of international profit shifting strongly depends on the organizational structure of the MNE. Precisely, MNEs with service centers located at low-tax countries are shown to engage in more profit shifting activities than MNEs with service centers located at high-tax locations. Moreover, consistent with this prediction, we will provide evidence that multinationals systematically locate central services to low-tax locations within their corporate group.

The basic argument is illustrated in a simple theoretical model. We consider a world with three countries. Each country hosts an affiliate of a representative MNE. One of the affiliates takes on the function of a corporate head office whereas this refers to the provision of an intermediate good or intercompany service that is used in the production process at all three affiliates. Hence, in our model, legal ownership of all affiliated companies is not sufficient to constitute the multinational headquarters. In contrast, our model refers to the observation that headquarters commonly provide management and administrative services to their affiliates. Since the service good provided by the corporate head office is delivered to the affiliates in the other two countries, the MNE may distort the transfer price for this good from its true value to shift profit between the affiliates. We consider a three stage game in which the governments choose the corporate tax rates at the first stage by maximizing corporate tax revenues. At the second stage, the MNE decides in which country to locate its corporate headquarters.

At the third stage, the MNE chooses optimal production and sets the transfer price. The game is solved by backward induction.

At the third stage, the MNE decides on the transfer price for the intermediate good or intercompany service. We restrict profit shifting to take place between the headquarters and the affiliates, but *not* between the subsidiaries. This assumption rests on the idea that most profit shifting takes place by the distortion of transfer prices for intangibles like general management services, for which a market price is usually hard to determine. As we regard the affiliates as pure production plants, the presumption that profit shifting among the affiliates is not feasible, seems rather natural. This assumption has profound consequences for profit shifting possibilities and optimal transfer pricing strategies, as these now depend crucially on the headquarters location. Consider the case in which the head office resides in the country with the highest corporation tax. Then shifting activities are hampered for two reasons. First, since profit is relocated from the headquarters to the subsidiaries, the *sum* of shifting volumes to both subsidiaries is restricted by the amount of pre-tax and 'pre-shifting' profit earned at the headquarters location. In contrast, if the headquarters were located at a low-tax country, then the upper limit to profit shifting activities through *each* 'subsidiary-channel'[1] is given by the amount of *each* subsidiaries' profit only. Provided that the headquarters location does not systematically earn a higher pre-tax and pre-shifting profit than other corporate affiliates, profit shifting opportunities may thus be more severely constrained for high-tax headquarters.[2]

Second, tax authorities may use the additional information from simultaneously controlling *several* profit shifting channels at the headquarters location. If they detect inconsistencies at one channel, they may intensify their screening activity on other

[1] In the following, we will call the connection between the headquarter and one of its subsidiaries a profit shifting channel. In our model the multinational has two affiliates and therefore two channels through which profit may be shifted.

[2] Note, that this result could equally be obtained by a tax evasion model in the tradition of Reinganum and Wilde (1985), in which tax authorities control (multinational) entities only if their declared pre-tax profit fell below a certain threshold level.

channels which increases the detection risk and thereby the MNE's profit shifting costs. In line with previous studies (e.g. Peralta et al. (2003)), we assume that tax authorities effectively control shifting activities at high-tax locations only. In low-tax countries, profit shifting enhances national tax revenues and hence officials do not have incentives to cut off shifting activities. It follows that the described increase in shifting costs falls on high-tax headquarters only since low-tax head offices are effectively not controlled.

At the second stage, the MNE chooses the optimal headquarters location which is modeled to be the location that maximizes the sum of overall corporate after-tax profit and an individual location preference parameter. We take this parameter to be a random variable with mean zero whose realisation is private information of the MNE. Hence, the headquarters location decision is stochastic but in expectation the MNE most likely locates in the country with the lowest corporate tax rate since it thereby maximizes the gains from profit shifting and its after-tax profit.
The first stage finally demonstrates that the corporate tax rate distribution assumed to be fixed so far is compatible with the equilibrium of a tax competition game between the countries.

In the empirical part of the paper, we test the main implications of our theoretical model using a large panel of MNEs headquartered in the countries of EU25. Following (most of) the previous empirical literature on profit shifting behavior, we will give indirect evidence for shifting activities by regressing the subsidiaries' pre-tax profitability on the differential of statutory tax rates at the subsidiary and parent location. The basic idea behind this approach is that capital market theory predicts investment profitability to be equal across countries. Thus, higher profitability of investments in low-tax countries as compared to high-tax countries may point to profit shifting behavior, while controlling for a range of firm and country characteristics.

Our estimations confirm other authors' results that profit shifting is determined by the difference in corporate tax rates between multinational affiliates. Since we are interested in the question how the corporate structure affects profit shifting possibilities,

we split our sample into affiliates belonging to MNEs with headquarters in high-tax and low-tax countries, respectively. Precisely, the affiliates of a multinational group are allocated to the 'high-tax-parent-sample' ('low-tax-parent-sample') if at least 90% of the subsidiary assets are located in countries with a lower (higher) statutory corporate tax rate than the parent.[3] In line with our theoretical predictions, we find evidence for significant and large profit shifting activities in the 'low-tax-parent-sample', while profit shifting of 'high-tax-parent-groups' is found to be substantially smaller and marginally significant at best.

In a second step, we account for the size of the multinational group. Our theory predicts that profit shifting activities (per channel) are deterred by the presence of additional shifting opportunities if the headquarters were located in a high-tax country. In contrast, additional shifting opportunities should not affect the shifting volumes per channel in 'low-tax headquarters groups'. We therefore interact the tax differential with various measures for corporate shifting opportunities (e.g. the number of subsidiaries) apart from the considered shifting channel. In line with our theoretical predictions, we find that shifting activities of 'high-tax headquarters groups' are heavily deterred by the presence of additional shifting channels. In contrast, the presence of additional shifting channels does not seem to affect shifting volumes in companies with headquarters at low-tax locations.

Finally, we would like to determine whether MNEs adjust their corporate structure to optimize their profit shifting possibilities. Since the ownership information in our data set has a cross-sectional dimension only, we cannot investigate the relocation decision of headquarters. However, as laid out above, our argument does not build on ownership issues but refers to special purpose units within multinational firms that centrally provide services or goods to various production units. Since these units often rely on intangible goods like patents, royalties or brands, we determine how corporate taxation affects the location of these intangibles within the corporate group. Thus, we regress intangibles as a share of overall affiliate assets on the tax rate differential

[3]Note, that a Chow test suggests separate estimation for the two subsamples.

between the respective subsidiary and other affiliates of the corporate group. Our theory predicts that the smaller a subsidiary's tax rate relative to the other affiliates within the group, the higher should be its share of intangible assets. This prediction is confirmed in the data.

The paper adds to a growing empirical literature that provides evidence for profit shifting activities. The first papers in this field were brought forward by Hines and Rice (1994) and Grubert and Mutti (1991) based on macro data for several countries. They find evidence in line with profit shifting activities. Follow-up studies by Collins et al. (1998) and Clausing (2003) support these qualitative results but rely on micro data that allow identification of the effect without imposing strong assumptions. Recent papers by Weichenrieder (2007), Dischinger (2007), Overesch (2006) and Huizinga and Laeven (2005) investigate shifting using European or German micro data, respectively. Our paper is most closely related to a work by Desai et al. (2006) who show that large firms with high R&D intensities are likely to locate in tax havens.[4] Starting from this result, we investigate how organizational structure affects shifting possibilities and find that locating in a tax haven may not be enough. In contrast, complex MNEs have to locate their service and special purpose units at low-tax locations to engage in significant profit shifting. We provide evidence that intangibles in fact tend to be located at low-tax countries relative to other group-affiliates.

The following chapter is structured as follows. Section 2 presents a simple theoretical model. In Section 3 we describe our data base. Section 4 states the basic estimation methodology while the estimation results are presented in section 5. Section 6 discusses the results and concludes.

[4]In addition, Grubert (2003) provides evidence that subsidiaries in countries with a relatively low or high tax rate engage in a significantly larger volume of intercompany transactions which consist mainly of immaterial, R&D intensive goods like royalties or patents.

6.2 A Simple Theoretical Model

We consider a model with three countries a, b and c. Each country hosts one affiliate of a representative multinational corporation that produces a homogeneous good for the local market. The price of the good is normalized to 1 in all countries for simplicity reasons. The production of the good uses labor L as only input factor and is represented by a production function with the standard properties $F(0) = 0$, $F'(L) > 0$ and $F''(L) < 0$. Wage costs are given by w and are considered to be fixed from the perspective of the multinational firm. We assume that one of the corporate entities has the status of the multinational 'headquarters' and provides some management service or patent to all affiliates. The true price for the production of this good is assumed to be 1. However, the headquarters may charge a transfer price p_i from the corporate affiliate located in i that differs from the true price. Thus, pre-tax profits at the headquarters location read

$$\Pi_h = [F(L_h) - wL_h] + \sum_i (p_i - 1) - 1, \quad h, i \in \{a, b, c\},\ i \neq h. \tag{6.1}$$

whereas the index h indicates the headquarter location, while the index i stands for the non-headquarter locations. At the subsidiaries pre-tax profit is given by

$$\Pi_i = [F(L_i) - wL_i] - p_i, \quad i \in \{a, b, c\}, i \neq h. \tag{6.2}$$

To derive a finite solution with respect to the choice of transfer prices, we assume that distorting the transfer price from the true price involves costs. These costs are assumed to comprise fine payments to a tax authority in case the profit shifting activity is detected by the national tax office. We assume transfer pricing cost to take on the following functional form[5]

$$C_i = C_i(s_i, s_j \cdot \alpha), \quad C_i(0,0) = 0, \quad sign\left(\frac{\partial C_i}{\partial s_i}\right) = sign\left(s_i\right), \quad \frac{\partial^2 C_i}{\partial s_i^2} > 0 \tag{6.3}$$

whereas $s_i = p_i - 1$ denotes the profit shifted between the subsidiary i and the corporate headquarters. This implies that s_i takes on positive (negative) values if profit is shifted from the subsidiary to the headquarter (from the headquarters to the subsidiary).

[5]The interpretation of the parameter α is discussed in the next sub-section.

The assumptions in equation (6.3) formally capture that tax authorities do not observe the true price for the internally provided headquarters service. Thus, the MNE can set a transfer price that differs from the true value in order to shift profit between its affiliates. However, profit shifting causes costs which are assumed to be increasing and convex in the transfer price distortion. This corresponds to the perception that tax authorities are more likely to detect irregularities in transfer pricing behavior if the price strongly deviated from the good's true value. If the detection of shifting activities entails fine payments, expected shifting costs rise in the transfer price deviation.[6]

We assume that profit shifting opportunities exist between the corporate headquarters and the affiliates, but that the subsidiaries can not shift profit among each other. Our modeling strategy thus refers to (mainly) horizontally organized MNEs which comprise several local production units and concentrate special functions like management and R&D activities at the headquarters location.[7] Since management and R&D services are largely corporation specific goods, their true value is hardly observable by national tax authorities. Many tax experts claim that most of the transfer pricing distortions occur on these intangible goods, hence, our modeling strategy should be compatible with reality (see also Grubert (2003)).

In contrast to the existing profit shifting literature, we do not restrict our analysis to corporate entities with two affiliates only, but allow for more complex groups with shifting options through more than one shifting channel. This setting gives rise to the necessity of specifying assumptions with respect to the interaction of profit shifting costs across channels.

First, we assume that the national tax authority at the headquarters location may use the additional information from controlling more than one shifting channel. This im-

[6]See Huber (1997) and Haufler and Schjelderup (2000).

[7]As already mentioned, the term 'headquarters' has not to be taken literally in this context. Our model refers to MNEs that tend to concentrate their management and R&D service units at certain locations which may or may not be the corporate headquarters in an ownership context. We should point out moreover, that international economics classifies the overwhelming share of MNEs located in Europe and Northern America to be horizontal in nature. See Markusen (2002).

plies a positive correlation in detection risks. If tax officials find an implausible transfer pricing behavior on one channel, they are likely to increase their screening activities on other channels. Formally, this is captured by a positive cross derivative of the shifting terms in equation (6.3). It holds, $\partial^2 C_i/(\partial s_i \partial(|s_j|)) > 0$ for $i \neq j$. Hence, increased profit shifting activities between the headquarters and affiliate j increase shifting costs at channel i.

However, only tax authorities in high-tax countries have an incentive to stop profit relocation since profit is shifted *out* of their country. Tax authorities in low-tax countries, in contrast, gain corporate tax base through profit shifting activities. Therefore, in line with previous studies (e.g. Peralta et al. (2003)), we assume effective transfer pricing control solely in high-tax countries. Thus, increased shifting costs are observed for high-tax headquarters only, since multinational groups with head offices in low-tax countries are effectively controlled solely at the high-tax subsidiaries.[8] Since international cooperation between tax authorities is basically non-existent they do not face increased shifting costs.[9] We formalize this reasoning by assuming that α takes on the value of 1 if the headquarters are located in the high tax country, and the value 0 otherwise.

The multinational's overall after-tax profit is given by

$$\Pi = (1 - t_h)\Pi_h + \sum_i (1 - t_i)\Pi_i - \sum_i C_i, \quad i, h \in \{a, b, c\},\ i \neq h \tag{6.4}$$

with t_h and t_i being the corporate tax rates at the headquarters and subsidiary locations

[8] Remember that we assume that the subsidiaries can shift profits only to the headquarters and not to other subsidiaries. Hence, each subsidiary has only a single channel available to shift profits.

[9] Although some international cooperation among tax authorities had been observed during the last decades, communication and information exchange is far from perfect. In an interview Jeffrey Owens, Head of Fiscal Affairs at OECD, complains about non-conformities with 'international standards on transparency and exchange of information' (OECD Observer (2000)). Note, however, that our qualitative results will not depend on the assumption that tax authorities from different countries do not interact with each other at all. A sufficient presumption would be that information exchange is not perfect and hence tax authorities at the subsidiary locations obtain less information than tax authorities at the headquarters location.

respectively.

In the following, we will consider a three stage game. At the first stage the countries choose the optimal corporate tax rate that maximizes tax revenues. At the second stage, the MNE decides where to locate its headquarters. At the third stage, transfer prices are set and production takes place. The game is solved by backward induction.

6.2.1 Transfer Price and Labor Demand

At the third stage the MNE chooses its optimal transfer prices for the goods delivered to the subsidiaries and determines optimal labor demand at the three locations. Maximizing after-tax profit in equation (6.4) with respect to s_i gives

$$t_i - t_h = \frac{\partial C_i(s_i, (s_j) \cdot \alpha)}{\partial s_i}, \quad i, j, h \in \{a, b, c\},\ i \neq j,\ i, j \neq h \tag{6.5}$$

whereas $\alpha = 1$ if $t_h > t_i$ and $\alpha = 0$ if $t_h < t_i$. If $t_h < t_i$, the corporate tax rate at the subsidiary location exceeds the corporate tax at the headquarters country and profit is shifted from the subsidiary to the headquarters by choosing a transfer price p_i larger than the true price 1. Analogously, if $t_h > t_i$, the headquarters are located in the high-tax country and profit is shifted from the headquarters to the subsidiaries by choosing a transfer price smaller than 1.

Thus the direction and volume of profit shifted is shown to depend on the difference in the statutory corporate tax rates between the two countries. In the following, we will demonstrate that profit shifting reacts less sensitively to tax rate differentials if the headquarters were located in a high tax country. There are two reasons for this. First, if the MNE's headquarters are located at a high-tax country ($\alpha = 1$), shifting costs are ceteris paribus larger than in case of headquarters location at the low-tax country as we clarified in the previous section. Second, for $t_h > t_i$, an inner solution to equation (6.5) is guaranteed only if $\Pi_h > s_i + s_j$. Thus, if the headquarters were located in the high-tax country, then profit shifting is determined by equation (6.5) only in the case that the profit at the headquarters location exceeds the desired shifting amount

to the affiliates. Otherwise, profit shifting from the headquarters to the affiliates is characterized by

$$\frac{t_i - t_h}{\partial C_i(s_i, (s_j)\alpha)/\partial s_i} = \frac{t_j - t_h}{\partial C_j(s_j, (s_i)\alpha)/\partial s_j} > 1 \qquad \text{with } h \neq i \neq j \tag{6.6}$$

Thus, if the amount of profit generated at the headquarters location is low and falls short of the optimal shifting amount to the affiliates located in low-tax countries, the MNE adjusts its profit shifting activities such that the ratio of marginal shifting gains to marginal shifting costs is equated across channels (equation (6.6)).

Compare this with the case $t_h < t_i$. Then, we arrive at an inner solution only if equation (6.5) holds, i.e. if $\Pi_i > s_i$ for $i \in \{a, b, c\}$ and $i \neq h$. Hence, the optimal shifting amount determined in equation (6.5) is chosen only if affiliate i's profit exceeded the desired shifting amount. Otherwise, it holds that $s_i = \Pi_i$. Due to the symmetry in the modeling of headquarters and affiliates, the overall pre-tax profit *before shifting* is equal across countries as can easily be seen from equations (6.2) and (6.3). Thus, $[F(L_i) - wL_i] = [F(L_h) - wL_h]$ holds for $i, h \in \{a, b, c\}$ and $h \neq i$. It follows that the restriction of profit shifting through limited amounts of earnings is more likely to occur if the headquarters were located in the high-tax than if they were located in a low-tax country.[10] The effects described above lead to the following proposition.

Proposition 6.1. *The volume of profit shifted between the headquarters and its subsidiaries will be more sensitive to tax rate differentials if the headquarters were located in a low-tax country than if they were located in a high-tax country.*

Since we assume labor cost to be fully deductible from the corporate tax base, we find that optimal labor demand is undistorted by the corporate tax rate and determined by the following equation.

$$F'(L_i) = w_i \qquad \text{with } i \in \{a, b, c\} \tag{6.7}$$

[10]Note, that the same pattern could be generated with a tax evasion model in the tradition of Reinganum and Wilde (1985) in which tax authorities control profit shifting behavior only if the MNE's declared profit fell below a certain threshold.

Equation (6.7) thereby replicates the well-known results that marginal product equals marginal cost at the optimum allocation.

6.2.2 Headquarters Location Choice

At the second stage the MNE decides where to locate the corporate headquarters. Its objective function is thereby to maximize overall after-tax profits and hence it will choose the headquarters location which implies the highest corporate profit. As described above the headquarters function is to provide an intra-firm good to the local subsidiaries. Hence, the MNE will locate its headquarters in country c if the multinational's after-tax profit Π^c which corresponds to headquarters in country c is larger than profits Π^a and Π^b that correspond to headquarters locations in country a and country b respectively. Since production takes place at the affiliates irrespective of the head office functions, the headquarters choice is determined by profit shifting gains. For the model to fit the data we would like to specify a non deterministic location choice and therefore make the additional assumption that the location decision of each firm is also governed by a specific valuation parameter μ_h for each possible location $h \in \{a, b, c\}$. μ_h is taken to be a random variable with mean zero (and positive variance). Both aspects are reflected in

$$S^h = \sum_i [(t_i - t_h)(p_i - 1) - C_i(s_i, (s_j) \cdot \alpha)] + \mu_h, \quad h, i, j \in \{a, b, c\},\ i \neq j \neq h \quad (6.8)$$

S^h thereby stands for the profit shifting gain if the MNE was headquartered in country h plus the firm specific location valuation. The MNE will for example choose location c as corporate headquarters if $S^c > S^a$ and $S^c > S^b$. Let us first focus on potential shifting gains conditional on the headquarters choice. Consider for example the tax rate distribution $t_a > t_b > t_c$. If we abstract from shifting costs for the moment we know that the gross shifting gain is identical irrespective of whether the headquarters are located in country a (with the highest tax rate) or in country c (with the lowest tax rate). This is true because the tax rate differentials between the affiliates and thus the shifting gains are identical. However, from equation (6.5) it follows that, for a given difference

in corporate tax rates, the shifting costs are larger if the headquarters were located at the high-tax country. Therefore, since location in the high-tax country implies higher shifting costs as well as shifting caps caused by limited pre-tax (and pre-shifting) profit, the MNE will always strictly prefer the low-tax country c as headquarters location.

If the headquarters instead were located in country b, the MNE had an incentive to shift profit from the headquarters location b toward the low-tax country c and from the high-tax country a to the headquarters location. Thus, profit is shifted out of country b only via one channel, and hence the detection risk of profit shifting through different channels is independent from each other. Therefore, the same amount of profit would be shifted from countries b to c irrespective of headquarters location in country b or c. However, it holds that $t_a - t_c > t_a - t_b$ and hence the tax rate differential between countries a and c is larger by assumption than the tax rate differential between countries a and b (in absolute terms). Thus, the MNE will earn larger gains by shifting profit from country a to country c and taxing it there at the lowest available corporate tax rate. It follows from the reasoning above that the MNE prefers headquarters location in the low-tax country. Taking into account the intrinsic valuation μ_h for each location h, the tax rate distribution $t_a > t_b > t_c$ implies that $E(S^c) > E(S^b) > E(S^a)$. We arrive at the following proposition.

Proposition 6.2. *For a given distribution of corporate tax rates, the probability to attract the headquarters of the MNE decreases in the corporate tax rate. Thus, the country with the lowest corporate tax rate has the highest probability to attract the multinational headquarters.*

6.2.3 Corporate Tax Rate Choice

The purpose of this section is to sketch shortly that the tax rate distribution assumed so far could be the equilibrium outcome of a tax competition game between the three countries. At the first stage, the government maximizes the corporate tax revenues by choosing the corporate tax rate. We assume that each country hosts a national industry

in addition to the multinational affiliate. To keep the model simple, we will consider an inelastic *national* tax base which may differ across regions. Hence, the national tax base in country i is denoted R_i with $i \in \{a, b, c\}$. We allow these national tax bases to differ across countries. In the country that attracts the corporate headquarters, corporate tax revenues are defined by

$$T_h = t_h(R_h + \Pi_h), \quad h \in \{a, b, c\} \tag{6.9}$$

whereas Π_h denotes the profit generated at the headquarters location and is defined by equation (6.1). Instead, in the other countries corporate tax revenue reads

$$T_i = t_i(R_i + \Pi_i), \quad i \in \{a, b, c\},\ i \neq h \tag{6.10}$$

whereas Π_i is defined by equation (6.2). Since the MNE's pre-tax profit and the multinational headquarters are mobile (the former via profit shifting activities), the regions compete to attract this flexible tax base. As was shown in Propositions 1 and 2, the smaller the corporate tax rate chosen by the national government, the larger are the profit shifting gains. Moreover, the probability to attract the corporate headquarters rises when the corporate tax rate declines. Thus, the gains from lowering the corporate tax rate comprise the attraction of shifty profits.[11]

However, these gains come at the cost of loosing tax revenues from the inelastic domestic corporate tax base. The higher this domestic tax base, the higher are the cost of reducing the corporate tax rate. This trade-off defines the aggressiveness of a country in attracting the corporate headquarters and shifty profits from the foreign countries. The larger the domestic corporate tax base, the higher the costs of lowering the corporate tax rate and hence the larger is the corporate tax rate in equilibrium. Thus, if we

[11]Note that the expected shifting gains increase monotonically in the local corporate tax rate. Although the shifting gains from a corporate tax reduction are larger if the country hosted the multinational headquarters, the assumption that headquarters location follows shifting considerations as well as an intrinsic location valuation not observable to national governments ensures that a decrease in the tax rate only raises the *probability* to attract the headquarters. Thus the objective function of each government is a continuous function of the tax rates.

considered the national tax base distribution $R_a > R_b > R_c$, then corporate tax rates in equilibrium are characterized by $t_a > t_b > t_c$.

6.3 Empirical Analysis

The empirical section will investigate the basic hypotheses derived from our theoretical model above. First, we will test the prediction of the third stage of our theoretical model that profit shifting behavior is more sensitive to corporate tax rates if a group's headquarters (or more generally, a corporate unit that provides an intermediate good or intercompany service) were located in a low-tax country. Second, we will investigate the prediction of the second stage and determine whether the location decision of special, R&D intensive function units within corporate groups is actually distorted towards low-tax countries.

6.3.1 Data

We use the commercial database AMADEUS which is compiled by Bureau van Dijck. The version of the database available to us contains detailed information on firm structure and accounting of 1.6 million corporations in 38 European countries from 1995 to 2005, but is unbalanced in structure. Since our theoretical model accounts for multinational firms only, we restrict our sample to internationally operating corporations with headquarters in the EU25. The observational units in the data are the corporate subsidiaries which are directly owned by a foreign parent firm. Like the parent, the subsidiaries are restricted to be located within EU25. Moreover, the parent must hold at least 90% of the subsidiary shares for the affiliate to be included in our sample.[12] Nevertheless, our sample will account for information on the worldwide structure of the corporate groups which is generally available with the AMADEUS data. Thus, we will calculate the number of subsidiaries within a corporate group as well as the

[12]Additionally, we include only subsidiaries owned by an industrial corporation.

average tax differential between the headquarters and all the groups' affiliates. These calculations include all affiliates irrespective of location within or outside EU25, but are restricted to affiliates owned by at least 90%.[13]

The AMADEUS data has the drawback that the information on the ownership structure is available for the last reported date only. Thus, there exists some scope for misclassifications of 'subsidiary-parent-connections' that changed during the sample period. However, in line with previous studies, we are not too concerned about this issue since the described misclassifications introduce additional noise to our estimations that will bias our results towards zero (see e.g. Budd et al. (2005)). Since our analysis focuses on the detection of profit shifting activities between corporate affiliates, we merge data on statutory corporate tax rates at the parent and subsidiary location, as well as other basic country characteristics like the population size and GDP per capita.[14]

Table 1 in the Appendix contains the country statistics of our sample. We observe affiliates in all EU 25 countries apart from Malta and Cyprus, whereas a large share of the firms is located in France, Great Britain, Spain and Italy. Parent firms are mainly located in the Continental European countries, e.g. in Germany and France.

[13]The information on the multinational ownership structure is available for basically all corporate groups in the AMADEUS database. That is, one may derive the subsidiary country and basic information on sales and total assets for all affiliates within a group. Therefore, we determine the tax rate differential between the headquarters location and all directly and majority owned subsidiaries contained in the AMADEUS database. There might be concerns that we do not capture the whole multinational group since some affiliates might not be contained in the database. For every parent corporation the database embodies a variable describing the number of (known) corporate affiliates. Hence, we could check the difference between the number of subsidiaries which are actually contained in the dataset and the number of known affiliates. Since we found that the difference is very small (maximum two subsidiaries), we think this is a minor problem.

[14]The statutory tax rate data for EU25 is taken from the European Commission (European Commission, 2006), while the rates for affiliates outside the EU are based on data of the tax consultancy firm KPMG (KPMG (2006)). Country data for GDP per capita and population are obtained from the OECD (OECD (2007)).

Table 2 exhibits the descriptive statistics of the main variables. Our sample comprises 56,475 year-affiliate cells and 8,237 affiliates, hence we observe each affiliate for 6.8 years on average. The average fixed asset investment at the affiliate level amounts to 57.1 million US dollars, the average ownership of intangibles is calculated to be 2.9 million dollar on average. Non-surprisingly, the average capital investment at the parent location is substantially larger than fixed asset investment at the subsidiary level and amounts to 2,590.4 million US dollars. The MNEs in our sample employ 201.3 workers on average and earn a pre-tax profit of 3.1 million dollars. In line with the country statistics presented in Table 1, we find that the average statutory corporate tax rate at the subsidiary location falls short of the parent tax since most corporate owners are located in the high-tax countries of Continental Europe. In a last step, we calculated the average number of corporate affiliates within a multinational group. If we account for affiliates with an ownership share of strictly larger than 90% only, we find the average number of affiliates to be 66.65. Since for a quite large number of affiliates ownership is not observed, we add these firms for the calculation of subsidiary numbers in a second step and find the average number of affiliates to be 117.44. As these average subsidiary numbers appear to be rather large, note, that the calculated averages are partly driven by a few very large multinational corporations. The median of the affiliate number distribution is calculated with 17 and 25 respectively.

Since our theoretical model predicts that shifting possibilities are substantially hampered if a MNE is headquartered in a high-tax country, we will split our sample into corporate groups for which a major fraction of the subsidiaries observes a lower and higher corporate tax rate than the parent firm respectively. Low-tax headquarters groups are thereby defined according to the threshold that less than 10% (and in an alternative specification less than 20%) of the subsidiaries are located in countries with a lower tax rate than the parent firm. In contrast, high-tax headquarters groups are defined to be those with more than 90% (and in an alternative specification more than 80%) of subsidiaries in countries with a lower corporate tax rate than the parent firm. Table 3 contains the country statistic for the split sample. Subsidiaries of high-tax

headquarters groups are largely located in Spain and the new European member countries Poland and the Czech Republic. In contrast, affiliates of low-tax headquarters groups are often located in Germany, Denmark and Italy. The distribution of parent firms exhibits a similar picture. The headquarters of high-tax groups often locate in Germany, France and Italy, while many low-tax headquartered groups observe the parent in Sweden, Ireland and Spain.[15]

Tables 4 presents descriptive statistics for the split samples according to the thresholds of less than 10% (more than 90%) of subsidiaries being located in countries with a lower corporate tax than the parent. As expected, the number of observations belonging to 'high-tax headquarters groups' is around twice as large as the number of observations belonging to 'low-tax headquarters groups' (14,553 vs. 7,802). On average, subsidiaries of corporate groups which are headquartered in a high-tax country are found to be slightly smaller than affiliates of corporate groups which are headquartered in low-tax countries. The mean of fixed asset investment is calculated to be 46.0 million US dollars for affiliates with high-tax headquarters versus 55.8 million US dollars for affiliates with low-tax headquarters. In contrast, headquarters of 'high-tax headquarters groups' are more than twice as large with respect to fixed assets investment as headquarters of 'low-tax headquarters groups' (1,2 billion US dollars versus 2,9 billion US dollars). Moreover, corporate groups headquartered in low-tax countries tend to exhibit slightly fewer corporate affiliates (owned by strictly more than 90%), on average 48.8 in contrast to 51.8 affiliates for corporate groups headquartered at a high-tax location. For firms headquartered at low-tax countries, the average tax rate at the subsidiary level is calculated with 0.35 while the average corporate tax rate at the parent level amounts to 0.30. In contrast, corporate groups headquartered at high-tax locations have a statutory corporate tax of 0.40 on average at the parent location and 0.32 at the subsidiaries. The analogous sample statistic for the thresholds of 20% and 80% respectively can be found in Table 5.

[15]Note, that the definition of high-tax and low-tax groups is undertaken on a year-basis. Since the corporate tax rate changes over time, corporate groups may be defined to be high-tax headquarters group in one year and low-tax headquarters groups in the following year.

6.3.2 Methodology and Identification

Our basic estimation strategy is described by the following equation

$$\log\ PBT_{i,t} = \beta_0 + \beta_1 TAXDIFF_{i,t} + \beta_2 X_{i,t} + \phi_i + \epsilon_{i,t} \tag{6.11}$$

whereas $PBT_{i,t}$ denotes the pre-tax profit of subsidiary i at time t, $TAXDIFF_{i,t}$ represents the difference in statutory corporate tax rates between affiliate i and the corporate headquarters. $X_{i,t}$ comprises time-varying control characteristics for the affiliate and the parent corporation, e.g. one-digit NACE code industry-year dummies; $\epsilon_{i,t}$ describes the error term. Additionally we add affiliate fixed effects to control for time constant affiliate characteristics as well as time dummies to capture shocks over time common to all subsidiaries. Since the dependent variable pre-tax profit observes a rather skewed distribution we estimate a semi-logarithmic equation.

Since we would like to capture the impact of the multinational corporate structure on a MNE's profit shifting opportunities, we extend the basic estimation model in (6.11) by an interaction term between the tax rate difference $TAXDIFF_{i,t}$ and the share of subsidiaries in the corporate group that are located in countries with a lower corporate tax rate than the headquarters location. The prediction from our theoretical model is that profit shifting opportunities are better if the headquarters (as a unit that provides general services to the multinational affiliates) were located in a country with a low corporate tax rate and hence we expect the coefficient estimate for this interaction term to exhibit a negative sign.

A look at the distribution of corporate groups in our data, however, reveals that 85% of the observations belong either to a corporate group with less than 20% of their corporate affiliates in low-tax countries or to a corporate group with more than 80% of subsidiaries in low-tax countries (see figure 1). Since our theoretical hypotheses with respect to profit shifting behavior should be most clearly seen for subsidiaries that belong to 'extreme' corporate groups in the sense that headquarters service are either provided from a high-tax location or from a low-tax locations, we will contrast profit

shifting behavior for these two subsamples of firms.[16] The corporate tax effects on pre-tax profitability are thereby estimated separately as suggested by a Chow test on the data.

To get a better understanding for the determinants of the profit shifting intensity, we interact the tax rate differential between the headquarters and a respective subsidiary with potential shifting opportunities via other group channels. The shifting potential is thereby proxied by various measures which are summarized in Appendix A. According to our theoretical model profit shifting between a subsidiary and the corporate headquarters should be hampered by the presence of additional shifting channels for high-tax headquarters groups, while profit shifting activities of low-tax headquarters groups should not be affected. In contrast, if economies of scope in profit shifting played a significant role (e.g. upfront laywer costs to engage in shifting activities) the average shifting volume may even increase in the availability of additional shifting channels.

The analysis so far was concerned with the predictions of the third stage of our theoretical model. Moreover, we would like to test the predictions of the second stage and will determine whether MNEs actually distort their corporate structures in a manner that optimizes profit shifting opportunities. Since we observe the ownership information in our panel for the last reported date only, we are not able to track relocations of the headquarters or ownership changes. However, as stated above, our basic argumentation refers to all central services provided within a corporation which constitute profit shifting possibilities. This may refer to headquarters functions like the provision of management or administrative services but might also comprise R&D units that provide patents to the whole group or brand names owned by special purpose affiliates. The perception of many authors in the profit shifting literature is that profit shifting by transfer pricing distortions largely takes place via the provision of these intangible

[16] Note that our theory does not derive clear-cut predictions with respect to profit shifting by corporate groups with an intermediate corporate tax rate compared to other affiliates. However, if the headquarters have an incentive to shift profit to some of their subsidiaries while in turn re-allocating profit from others to the headquarters location, the analysis should be closer to the 'low-tax' headquarters case than to the 'high-tax' headquarters case.

services, patents or brands. Our theory predicts that intangible assets provided within a corporate group should be located at low-tax countries to optimize profit shifting possibilities. Therefore, we estimate the following equation

$$INTANG_{i,t} = \gamma_0 + \gamma_1 TAXDIFFG_{i,t} + \gamma_2 X_{i,t} + \phi_i + \epsilon_{i,t} \tag{6.12}$$

whereas $INTANG_{i,t}$ represents the ratio of intangible assets to the overall subsidiary assets. We refrain from using the direct size of intangible assets as dependent variable to hedge against mixing up general tax effects on corporate investment with effects on the size of intangible assets. $TAXDIFFG_{i,t}$ is calculated as the unweighted average tax between all other affiliates (including the corporate headquarters) and the considered affiliate. Theory predicts that the larger this difference, the larger should be the amount of intangible assets owned by the subsidiary.

6.3.3 Empirical Results

Following the theoretical model, our empirical analysis aims at determining the interaction between the multinational corporate structure and profit shifting opportunities. As laid out above, MNEs can exploit shifting possibilities much easier if the goods traded were owned or provided by low-tax affiliates.

Table 6 describes the basic fixed effect estimation. The endogeneous variable is profit per sales at the subsidiary level. We estimate a standard production function including fixed assets per sales and employees per sales as explanatory variables in the equation. Additionally, we include the corporate tax rate difference between the affiliate and headquarters location which is defined by corporate tax at the headquarters location minus corporate tax at the affiliate location. Moreover, the analysis includes a full set of year dummies, a full set of industry-year dummies and firm fixed effects. We find a positive and significant impact of the defined tax rate differential on the affiliate's pre-tax profitability. Following the predictions of our theoretical model, we now interact the corporate tax rate difference with the share of subsidiaries within a corporate

group with a lower statutory tax rate than the parent firm. The prediction is that the larger this share the lower are the corporate shifting possibilities. This hypothesis is impressively confirmed by the results presented in specification (2). While the direct corporate tax effect that captures the impact for pure low-tax headquarters groups doubles in size to 1.15, the interaction term carries a negative sign, suggesting that the larger the share of subsidiaries with a lower corporate tax rate than the parent firm, the smaller the profit shifting activities. Specification (3) additionally includes control variables for basic country characteristics like GDP per capita and population size. The estimated coefficients for the country controls do not exhibit a significant impact on corporate profitability, whereas the impact of corporate taxes on the profitability measure remains unchanged.

As already mentioned above, the overwhelming part (85%) of corporate groups in our sample are extreme in the sense that more than 80% of the corporate subsidiaries are located in countries that either all have a higher or all have a lower statutory corporate tax rate than the headquarters location. Since our theory draws conclusions for profit shifting activities of high-tax and low-tax headquarters while the predictions for intermediate cases are not fully clear, we build subsamples containing the extreme cases of high-tax and low-tax headquarters firms. The results can be found in Tables 7 and 8.

Table 7 compares the impact of the corporate tax rate differential on pre-tax profitability distinguishing between corporate groups for which less than 10% of the subsidiaries are located in low-tax countries and corporate groups for which strictly more than 90% of the corporate subsidiaries are located in low-tax countries. Specifications (1) and (2) thereby control for input factors per sales, year dummies and include firm fixed effects. The estimation confirms and even amplifies the results in Table 6 as we find that the corporate tax differential does not to have any statistically significant impact on pre-tax profitability of subsidiaries with high-tax headquarters.[17] In contrast, for the

[17]Note, that the subsample contains 3,897 firms and we can therefore exclude possible explanations for the statistical insignificance on the basis of large standard errors induced by a small sample size.

sample of low-tax headquarters groups, the tax rate differential exerts a strong impact on pre-tax profitability which is 200% larger than the effect estimated in Specification (1) of Table 6. Note moreover, that the estimated coefficients are statistically different at the 5% level. Specifications (3) and (4) additionally control for industry-year effects. This slightly increases the estimated tax effect on pre-tax profitability for both subsamples. However, the estimated coefficient for the corporate tax difference remains statistically insignificant for the subsample of affiliates belonging to high-tax parent groups. Specifications (5) and (6) add GDP per capita and the population size as control variables to the analysis. This additionally increases the estimated coefficient for the tax difference in the subsample of firms in 'high-tax headquarters groups', but still it does not gain statistical significance while the corporate tax difference effect on pre-tax profitability remains high and stable for the subsample of firms in 'low-tax headquarters groups'. Table 8 reruns the estimations for the subsamples of corporate groups with at least 80% or less than 20% of corporate affiliates located in countries with a tax rate lower than the headquarters statutory tax. The estimated results are similar although the specification with country control characteristics now exhibits a statistically significant effect for the sample of high-tax headquarters groups (Specification (5)). Nevertheless, the point estimate for the subsample of low-tax headquarters groups still exceeds this coefficient by 200% (Specification (6)).

Our theory predicted that the reduced profit shifting opportunities with high-tax headquarters locations root in a combination of earnings limitations and increased monitoring possibilities on the side of the tax authority. This predicts profit shifting options to decline with increased shifting activities between the headquarters and other subsidiaries. In contrast, for groups of multinational firms with headquarters in low-tax countries, we should not find this effect.[18]

[18]In the latter case, an increase in the profit shifting options through other channels may even exert a positive impact on shifting volume if we observe economies of scope in profit shifting in the sense that average per-unit concealment costs fall in the shifting volume. This would for example be the case if the cost of profit shifting entailed a fixed component.

The results for the subsample definition according to the 10% and 90% threshold respectively are presented in Table 9. In Specifications (1) and (2), we employ the number of corporate affiliates within the group (apart from the considered affiliate) as proxy for profit shifting activities on other channels and interact this variable with the tax rate differential between headquarters and the subsidiary location. Specification (1) shows the result for the subsample of subsidiaries in high-tax headquarters groups. As predicted by our theory, the estimated coefficient on the tax rate differential now becomes positive and statistically significant, while the interaction term exhibits a negative sign. The estimation for the group of subsidiaries with the headquarters located in a low-tax country shows the opposite result. Here, the direct effect of the corporate tax differential on pre-tax profitability remains quantitatively large while the interaction term is positive but does not gain statistical significance. However, the number of foreign subsidiaries may be a bad proxy for shifting activities between the corporate headquarters and other affiliates. Hence, we employ the average absolute tax rate difference multiplied by the number of foreign subsidiaries as proxy for shifting opportunities through other channels in Specifications (3) and (4). The picture is qualitatively similar to the estimations beforehand and points to a reduced shifting activity per channel if the headquarters were located in a high-tax country while the shifting possibilities through other channels do not affect profit shifting if the headquarters were located in a low-tax country. In a third step we account for the fact that profit shifting possibilities may depend on investment size at the headquarters and affiliate location. We therefore define a measure that relates profit shifting possibilities on other channels to the investment at the headquarter location. We thus multiply the absolute tax rate difference on each channel by the amount of fixed assets invested at the subsidiary and sum this up for all but the considered affiliate. We then divide by the fixed asset size at the headquarter location, as described in Appendix A. The results can be found in Specifications (5) and (6) of Tables 9 and are in line with our presumption that profit shifting is deterred by additional shifting channels and low investment and profit levels at the parent location for 'high-tax headquarters' groups, while this does not male a difference for shifting activities of 'low-tax headquarters' groups.

A general concern with the results may be that we interact the tax rate differential with a continuous variable that may exhibit outliers that drive the coefficient estimate for the interaction term. We ran sensitivity checks by generating a set of dummy variables that capture different percentiles of the shifting measure distribution. If we interacted these with the tax rate difference variable we obtain qualitatively equal results (not reported).[19]

Finally, we would like to determine whether corporate tax considerations play a role in the corporate structure choice of MNEs. We therefore investigate in which subsidiaries the MNE allocates intangible assets that are likely to be used as intermediate factors at the corporate production sites. Our theory suggests that these intermediates should be located in low-tax subsidiaries since this opens up profit shifting channels through transfer pricing distortions that are more pronounced than if the unit was located at a high-tax location. The estimation results can be found in Table 10. The endogeneous variable is the ratio of intangible assets to the affiliate's overall assets. We employ the ratio of intangible assets over total assets to avoid capturing general investment incentives induced by corporate tax considerations. If instead the ratio of intangibles was distorted towards low-tax countries, this might be valued as indirect evidence for our theory. Specification (1) includes the corporate tax rate as explanatory variable. Controlling for firm fixed effects, year effects and year-industry effects, we find that

[19]Note, that we find no evidence for economies of scope in international profit shifting in the sense that larger shifting opportunities reduce per unit shifting costs and therefore increases the shifting volume. As we described above, the obstacles to profit shifting should be absent for low-tax headquarters groups. Nevertheless, an economies of scope effect, if present, should apply to all groups. Since we find no statistically significant positive effect for the interaction term of the corporate tax rate differential with additional profit shifting opportunities through other channels, we see this as evidence that economies of scope play no major role for international profit shifting. However, economies of scope may arise through fixed costs in the profit shifting process. If this notion was correct, the effect should exhibit with relatively small multinational groups foremost. We therefore reran our regressions for the low-tax parent sample restricting observations to affiliates with below average fixed asset investment. The estimated coefficient on the interaction term tends to be positive and to increase in size and significance, however, we still find no stable effect across specifications.

the share of intangible assets held by the affiliate falls in the corporate tax rate at the subsidiary location. Thus the result is in line with our theory. However, the absolute corporate tax rate at a location may be a relatively imprecise measure since our model predicts central service units to be located in countries with a low corporate tax *relative* to other group members. This is captured in Specifications (2) and (3). Here, we include the (unweighted) average tax difference between a respective subsidiary and all other affiliates of the corporate group (that are owned by the parent with a share of 90% or more) as explanatory variable. The larger this difference, the smaller the subsidiary tax compared to other affiliates in the group and the larger should be the amount of intangible assets located there. This theoretical notion is confirmed by the data since the estimated coefficient for the average tax rate difference is positive and statistically significant.

6.4 Conclusion

Although the economic literature has provided extensive evidence on profit shifting behavior of MNEs, the interaction between organizational structure and the volume of profit shifting has been largely unexplored. Desai et al. (2006) and Grubert and Slemrod (1998) are notable exceptions that touch this question. They show that a multinational's presence in tax havens is related to the importance of intra-firm trade and intangible assets within a firm. Our paper goes one step further. We analyze where central multinational functions have to be located within a corporate group to obtain the best profit shifting opportunities. We provide evidence that profit shifting to corporate subsidiaries is substantially larger if central units that provide intermediate goods or services (in our case the corporate headquarters) are located in a low-tax country relative to the rest of the group. Moreover, we show that MNEs in fact distort the location of intangible goods towards countries with low corporate tax rates.

While MNEs have been known to relocate production to low-tax countries for some time, a recent feature of organizational change within MNEs has been the relocation

of central management units as well as R & D centers and brand holding companies to tax havens. Our theoretical and empirical model provides a rational and evidence that a relocation of these special purpose units to low-tax countries may be attractive under profit shifting considerations. Given that these central corporate entities are often skill-intensive and comprise the central decision units within the MNE, countries may desire to locate these parts of the firm within their borders (BMF, 2007), even beyond profit shifting considerations. This new mobility of central service units within the multinational firm may thus foster tax competition behavior between governments.

6.5 Appendix

Number of Subsidiaries

'Number of Subsidiaries' describes number of affiliates within multinational group (apart from the considered subsidiary) that are owned by the parent with a share of at least 90%. The notion behind this approach is that the multinational firm may shift approximately the same amount of profit between the multinational headquarters and an affiliate. Hence profit shifting opportunities through other channels may be proxied by the number of subsidiary firms.

Sum of Absolute Tax Differentials

The 'Sum of Absolute Tax Differentials'- measure accounts for the fact that profit shifting opportunities and incentives depend on the corporate tax rate difference between multinational headquarters and its subsidiary. The larger the absolute tax differential between the two locations the larger the gains from engaging in shifting activities and henceforth the larger the shifting volume. We therefore determine the average *absolute* tax rate differentials between the headquarters and all other group affiliates and multiply it by the number of group affiliates (apart from the considered subsidiary). The measurement problem attached here might be that profit shifting increases underproportionally in the absolute corporate tax rate differential due to convex shifting costs. This would however lead to an underestimation of the coefficient for the interaction term between the corporate tax rate differential and our shifting measure. Hence, provided we find a negative and significant effect for the interaction term, we can be save that it eventually captures a true underlying systemtatic.

Sum of Absolute Tax Differentials, Adjusted for Subsidiary and Parent Size

Several authors have pointed out that profit shifting opportunities may in fact depend

on investment at the subsidiary location (Grubert and Slemrod (1998), Eggert and Schjelderup (2005), Riedel and Runkel (2007)). We account for this idea by adjusting our profit shifting measure by the investment size at the subsidiary location. Hence, we multiply the absolute tax rate difference by the size of fixed assets at the subsidiary and calculate the sum of this product for all affiliates in a corporate group (apart from the considered subsidiary). Moreover, our theory predicts that profit shifting from the headquarters to the subsidiaries should be more strongly deterred the smaller the size and pre-tax profit of the parent. We therefore divide the just calculated measure by the parent fixed assets. For high-tax headquarters groups, an increase in the described shifting measure is expected to reduce shifting activities for two reasons. First, an increase in the absolute tax rate differential as well as an increase in the fixed assets raise the shifting volumes through other channels and thereby reduce shifting activities on the considered transaction channel. Moreover, the shifting measure also increases if the size of fixed assets at the parent firm falls. A small parent firm (with a small pre-tax and pre-shifting profit) should deter shifting activities even further due to profit limitations. For low-tax groups, we again do not expect a significant effect.

Note: Throughout * will indicate significance on the 10% level, ** significance on the 5% level and *** significance on the 1% level.

Table 1: Country Statistics - Whole Sample

Country	*Affiliate*	*Parent*
Austria	102	95
Belgium	491	257
Cyprus	0	1
Czech Republic	241	4
Germany	388	669
Denmark	503	371
Estonia	155	15
Spain	844	179
Finland	356	123
France	989	572
Great Britain	1,241	335
Greece	64	9
Hungary	105	4
Ireland	169	41
Italy	540	250
Lithuania	46	3
Luxembourg	37	18
Latvia	74	1
Netherlands	723	231
Poland	481	9
Portugal	115	31
Sweden	520	545
Slovenia	7	2
Slovakia	46	2
Sum	8,237	3,767

Table 2: Descriptive Statistics - Whole Sample			
Variable	*Observations*	*Mean*	*Std. Dev.*
Fixed Assets/1000, Affiliate	55,921	57,073.43	668,000.00
Intangible Assets/1000, Affiliate	56,055	2,899.54	105,295.40
Relative Intangible Assets, Affiliate	56,054	0.0250	0.1527
[Intangible Assets/Total Assets ·1/1000]			
Fixed Assets/1000, Parent	43,220	2,590,380	8,624,102
Employees	44,010	201.30	856.89
Sales	37,529	71,861.14	412,996.30
Pre-tax Profit	53,247	3,092.01	52,706.78
Statutory Tax Rate, Affiliate	56,475	0.3311	0.0632
Statutory Tax Rate, Parent	56,475	0.3615	0.0754
Difference Statutory Tax	56,475	0.0304	0.0879
[Tax Parent-Tax Affiliate]			
Number of Affiliates	56,475	66.65	125.78
(> 90% Ownership)			
Number of Affiliates, NA	56,475	117.44	228.85
(> 90% Ownership)			

Table 3: Country Statistics - Divided Sample								
	Subsidiary Country				**Parent Country**			
Country	$> 90\%$	$> 80\%$	$< 20\%$	$< 10\%$	$> 90\%$	$> 80\%$	$< 20\%$	$< 10\%$
Austria	43	44	9	7	38	38	45	45
Belgium	249	273	276	247	179	180	115	115
Cyprus	0	0	0	0	0	0	1	1
Czech Republic	130	145	67	58	2	2	1	1
Germany	25	39	110	102	555	555	16	14
Denmark	129	134	154	147	210	216	145	142
Estonia	123	129	38	34	13	13	2	2
Spain	452	469	273	244	59	60	78	74
Finland	187	201	203	192	62	66	65	65
France	451	462	435	409	424	432	210	193
Great Britain	842	866	327	282	45	46	151	150
Greece	45	49	25	21	6	6	1	1
Hungary	7	10	1	1	0	0	4	4
Ireland	38	39	9	7	0	0	31	31
Italy	260	282	319	287	192	193	26	25
Lithuania	26	32	11	10	2	2	2	2
Luxembourg	12	12	4	3	12	12	8	8
Latvia	52	55	12	12	0	0	1	1
Netherlands	126	133	94	82	114	118	95	89
Poland	317	330	120	103	4	4	5	5
Portugal	24	29	24	21	17	17	18	18
Sweden	333	363	121	106	150	150	368	367
Slovenia	0	0	0	0	0	0	1	1
Slovakia	22	24	8	6	0	0	2	2
Sum	$3,897$	$4,126$	$2,640$	$2,381$	$2,084$	$2,110$	$1,391$	$1,348$

Table 4: Descriptive Statistics- Divided Sample						
	Low Tax Parent ($< 10\%$)			**High Tax Parent** ($> 90\%$)		
Variable	*Observations*	*Mean*	*Std. Dev.*	*Observations*	*Mean*	*Std. Dev.*
Fixed Assets/1000, Affiliate	7,802	55,840.48	557,504.80	14,553	46,023.80	616,979.70
Fixed Assets/1000, Parent	6,247	1,210,119	3,876,028	10,677	2,917,035	1,017,854,933
Employees	7,802	219.89	1085.26	14,553	205.72	839.24
Sales	7,802	82,927.80	444,196.90	14,553	81,332.93	418,427.80
Pre-tax Profit	7,802	7,521.96	65,144.25	14,553	5,491.21	36,112.65
Statutory Tax Rate, Affiliate	7,802	0.3516	0.0610	14553	0.3221	0.0552
Statutory Tax Rate, Parent	7,802	0.3045	0.0467	14,553	0.4010	0.0793
Difference Statutory Tax [Tax Parent-Tax Affiliate]	7,802	−.04710	0.0582	14,553	0.0789	0.0732
Number of Affiliates ($> 90\%$ Ownership)	7,802	48.84	111.69	14,553	51.84	100.75
Number of Affiliates, NA ($> 90\%$ Ownership)	7,802	76.69	167.29	14,553	95.90	189.19

Table 5: Descriptive Statistics - Divided Sample						
	Low Tax Parent ($< 20\%$)			**High Tax Parent** ($> 80\%$)		
Variable	*Observations*	*Mean*	*Std. Dev.*	*Observations*	*Mean*	*Std. Dev.*
Fixed Assets/1000, Affiliate	8,673	54,990.93	541,002.20	15,811	45,387.47	592,946.20
Fixed Assets/1000, Parent	6,988	1,387,047	4,049,922	11,842	3,062,643	9,736,852
Employees	8,673	223.65	1,050.27	15,811	215.19	861.84
Sales	8,673	85,371.55	438,700.60	15,811	85,691.49	421,060.80
Pre-tax Profit	8,673	7,554.81	62,777.97	15,811	5679.10	35,165.26
Statutory Tax Rate, Affiliate	8,673	0.3510	0.0621	15,811	0.3231	0.0560
Statutory Tax Rate, Parent	8,673	0.3077	0.0472	15,811	0.3975	0.0776
Difference Statutory Tax [Tax Parent-Tax Affiliate]	8,673	−0.0432	0.0601	15,811	0.0745	0.0738
Number of Affiliates ($> 90\%$ Ownership)	8,673	54.99	120.37	15,811	65.68	121.37
Number of Affiliates, NA ($> 90\%$ Ownership)	8,673	86.11	182.12	15,811	116.75	229.92

Table 6: Endogenous Variable: Log Profit/Sales - Subsidiary Level

Variable	*(1)*	*(2)*	*(3)*
Tax Difference	0.5861^{***}	1.1514^{**}	1.1299^{***}
	(0.1577)	(0.3268)	(0.3569)
Tax Difference*Share Low-Tax Subsidiaries		-0.7567^{**}	-0.7329^{*}
		(0.3743)	(0.3995)
Log Employees/Sales	0.1101^{***}	0.1171^{**}	0.1246^{***}
	(0.0148)	(0.0149)	(0.0158)
Log Fixed Cost /Sales	0.0634^{***}	0.0597^{***}	0.0658^{***}
	(0.0090)	(0.0092)	(0.0100)
Log GDP per Capita			-0.1213
			(0.2987)
Log GDP per Capita			-0.8097
			(0.8821)
Year	$\surd$	$\surd$	$\surd$
Industry-Year Dummies	$\surd$	$\surd$	$\surd$
Number of Observations	$28,640$	$28,140$	$25,138$
Number of Firms	$5,935$	$5,912$	$5,521$
R^2	0.69	0.69	0.70

Table 7: Endogenous Variable: Log Profit Per Sales- Subsidiary Level						
Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Tax Differential	0.0776	1.4773***	0.1046	1.8976***	0.2718	1.7265***
	(0.2369)	(0.5031)	(0.2426)	(0.5232)	(0.2660)	(0.6007)
Log Employees/Sales	0.0931***	0.1362***	0.0991**	0.1440***	0.0726***	0.1320***
	(0.0221)	(0.0310)	(0.0224)	(0.0320)	(0.0237)	(0.0333)
Log Fixed Assets/Sales	0.0595***	0.0730***	0.0586***	0.0789***	0.0634***	0.0766***
	(0.0130)	(0.0195)	(0.0131)	(0.0200)	(0.0145)	(0.0214)
Log GDP/Capita					−0.2228	0.6276
					(0.4604)	(0.6693)
Log Population					−0.8448	−1.2898
					(1.2503)	(2.1501)
Year Dummies	√	√	√	√	√	√
Industry Dummies			√	√	√	√
Sample	> 90%	< 10%	> 90%	< 10%	> 90%	< 10%
Number of Observations	14,553	7,802	14,340	7,623	12,598	6,893
Number of Firms	3,897	2,381	3,833	2,325	3,405	2,082
R^2	0.72	0.73	0.72	0.74	0.73	0.74

Table 8: Endogenous Variable: Log Profit Per Sales- Subsidiary Level						
Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Tax Differential	0.3045	1.5928***	0.3347	1.8527***	0.4809**	1.6910***
	(0.2244)	(0.4643)	(0.2299)	(0.4814)	(0.2507)	(0.5554)
Log Employees/Sales	0.0913***	0.1438***	0.0972***	0.1508***	0.1118***	0.1341***
	(0.0213)	(0.0290)	(0.0216)	(0.0297)	(0.0229)	(0.0311)
Log Fixed Assets/Sales	0.0522***	0.0716***	0.0516***	0.0757***	0.0560***	0.0722***
	(0.0125)	(0.0184)	(0.0126)	(0.0188)	(0.0139)	(0.0203)
Log GDP/Capita					−0.1578	0.3070
					(0.4368)	(0.6208)
Log Population					−0.8515	−1.2943
					(1.1965)	(2.0198)
Year Dummies	√	√	√	√	√	√
Industry Dummies			√	√	√	√
Sample	> 80%	< 20%	> 80%	< 20%	> 80%	< 20%
Number of Observations	15,811	8,673	15,567	8,467	13,738	7,647
Number of Firms	4,120	2,640	4,050	2,574	3,605	2,324
R^2	0.73	0.73	0.73	0.73	0.74	0.74

Table 9: Endogenous Variable: Log Profit Per Sales- Subsidiary Level						
Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Tax Differential	0.6400^{**}	1.5200^{**}	0.6296^{**}	1.7264^{***}	0.9378^{***}	1.5717^{***}
	(0.2866)	(0.6603)	(0.2900)	(0.6596)	(0.3641)	(0.7973)
Tax Differential * Shifting Others	-0.0066^{***}	0.0039	-0.0601^{***}	-0.0098	-0.0641^{***}	-0.0737
	(0.0019)	(0.0052)	(0.0157)	(0.0801)	(0.0189)	(0.0977)
Log Employees/Sales	0.1133^{***}	0.1320^{***}	0.1130^{***}	0.1342^{***}	0.1366^{***}	0.0540^{***}
	(0.0237)	(0.0333)	(0.0241)	(0.0337)	(0.0293)	(0.0391)
Log Fixed Assets/Sales	0.0626^{***}	0.0761^{***}	0.0595^{***}	0.0729^{***}	0.0604^{***}	0.0673^{***}
	(0.0145)	(0.0214)	(0.0147)	(0.0218)	(0.0175)	(0.0254)
Log GDP/Capita	-0.1694	0.5680	-0.0241	0.5624	0.1907	1.1403^{*}
	(0.4603)	(0.6740)	(0.5598)	(0.6893)	(0.5598)	(0.8163)
Log Population	-0.7810	-1.1834	-0.7376	-0.9143	0.9026	-3.5460
	(1.2498)	(2.1548)	(1.2764)	(2.1775)	(1.5598)	(2.4545)
Year Dummies	√	√	√	√	√	√
Industry Dummies	√	√	√	√	√	√
Sample	$> 90\%$	$< 10\%$	$> 90\%$	$< 10\%$	$> 90\%$	$< 10\%$
Number of Observations	12,598	6,893	12,082	6,712	8,841	5,384
Number of Firms	3,405	2,082	3,275	2,029	2,811	1,828
R^2	0.73	0.74	0.73	0.74	0.77	0.72

Table 10: Endogenous Variable: Relative Share Intangible Assets

Variable	*(1)*	*(2)*	*(3)*
Tax Rate	-0.0426^{***}		
	(0.0108)		
Average Tax Difference To Others		0.0243^{***}	0.0319^{***}
		(0.0087)	(0.0977)
Population/100,000	0.248^{***}		0.165^{***}
	(0.0621)		(0.0689)
GDP per Capita/1,000,000	0.123		0.235
	(0.340)		0.365
Year	$\surd$	$\surd$	$\surd$
Year Dummies	$\surd$	$\surd$	$\surd$
Number of Observations	49,714	45,806	41,577
Number of Firms	7,730	6,658	6,411
R^2	0.75	0.73	0.74

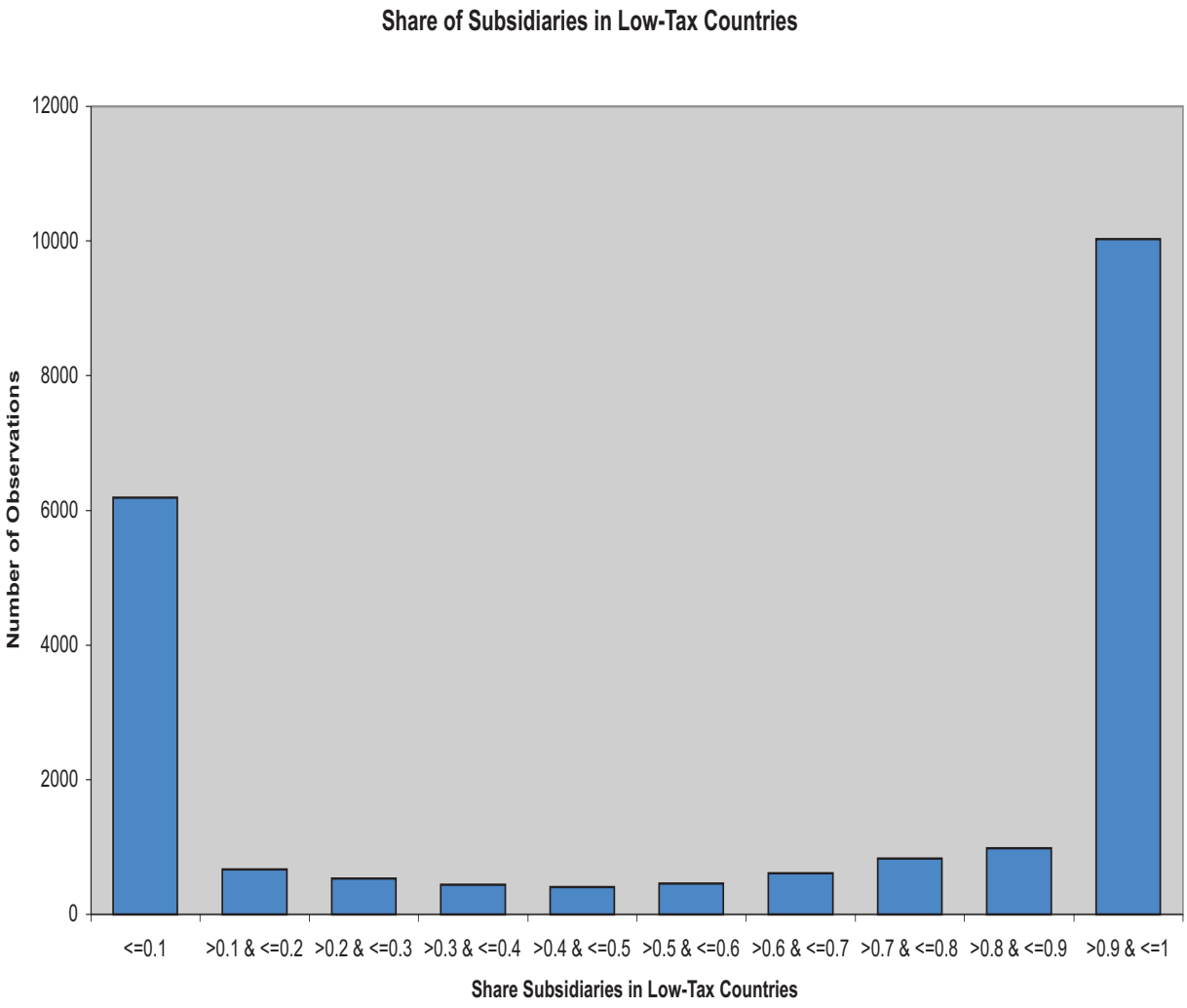


Figure 6.1: Share of affiliates located in low tax countries

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Eidesstattliche Versicherung

Ich versichere hiermit eidesstattlich, dass ich die vorliegende Arbeit selbständig und ohne fremde Hilfe verfasst habe. Die aus fremden Quellen direkt oder indirekt übernommenen Gedanken sowie mir gegebene Anregungen sind als solche kenntlich gemacht.

Die Arbeit wurde bisher keiner anderen Prüfungsbehörde vorgelegt und auch noch nicht veröffentlicht.

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