Federal Tax Competition

- How a Country's Federal Framework Affects its Position in Competing for Increasingly Mobile Capital -

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List of Abbreviations

CEEC	Central and Eastern European Countries
EU	European Union
EU-15	Fifteen member states comprising the European Union until 2004
IMF	International Monetary Fund
LHS	Left-hand side (of an equation)
MCF	(Perceived) marginal cost of public funds
ML	Maximum-Likelihood
OECD	Organisation of Economic Cooperation and Development
RHS	Right-hand side (of an equation)
SMBF	Social marginal benefit of public funds
SMCF	Social marginal cost of public funds
TFEU	Treaty on the Functioning of the European Union
U.S.	United States
ZMW	Zodrow-Mieszkowski-Wilson model of interregional tax competition

List of Symbols

b	State/regional tax base
B	Federal tax base
C	Cost of investing abroad
c	Consumption of a private good
$f'(k)$	Marginal product of capital
g	Consumption of a public good provided at the state/regional level
G	Consumption of a public good provided at the federal level
k	Amount of capital invested in one state/region
n, m	Number of states/regions in federation A, B respectively
$\bar{r}$	World market interest rate
r	Tax revenue generated in one state/region
R	Tax revenue generated by the central government of a federation
t	Capital tax rate prevalent in one state/region
T	Capital tax rate chosen by the federal government
u	Utility
w_{ij}	Weight assigned to region j according to shared borders with region i
y	Production in one state/region
$\Gamma(g, G)$	Utility function for the consumption of public goods
δ	Tax rate on rental income π levied by the state/regional governments

Δ	Tax rate on rental income π levied by the federal government
θ	Consolidated tax rate on rental income π
π	Rental income accruing to an individual in one state/region
ρ	Net return on capital investments
σ	Degree of international capital mobility
τ	Consolidated capital tax rate prevalent in one state/region

Chapter 1

Introduction

1.1 Purpose of the Study

This dissertation intends to enhance the discussion of how a country's federal framework shapes its position in the context of international competition for a mobile capital tax base. Precisely, it examines how multi-levelled government affects the efficiency of chosen capital tax rates with a particular focus on the internationalisation of capital markets. It derives its raison d'être from various perspectives. For one, a federal structure leads to an ease of mobility between regions, such that these are faced with a mobile tax base, which may not be the case for the central government. Then, with a worldwide trend towards fiscal decentralisation and the integration of international capital markets, competition for mobile tax base not only within the federation, but between countries of different federal design, is a particularly relevant issue.

The public perception of an increasingly globalised economy appears to be shaped by the potential threats rather than the opportunities. The connotation of international capital investment activities with the biblical 'Plague of the Locusts' prominently shaped by representatives of the German Social Democratic Party,[1] which has even found its way into the annual report of the German Council of Economic Experts,[2] seems to have hit a nerve then and has been further fuelled as a consequence of the recent financial crisis. The perception of international tax competition, particularly for mobile capital, leading to a 'race to the bottom' in tax rates culminating in an attempt to attract mobile capital at the cost of citizens appears to be widespread and resilient. Yet countries do not seem to have gone bankrupt in droves, such that the analysis of the exact forces shaping the consequences of globalisation is highly relevant.

In fact, capital income or corporate tax rates in the OECD countries have been reduced

[1] See, for example, NZZ (2005).

[2] See German Council of Economic Experts (2005), page 35.

over the past decades.[3] Nonetheless, tax revenues have remained relatively stable. Figure 1.1 shows the development of revenues from the taxation of corporate income for the time between 1965 and 2008. They are depicted as a percentage of total taxation and of GDP for the EU-15 and the OECD. Over the considered time period, a drop can be observed for

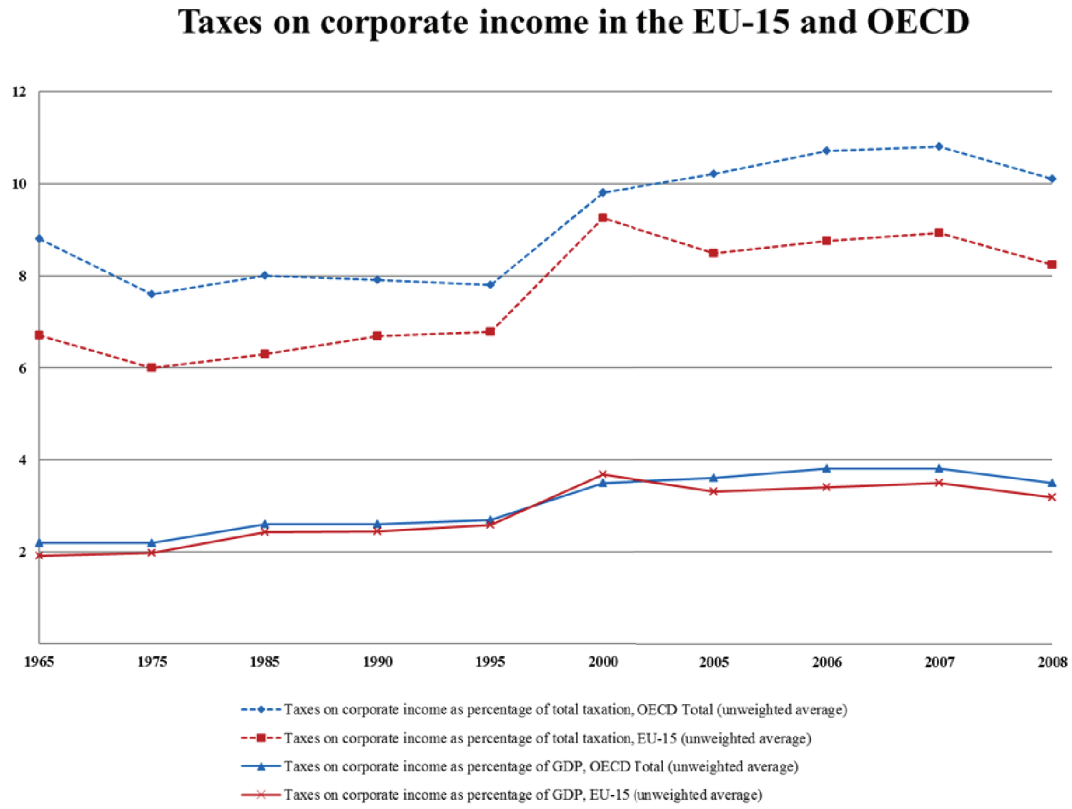

Figure 1.1: Taxes on Corporate Income in the EU-15 and OECD
Source: Based on OECD (2010)

the EU-15 from 2000 to 2005, which may be indicative of the 2004 enlargement to have had an impact on corporate income taxation. Yet, abstracting from the dip in 2008, which is likely to have been essentially driven by the consequences of the financial crisis, the overall trend shows that tax revenues relative to GDP have not been subject to significant declines. Likewise, the weight of corporate tax receipts in the composition of total tax revenues also does not appear to have receded significantly. Figure 1.1 thus illustrates that the feared loss of corporate tax proceeds does not seem to have become manifest on average in the OECD and EU-15 over the past decades. In the same direction, Devereux et al. (2004) examine corporate taxation in the UK to find that the observed reduction of tax rates did not have an impact on tax revenues. Auerbach (2007) studies the taxation of corporate income in the

[3]See, for example, OECD (2010) or Devereux et al. (2008) for more detail.

United States, where likewise, tax rates have gone down, while revenues have gone up. In the same direction, Becker and Fuest (2010) find that German corporate tax revenues at the German state level ('Länder') have in fact risen with a higher degree of internationalisation. With these studies not necessarily supporting the view of the negative impact of globalisation, it becomes an even more relevant question as to which factors drive the development of tax rates and tax revenues. Some potential explanations, such as a broadening of tax base or the growth of the respective sector, are given in the cited studies. The explicit consideration of a country's federal setup may yield further insights.

The relevance of this topic becomes apparent by considering the case of the European Union. It currently consists of 27 member states, each of which have their own historically grown federal framework. With EU enlargement and integration, capital flows easily within Europe[4] and the number of member states is growing. That has various implications relevant in the context of this study. For one, next to increasingly intense worldwide competition for mobile capital, EU member states are faced with strong tax competition by other member states due to free capital mobility, where a common labour market and increasingly uniform adjudication across countries further raise the possibilities for investors to freely choose where to locate their capital. Next to the perception of individual member countries, the European Union may be seen as a player in its own right. As the recent financial crisis demonstrated, it is not simply a loose collection of nations sharing open borders. On the contrary, monetary and commodity markets are interdependent to such an extent that policies of one country affect the entire union. The need for consolidated activities might lead to the EU being justly perceived as a single federation of states. While there is as yet no genuine supranational revenue source, its introduction has been on the political agenda since the early stages of the European Economic Monetary Union.[5] The most recent advance by the European Commission in favour of a genuine EU tax as part of a reform of its financing scheme[6] may, however, be quite relevant given the recent shift towards a higher degree of fiscal responsibility at the EU level. To that end, the European Union may well be perceived as directly competing with countries such as the United States or China, which themselves have a more or less federal structure.[7] Hence, the explicit recognition of the federal design of competing nations, which may as well shape how the respective country is affected by tax competition,[8] is of high relevance for the analysis of tax setting within the Union as well as for its position competing with other regions.

[4]EU membership grants the full liberalisation of capital flows between countries, as established in articles 63ff. TFEU.

[5]See Wartha (2007) for a detailed discussion.

[6]See European Commission (2010).

[7]In that context, see, for example, the empirical results by Altshuler and Goodspeed (2003) on tax competition between the United States and the European Union, which will be discussed in section 2.2.2.

[8]See section 2.1.3.

Beyond Europe, there has been a worldwide trend towards fiscal decentralisation over the past decades. Next to those established federal countries that have been studied extensively in the existing literature,[9] several emerging and developing countries have introduced elements of fiscal decentralisation.[10] This tendency may be driven by such promotion through the World Bank or the IMF and may be restricted to the implementation of transfer schemes rather than actual local revenue autonomy, as suggested by Brueckner (2009). A global trend towards fiscal decentralisation may nonetheless culminate in growing numbers of countries actually adapting federal tax systems, such that the recognition of the consequences of tax base overlap becomes even more relevant.

1.2 A Note on Fiscal Federalism

The concept of federalism is subject to the dynamic character of the political process. A federation may be defined as a country comprising a number of independent states[11] under a common legislature, with public responsibilities divided between the central and the state governments as assigned by the constitution.[12] According to Galligan (2008), a federation is characterised by three features: (i) a written constitution that cannot be easily amended; (ii) bicameral legislature by the central and regional government representatives; (iii) judicial review. The evolution of federal structure may be politically motivated or promise economic advantages by profiting from possible scale economies or reduced decision-making costs. It may arise as an agreement among formally independent states[13] or as a consequence of the decentralisation of a former unitary state, as, for instance, in Belgium or Brazil. Several unitary countries, such as France or Italy, while not being federations per constitution, in fact have introduced elements of decentralisation.[14] China, which has evolved from a centrally

[9] See section 2.2 for more detail.

[10] Among the former Soviet countries, for example, next to Russia, such reforms have been implemented in Poland (see, for example Shah (2004) for more detail), the Czech Republic and Slovakia (Bryson et al. (2004)) or Romania (Sorin-Dinca and Dinca (2009)). South Africa (see Bahl (2001) for an analysis), Kenia (Bagaka (2008)) or Nigeria (Shah (2004)) have introduced elements of fiscal federalism as well as Argentina and Chile (Shah (2006)), Brazil (deMello (2008)), Mexico and Colombia (Shah (2004)) or Peru (Ahmad and Garcia-Escribano (2006)). In the Asian region, fiscal decentralisation was a driver of reform in China and India (see Martinez-Vazquez and Rider (2005) for more detail), Indonesia (Comola and deMello (2010)) or the Philippines (Llanto (2009) and Uchimura and Suzuki (2009)).

[11] Or provinces, regions, cantons, departments, etc.

[12] See, for example, Schubert and Klein (2006).

[13] This is the case, for example, in the United States, Canada, Australia, Germany or Switzerland.

[14] Among others, Levi (2009) discusses the recent reform in Italy, whose fiscal system has been characterised by central revenue collection with subsequent distribution of revenues to the respective regions. It is currently in the process of passing a reform to resort to significantly higher degrees of revenue decentralisation with an equalisation grant scheme across provinces.

planned tradition, is often referred to as a 'de facto federation' given its high degree of state-level autonomy.[15] Such tendencies are often attributed to an attempt to stabilise large and highly heterogeneous or fragmented countries by granting the regions a strong degree of independence.[16] The latter may also apply to Spain, whose unitary structure is highly decentralised. The resulting devolution of (fiscal) responsibilities is often the consequence of extensive bargaining and interregional competition processes that may result in asymmetric intergovernmental arrangements within a federation.[17]

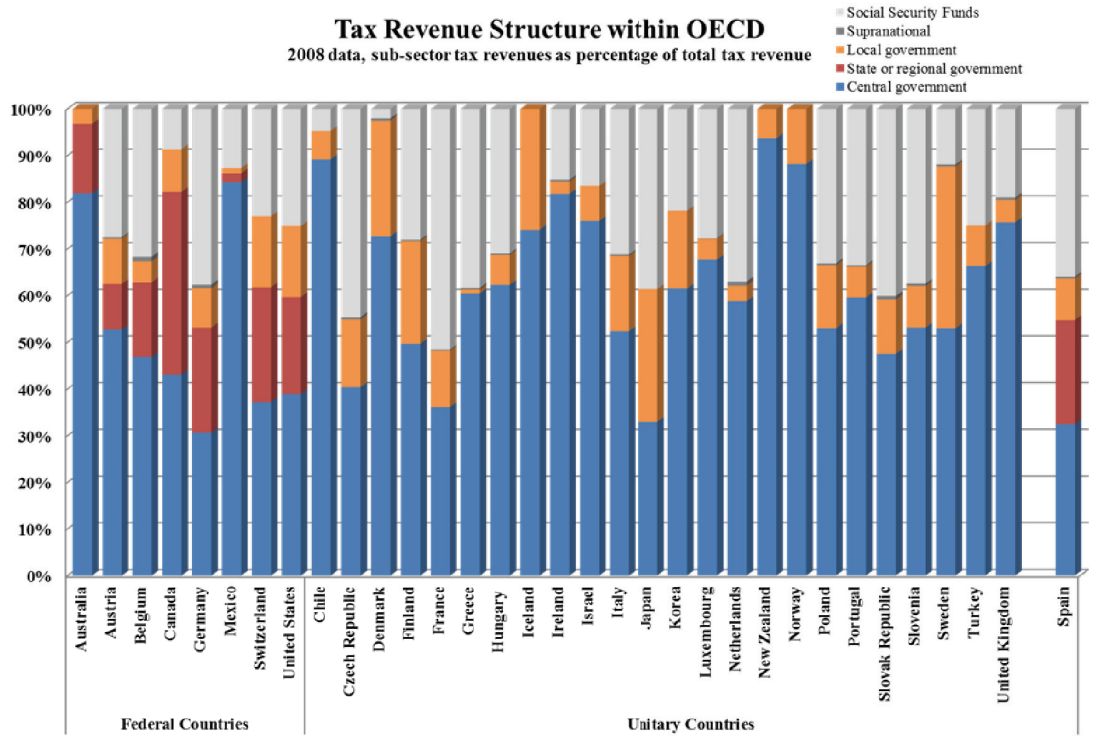

Figure 1.2: Tax Revenue Structure within OECD
Source: Based on OECD (2010)

This differentiated view of decentralised fiscal structure is illustrated by figure 1.2, which depicts the revenue structure of selected OECD countries for 2008. Precisely, it lists the share of government revenues at each jurisdictional level in total government revenues. It includes eight of its member states as federations and another 25 unitary countries. It becomes apparent that the attribution of tax revenues to lower level jurisdictions does not hinge on a

[15]See, for example, Ho (2010) or Zheng (2007). For an overview of the specific issues concerning the decentralisation of former centrally planned countries refer to Rao (2008).

[16]See, for example, Bird and Ebel (2008).

[17]For a further discussion, see Congleton (2008).

country being perceived as unitary or federal. Across individual countries, the composition of revenues differs significantly. OECD (2010)[18] shows that for the included federations, on average, 52% of total revenues are attributed to the central government, while 18.7% and 8.3% are attributed to the state/regional and local level respectively.[19] In Spain, 32.4% of total government revenues apply at the central level, while 22.3% (8.9%) apply at the state (local) level. Of the further included 24 unitary countries, an average of 62.8% of total government revenues are attributed to the central, while 12.4% are attributed to the local level. The individual figures for each country reflect the respective historically grown federal structure and interjurisdictional arrangements, such that they may not be too useful to be compared directly. Yet the point is illustrated that the decentralisation of revenues does not necessarily hinge on whether a country has a unitary or a federal structure.

The economic approach to fiscal federalism thus includes the analysis of the fiscal relations among jurisdictions at different levels,[20] while abstracting from the constitutional definition of a federal or unitary state. It comprises the decentralisation of expenditure or revenue authority as well as the existence of fiscal equalisation schemes. The economics literature on fiscal federalism has, over the past years, developed quite intensively and diversely.[21] Early approaches focus on the efficiency-enhancing effects of a decentralised federal structure. Tiebout (1956) is the first to point towards how interregional competition for mobile citizens within a federation can raise welfare. In his 'Decentralisation Theorem' Oates (1972) prominently formalises the argument that the uniform supply of public goods at the central level of a country can be replaced by local provision tailored to the actual preferences of the citizens, thereby increasing overall welfare.[22] Various strands of literature rooted in these perceptions subsequently evolved. The literature on environmental federalism that emphasises the benefits (and risks) of decentralised decision-making with respect to ecological standards builds on Oates' Decentralisation Theorem.[23] The ideas formulated by Tiebout (1956) have substantially shaped the most influential contributions on interregional tax competition, for example, by Zodrow and Mieszkowski (1986) or Wilson (1986). Further approaches, which have their roots in the Pigouvian perspective on the internalisation of spillover effects across

[18] See OECD (2010) table E, page 28.

[19] Percentage points missing to 100 are assigned to social security funds or supranational-level revenues (as in the case of the EU member states).

[20] See Ahmad and Brosio (2008).

[21] See, for example, Oates (2005, 2008), for relatively recent surveys on the different strands of research in fiscal federalism.

[22] Oates (1972) abstracts from possible scale economies and restricts the view to welfare-maximising governments.

[23] See, for example, Dinan, Cropper and Portney (1999), Oates (2002) or, more recently Banzhaf and Chupp (2010).

regions,[24] argue in favour of the existence of intergovernmental grant or fiscal equalisation schemes.[25] Extending Niskanen's (1971) view of policymakers as Leviathans rather than welfare maximisers, Brennan and Buchanan (1980) make the point of the welfare-increasing potential of decentralisation by constraining the incumbents' revenue-maximising ambitions.

Other approaches, which Oates (2008) refers to as the 'second generation of fiscal federalism' incorporate elements of public choice, contract theory or information asymmetries into the fiscal federalism literature and explicitly take into account the typical incentive and decision-making structures arising from decentralisation as well as including its possible distortive effects. Such approaches also analyse the devolution of fiscal responsibilities within a country.[26] One strand of literature takes a political economy approach to fiscal federalism and explicitly models the motivation behind a politician's actions as well as the structure of decision-making and electoral processes that shape fiscal outcomes under decentralised as opposed to unitary states.[27] Based on early contributions by Kornai (1979, 1986), some authors explicitly consider the formation of fiscal budget rules and how they influence government behaviour.[28] The yardstick competition literature, as shaped by Besley and Case (1995)[29] further conjectures that federal structure leads to a better comparability between regions, such that policymakers may have incentives to engage in tax mimicking behaviour, while at the same time voters have a means to evaluate the performance of their incumbents, thereby restraining possible rent-seeking behaviour of governments. Such informational spillovers within a federation are also incorporated into the so-called laboratory federalism approaches,[30] in which the direct comparison of regions under a federal structure provides a framework that favours innovation in such that fiscal reforms implemented by particularly innovative regions may later be adapted across the federation.

Notwithstanding the vast array of research on fiscal federalism, this dissertation focuses on the revenue side in the context of federal decisionmaking with a particular focus on competition for a mobile capital tax base.[31] In what follows, the distinction of a federation in

[24] See, Pigou (1947).

[25] See Boadway (2006) for a survey on the literature on equalisation grant schemes.

[26] See, for example, Congleton (2008) or Eichenberger and Frey (2008) for a detailed discussion.

[27] Some of the well-known contributions in that respect include Lockwood (2002, 2006), Besley and Coate (2003) as well as Persson and Tabellini (1992, 2002). Guriev et al. (2010) provide a recent contribution in that context discussing how interest groups shape federal policies.

[28] Ambrosanio and Bordignon (2008) develop instruments for the assignment of revenues within a federation. The consequences of soft or hard budget constraints within a federation have been analysed by Wildasin (1997), Qian and Roland (1998) or Goodspeed (2002a) and later Besfamille and Lockwood (2008) or Fink and Stratmann (2009).

[29] More recent contributions include Kotsogiannis and Schwager (2008) or Rincke (2006, 2009).

[30] See, for example, Rose-Ackerman (1980), Strumpf (2002), Kotsogiannis and Schwager (2006a, 2006b) or Kerber and Eckardt (2007).

[31] There are, of course, various approaches with a focus on other types of taxes in the existing literature on

contrast to a unitary country will thus refer to a country with a decentralised capital tax revenue structure irrespective of its constitutional specifications. The existing literature, which will be discussed in detail in chapter 2, analyses taxation in a federation with several states and one federal government, which is generally characterised by two elements: competition for mobile tax bases between lower level jurisdictions and concurrent taxation of the same tax bases by lower level jurisdictions and the central government. Tax competition gives rise to horizontal externalities, as each lower level jurisdiction ignores the positive effect of a higher own tax rate on tax revenue of the other lower level jurisdictions. Taxation will then be too low in equilibrium.[32] Concurrent taxation, on the other hand, gives rise to vertical tax externalities, as each lower level jurisdiction ignores the negative effect of a higher own tax rate on the central government's tax revenue, and vice versa. This leaves tax rates too high in equilibrium.[33] Given that the two elements of federal taxation have opposite welfare effects, the question which may be dominant in a given setting is of high relevance and will be discussed with reference to the international integration of capital markets in the course of this thesis.

1.3 Aims and Design of the Study

With the issues outlined so far, the intention of this contribution is to enhance the discussion regarding the following questions:

1. What is the current state of research on the consequences of international tax competition with regard to the decentralised revenue structure of a country?

2. How does the increasing integration of international capital markets affect the taxation of capital?

3. How does a country's federal framework affect its position when competing with other countries for an internationally mobile capital tax base?

Hence, this dissertation is setup the following way: The second chapter reviews the existing empirical and theoretical literature relevant in the context of this study. The theoretical focus will for one part lie on contributions concerning the taxation of mobile capital with

federal tax setting. As such, concurrent taxation of personal income has been the subject of analysis, among others, in Mintz and Tulkens (1986), Boadway et al. (1998) or, more recently, Klor (2006) and Aronsson (2010). Excise taxation of consumption goods is also widely examined, as, for example, in Besley and Rosen (1998), Devereux et al. (2007) or Rizzo (2010).

[32] Among others, refer to Wildasin (1989), or dePater and Myers (1994).

[33] See, for instance, Wigger and Wartha (2004), or Makris (2006).

interregional competition, thereby characterising the respective horizontal effects. Subsequently, models analysing taxation in a federation with an active federal and multiple lower level governments are considered. These identify tax base overlap as a source of vertical externalities, whose interaction with horizontal externalities triggered by lower level tax competition culminates in the question which of these will be dominant in a given setting. Finally, the small literature combining the contributions on international horizontal tax competition with the insights from the federal taxation literature is reviewed. The survey of the empirical literature starts by discussing studies aiming to find evidence of horizontal tax interaction between governments. It includes such interrelations among regional governments within one country as well as international horizontal tax interactions, and further discusses how these are affected by increased capital market integration. Subsequently, the studies seeking evidence of vertical tax interaction within a federation are reviewed, followed by a discussion of contributions aiming to clarify whether governments are more appropriately assumed to have revenue or welfare maximising intentions, a distinction that is found to be relevant in the review of the theoretical literature. Chapter 2 concludes by summarising the results and pointing towards further topics of research. It derives a set of key questions that appear to be relevant for the analysis of policy implications by federal tax competition. The thus identified key aspects are sought to be further analysed in chapters 3 and 4.

Chapter 3 considers a federation whose degree of integration into international capital markets is explicitly modelled and analyses the efficiency of the resulting tax rates. It is found that strong integration into international capital markets functions by limiting the extent to which horizontal externalities may deter tax setting within a federation, such that the vertical externality has a relatively stronger impact on the overall tax burden.

The scope is extended to analyse two countries competing for mobile capital while allowing for differences in federal design by each of the countries in chapter 4. It considers two unitary countries as a reference case for purely horizontal interaction. The model is then expanded to include the interaction of a federal and a unitary country, in order to finally examine two competing federations. The respective externalities arising in each of the three cases are evaluated and policy implications are derived. Among other things, it turns out that federal structure may have a positive impact regarding a country's position in international tax competition.

Finally, chapter 5 concludes by summarising the results and pointing out their implications with regard to the key questions derived in chapter 2. It further depicts the policy implications to be drawn from the discussion of federal tax competition as well as further topics of research.

Chapter 2

Literature Review

> *"Competition between government units at the same or at a different level explains fundamental characteristics of the working of decentralized systems, and is potentially a crucial factor for their efficiency."*

This quote from the introduction of the Handbook of Fiscal Federalism[1] highlights the relevance of strategic interaction between jurisdictional entities and its interdependence with a country's federal organisation. Given the abundance of literature on federal tax competition, this chapter intends to give a structured overview of the existing body of work. It is setup as follows: The next section reviews the existing theoretical literature on capital taxation in a federation and the implications of interregional tax competition within such a setting. The existing empirical literature concerning federal tax competition is surveyed in section 2.2, with a particular focus on interregional tax competition and its implications with respect to federal structure. Section 2.3 concludes and derives some key questions relevant to the evaluation of policymaking in the context of international federal tax competition.

2.1 Theoretical Approaches

This section gives an overview of the existing theoretical approaches to federal capital tax competition. It can be divided into the following major strands: For one, a federation is seen as a bundle of regions under the common legislation of one country, where the federal level does not actively participate in decisions. Hence, tax competition in a federation is characterised by horizontal effects occuring between jurisdictions at the same level.[2] In

[1] See Ahmad and Brosio (2008), p. 22.

[2] In that respect, it is equivalent to international tax competition between countries. Surveys of the literature on interregional tax competition exist, for instance, by Wilson (1999) or Wildasin and Wilson (2004).

another strand, the federal government is explicitly recognised as an active player, which leads to vertical tax competition effects being triggered by regional and federal decision-makers interacting within one country. A third, more recent field analyses tax regimes when federations are explicitly modelled in competition with other countries. This section will give an overview of the existing literature in each of these fields.

The reference case to assess the efficiency of tax setting is the solution reached by an omniscient central planner under distortive taxation tailored to each region. The analysis is restricted to approaches in which the strategy variable is the chosen tax rate, despite being perfectly aware that other variables, such as the level of expenditures, the provision of a public consumption good or publicly provided inputs for production have also been considered. The respective outcomes essentially hinge on the government's objective function. Typically, the literature distinguishes between the perception of revenue-maximising Leviathan governments or benevolent welfare-maximising decision-makers.[3]

In the reference case, a central Leviathan government will choose tax rates, such that the country reaches the maximum of the Laffer curve[4]. By contrast, in a federation of Leviathans, the objective functions of governments differ in such that each policymaker only cares about own revenues, which triggers the respective externalities to be characterised in the proceeding sections. Inefficient taxation then implies that revenues are not maximised by choice of the tax rate. With inefficiently low tax rates a country finds itself on the upward-sloping side of the Laffer-curve, while the reverse holds for inefficiently high tax rates.[5] Since revenue-maximisation does not imply welfare-maximisation,[6] by limiting the Leviathan in its possibility for wasteful consumption, welfare may in fact be raised through lower tax rates.

A benevolent government typically aims to maximise its citizens' utility $u(c, g, G)$, where c is private good consumption and g (G) is the amount of a public good provided at the regional (federal) level.[7] The omniscient central planner will achieve a second-best optimum with distortive taxes choosing tax rates, such that the social marginal cost of raising public funds equals their social marginal benefit, that is, $SMCF = SMBF$.[8] That equality may be distorted by decentralisation in such that one jurisdiction's government misperceives the marginal cost of public funds and thus over- or underprovides the respective public good. Inefficiently low tax rates then imply that welfare could be raised by an increase

[3] In that context, see, for example, Buchanan and Musgrave (2001).

[4] See Laffer (1979), which was earlier referred to by Wannisky (1978). The Leviathan approach is assigned to Brennan and Buchanan (1977, 1978, 1980).

[5] In the latter case, revenues could be raised by a drop in tax rates, which is also referred to as the Laffer paradoxon, as, for instance, in Dahlby (1996).

[6] See, for example, the seminal contributions by Brennan and Buchanan (1977, 1978, 1980).

[7] Utility may, of course, be varied or extended to include other elements. For instance, see Wrede (2002), p. 62.

[8] For instance, see Keen (1998).

in tax rates and vice versa. Inefficiencies may stem from differing objective functions or from the assumption of myopic governments.

2.1.1 Interregional Tax Competition

A federation consisting of n autonomous regions is first considered, where decision-making is perfectly decentralised. While the capital stock may be fixed within the federation, capital is typically assumed to be mobile across regions. That is, each jurisdiction i perceives its capital tax base as elastic. Upon choosing its tax rate, each regional government will trigger a positive horizontal externality, in such that investors will choose to relocate their capital, thereby raising the other regions' tax bases $b_{j\neq i}$,[9] such that

$$\sum_{j\neq i=1}^{n-1} b'_{jt_i} > 0.$$

Given that each government only accounts for its own tax base and neglects the expansion of the other regions' tax base, the resulting horizontal externality points towards inefficiently low taxation. Whether or not interregional tax competition enhances or deters welfare, is subject to the perspective taken. Therefore, those approaches assuming for governments to be benevolent will be reviewed first, followed by the results generated for Leviathans.

Benevolent Governments

With benevolent decision-makers, each regional government chooses to maximise its citizens' utility by providing optimal opportunities for the consumption of public and private goods, where public good provision is financed from capital taxation (and, possibly, the taxation of a fixed factor, which is, however, mostly assumed to be exogenous).[10] It will recognise how not only its own decisions, but also those by every other institution feed back into its inhabitants' welfare function. It neglects, however, how its own choices affect the utility of other regions' inhabitants, thereby triggering a horizontal externality that points towards an underprovision of public goods. Tiebout (1956) established the view of interregional tax competition raising efficiency via so-called Tiebout-sorting processes. The underlying reasoning is that by choosing their preferred location, perfectly mobile households will induce governments to internalise these externalities and to provide efficient levels of public goods and taxation.[11] One of the central assumptions in the Tiebout world is that of public good provision being financed by benefit taxation. That assumption is dropped in another strand

[9] See, for example, Wilson (2005).

[10] For instance, see Wilson (1999).

[11] Fischel (1976) and White (1976) first integrated mobile profit-maximising enterprises into a Tiebout-type setting. More recent approaches can be found in Richter and Wellisch (1996) or Wellisch (2000).

of tax competition literature, which was mainly shaped by Zodrow and Mieszkowski (1986) or Wilson (1986), hereafter referred to as ZMW.[12] Typically, these models consider benevolent regional governments which derive their entire budget from the taxation of capital[13] engaging in Nash competition over tax rates with the other regions. The federation consists of n identical regions, each inhabited by one individual endowed with one unit of an immobile factor to be used as an input for production (labour in the ZMW-approach) and one unit of interregionally mobile capital. Investors will react towards given tax rates by locating capital where its net return is highest, such that non-arbitrage will lead to the latter being equalised across states. In the resulting equilibrium, chosen tax rates and public good provision in the region will be inefficiently low due to interregional tax competition triggering the described horizontal externality. In neglecting the positive impact its tax hike has on other jurisdictions by expanding their tax base, the marginal cost of public funds perceived by each region is greater than the 'true' social marginal cost of public funds ($MCF > SMCF$).[14]

The situation changes when regions are no longer small (such that the net return on capital equals the exogenous world market interest rate), but when large regions influence the net return on capital within the federation by their choice of tax rate.[15] The basic ZMW-result still holds, but a tax hike in one region subsequently triggers a negative horizontal externality by reducing the federation-wide net return on capital.[16] That negative externality attenuates the positive horizontal externality characterised by ZMW, such that the MCF perceived by one region deviates from the SMCF by a lesser amount than in the case of small regions.

A further central result of the ZMW model is that while the mobile factor will be subject to low tax rates, the resulting loss of revenues will be compensated by higher tax rates on the immobile factor. Bond and Samuelson (1989) or Razin and Sadka (1991) even reach the solution that tax rates on mobile capital will be zero in equilibrium.[17] In contrast, if one country is modelled as a Stackelberg leader, Gordon (1992) finds that positive capital tax rates will be chosen. Furthermore, Goodspeed (1998) points out that the result of a zero tax

[12] A similar approach can be found in Wildasin (1989).

[13] The consideration of more than just one type of tax rate can be found in Bucovetsky and Wilson (1991) or Wilson (1991, 2005).

[14] Zodrow and Mieszkowski (1986) also examine the level of supply of a productive public good and also obtain the result of its underprovision. Yet this result is driven by a specific assumption necessary for the stability of their derived equilibrium, whose economic interpretation was criticised by Noiset (1995). The result is no longer obtained when that assumption is dropped, as shown by Dhillon et al. (2007) who find that public good provision can then either be too low, too high or efficient. Along the same lines, Keen and Marchand (1997) find indicators of overprovision of productive goods as opposed to private goods.

[15] Wildasin (1988) or Hoyt (1991) pursue such an approach.

[16] That horizontal externality is also characterised by DePater and Myers (1994), who speak of a 'pecuniary externality'.

[17] That result is in correspondence with Diamond and Mirrlees (1971), according to whom production efficiency requires for the governments to dispense with its taxation.

rate is driven by the implicit assumption that capital draws no utility from the provision of public goods and will no longer ensue if the latter is dropped.

Various subsequent papers dismiss the assumption of identical regions in favour of the recognition of asymmetric tax competition. While in those approaches considering identical regions, the resulting symmetric Nash equilibrium leads to an efficient allocation of capital, if this symmetry assumption is dropped, the ensuing asymmetric equilibrium will distort capital allocation. Bucovetsky (1991) or Wilson (1991) consider regions differing in size, as expressed by the number of inhabitants and the amount of capital available.[18] They generate an asymmetric equilibrium, in which the large region chooses a higher tax rate than the small region. That result can again be attributed to the large region's impact on the overall net return to capital within the federation, such that its tax base will react less elastically towards a change in tax rates than that of the small jurisdiction. Public good provision will be inefficiently low, yet welfare in the small region will be higher than in the large one, given that the former is a net importer of capital and profits from the positive externality triggered by its competitor. Cooperation would raise overall welfare, yet if differences in population are sufficiently large, the small region will be worse off under collusion. In an extention, DePater and Myers (1994) examine the strategic behaviour of large regions manipulating the net return on capital in their favour, where the results in turn hinge on whether a country is an importer or an exporter of capital. That is, in the former case, a country has an incentive to raise its tax rate, such that the resulting drop in the net return on capital is partially burdened on the foreign investors. The reverse holds in the latter case. Thereby, the tendency towards an underprovision of the public good will be attenuated for capital importing regions and augmented for capital exporting regions.

In another extention to the ZMW-model, Brueckner (2000, 2004) examines the effect of heterogeneous preferences regarding the supplied public goods. He shows that with an increasing valuation of the public good, equilibrium tax rates and levels of provision will rise at the cost of capital investments and wages. If one region is a monopolist in its production and exports it to a neighbour, Noiset (2003) finds that the monopolist can partially impose the burden of a capital tax hike on the consumers in the other region via the resulting mark-up in prices.

Lee (1997) considers a two-period model in which capital is subject to transaction costs in the second period after it was invested freely in period one. That limitation of interregional capital investment mobility points towards inefficiently high tax rates, given that a tax hike incurs a negative horizontal externality by reducing the net return on capital, while the loss of capital tax base will be significantly lower and may even approach zero.

[18] Bucovetsky (1991) assumes for a quadratic production function, while Wilson (1991) considers a general one as well as further including the taxation of mobile labour to show that Bucovetsky's results still hold.

Cross-regional landownership within a federation as a means to internalise the occuring positive externalities is discussed by Lee (2003). A region's MCF will then be the closer to the $SMCF$, the more interrelated ownership structures in the respective regions are.

If countries compete for capital tax base via the choice of capital tax rates and ecological standards, Oates and Schwab (1988) find that the prevalence of a tax on capital implies inefficiently low ecological standards across the federation in such that each region neglects the positive effect it triggers on the others by raising its eco-standard and thereby losing capital tax base.

An interesting recent contribution by Kempf and Rota-Graziosi (2010) includes the endogenisation of leadership in a federation of competing regions. They find that if regions display a sufficiently large degree of asymmetry, tax rates will be driven downwards less than standard theory predicts and that the larger country will not necessarily choose a higher level of tax rates.

Within the literature, remedies for the resulting inefficiencies have been suggested, for example, by cooperation,[19] Pigouvian subsidies or taxes,[20] or the introduction of a fiscal equalisation scheme.[21] These are discussed in more detail at the end of section 2.1.2.

Leviathan Governments

When the assumption of benevolent governments is dropped for a revenue-maximising Leviathan government, as prominently suggested by Brennan and Buchanan (1977, 1980), each regional government chooses a tax rate such that the Laffer curve with respect to its regional budget is maximised. With interregional tax competition, each decision-maker neglects the impact its decisions have on revenues in the other jurisdictions, thereby triggering a positive externality that distorts the Leviathan's tax rate choice in contrast to the centrally planned optimum. Each regional Leviathan government thus chooses inefficiently low tax rates in such that centrally coordinated tax setting would raise revenues for all regions. Brennan and Buchanan (1980), however, explicitly dismiss that possibility of collusion, accentuating the welfare-enhancing effects of decentralised taxation by reducing the wasteful activities and thus increasing citizens' welfare.[22]

When the government is assumed to be a Leviathan only to a certain degree and benev-

[19] Boadway and Wildasin (1984).

[20] Wildasin (1989) DePater and Myers (1994) or Bucovetsky et al. (1998).

[21] Köthenbürger (2002).

[22] In fact, Wilson (2005) questions the analysis of tax rate choices by Leviathan governments. He argues that revenue-maximising policymakers have an incentive to choose the (less transparent) amount of public expenditures rather than tax rates to maximise rents. He asserts that voters choosing a positive tax rate on interregionally mobile capital may then increase public sector efficiency.

olent otherwise,[23] Edwards and Keen (1996) examine the possibility of welfare-increasing cooperation agreements. They find that these are desirable if the marginal excess burden of taxation exceeds the rise in wasteful expenditure the government incurs for a marginal revenue increase.[24] Parry (2003) aims to quantify the welfare cost of interregional tax competition and concludes that it will be particularly low when governments are no longer modelled as perfectly benevolent and will approach zero for pure Leviathans. Zissimos and Wooders (2005) consider Leviathan governments in a model where public goods serve the regions to differentiate themselves from other jurisdictions. If firms differ in their appreciation of the public good, governments can use this fact to mitigate tax competition. They show that within this setting, such an alleviation of the degree of tax competition will reduce efficiency. Köthenbürger (2005) considers the possibility of a fiscal equalisation grant scheme for moderate Leviathan governments. Brennan and Buchanan (1980) had argued that such institutions will provide opportunities for pure Leviathans to collude and thus deter the welfare-enhancing effects of tax competition. Köthenbürger (2005) supports this argument for pure Leviathans, yet shows that a redistribution scheme will induce a moderate revenue-maximiser to choose a lower tax rate than it would otherwise, if the number of competing regions is large and/or if the incumbents place a high value on voter welfare. Besley and Smart (2007) discuss how tax competition affects welfare when voters do not know for certain whether their governments are welfare maximisers in a signalling model with elections and rent-seeking behaviour. Among other things, they conclude that tax competition will most likely improve welfare if policymakers are more likely to be benevolent and vice versa. This counterintuitive result is referred to an improvement of selection processes of the Leviathan policymakers when these are few in numbers. Janeba and Schjelderup (2009) consider regions competing for mobile capital and explicitly model the respective election processes. For benevolent governments, they find that welfare will be lower in an open as opposed to a closed economy, while the reverse holds true for Leviathan governments, unless the appreciation of the public good is sufficiently large. For moderate Leviathans, they further find that the respective legislative bargaining processes further influence outcomes in such that under a presidential-congressional regime tax competition will raise voters' welfare, while under a parliamentary democratic system the welfare of voters is likely to be reduced due to tax competition, if voters sufficiently value the respective public good.

[23] That assumption may be justified by the intention of a Leviathan government to be re-elected.

[24] In a similar direction, Rauscher (1998, 2000) analyses whether tax competition will raise public sector efficiency by reducing the waste of tax revenues and in an extention examines the effect of tax competition on public sector innovation.

2.1.2 Federal Tax Competition

In the previous section, a federation was characterised by a number of states competing for mobile tax base with one overarching, though passive, federal government. Yet, as Keen (1998) pointed out in his seminal paper, reality calls for the explicit recognition of the federal level as a player in its own right.[25] The earliest contributions in that respect can be traced back to Cassing and Hillmann (1982), Flowers (1988) or Johnson (1988). Dahlby (1994, 1996), Boadway and Keen (1996), Boadway et al. (1998) and, most prominently, Keen (1998) brought the focus of research towards an active role of the federal government.

Most of the more recent approaches extend the standard ZMW-model to include another level of government, as prominently done by Keen and Kotsogiannis (2002, 2003). By considering n identical regions, symmetric equilibria that do not distort capital allocation arise at the regional level, such that the focus of analysis can be restricted to the efficiency of chosen tax rates. The analysis typically considers interdependencies resulting from tax base overlap.[26] That is, upper- and lower level governments each levy a tax on a base that displays some degree of overlap between the different levels. Most models assume tax base congruency, in which case the federal tax base B can be denoted as the sum of the n regional tax bases b_i, that is $B = \sum_{i=1}^{n} b_i$. When federal and state governments each raise their own revenue from taxation, the aggregate tax burden τ_i prevalent in one region is the sum of the federal tax rate T[27] and the respective regional tax rate t_i, such that $\tau_i = T + t_i$.

Next to the previously characterised horizontal externalites at the regional level, each region's choice will also affect the federal tax base, which the regional policymaker does not

[25]The simultaneous taxation of the same tax base by two levels of government is relevant to the tax systems of many countries. Next to the federal level, Canadian provinces, Swiss cantons and the U.S. states impose their own corporate tax. The co-existence of the local business tax and the federal corporate tax in Germany are another example, although there is no perfect tax base overlap. See also section 5.2 for a further discussion.

[26]This survey will focus on such approaches. Other models consider the effects of tax deduction schemes between different levels of government, in which typically a single regional government is included, such that only vertical externalities occur. See, for example, Dahlby et al. (2000) who discuss the optimal deduction of regional from federal taxes in order to internalise the vertical externality triggered by a regional tax hike. In an extention of a spatial competition model developed by Salop (1979), Flochel and Madies (2002) find that deductibility of the regional from the national tax load will lead to the vertical externality triggered at the regional level being intensified: A regional tax hike not only triggers a vertical externality at the federal level by individuals relocating their investments, it also leads to the amounts deductible from the federal tax load to increase. Wrede (2002) analyses the reverse case, but generates analogous results. Additionally, Flochel and Madies (2002) extend the scope to include several regional governments and find that deductibility of regional taxes reduces the horizontal elasticity of the tax base. Regions will thus gain tax setting power such that they further increase the impact of the vertical externality.

[27]It is thereby implicitly assumed that the federal authorities set one uniform tax across all regions.

account for. Depending on whether capital supply is fixed within the federation or has the opportunity of being relocated abroad, the impact of a regional tax hike on federal tax base will be characterised by

$$B_{t_i} = \sum_{i=1}^{n} b_{it_i} \leq 0.$$

That is, in a closed economy, for a given regional tax hike capital will relocate between regions until its net return is equal across the federation and no vertical externality will occur. If capital can be relocated abroad or is in some other way endogenised as a function of tax rates,[28] a vertical externality is triggered by narrowing the federal tax base. Pointing towards inefficiently high regional taxation, it might attenuate the horizontal externality triggered at the regional level and even result in inefficiently high consolidated tax rates. The welfare effects again hinge on whether the governments are assumed to be benevolent[29] or Leviathans.[30] The additional recognition of the vertical externality thereby points towards a possible rise of welfare through an increase in public good provision for benevolent governments or a loss of welfare by reducing the extent to which tax competition curbs the revenue-maximising Leviathan governments' intentions.

The results further hinge on the timing of decision-making. That is, while regions are typically assumed to engage in Nash-competition, the federal government can either act simultaneously with the regions, as modelled by Grazzini and Petretto (2007) or Wrede (1996), or it can act as a Stackelberg leader, as modelled, for example, by Keen and Kotsogiannis (2002, 2003). If it plays Nash, it will choose its tax rate efficiently given state taxation. If it is a Stackelberg leader, the federal government will perfectly anticipate the tax rate choices of the following regions (who take the federal tax rate as given) and adapt its tax choice accordingly. It may set its tax rate higher or lower than in the Nash equilibrium in order to induce regional policymakers to choose efficient levels of taxation. That will in turn hinge on the strategic relationship of tax rates at both levels. If they are strategic substitutes, federal taxation will tend to be higher than in the Nash equilibrium, and lower in the case of strategic complementarity. The respective welfare effects of the resulting equilibria again depend on whether governments are assumed to be benevolent or Leviathans.

[28] For example, Keen and Kotsogiannis (2002, 2003) or Grazzini and Petretto (2007) model the supply of capital by means of the propensity for savings S in contrast to consumption, which hinges on the net return to capital ρ, such that $S = S(\rho)$, where ρ is in turn a function of the effective capital tax burden.

[29] Keen and Kotsogiannis (2002, 2004), Wilson (2003) or Madies (2008) develop approaches with welfare-maximising decision-makers.

[30] As modelled, for example, by Flowers (1988), Wrede (1996, 2000) or Keen and Kotsogiannis (2003). Wigger and Wartha (2004) consider the case of a moderate Leviathan government.

Benevolent Governments

With policymakers aiming to maximise voters' welfare, jurisdictions at each level finance the provision of public goods through the revenues generated from taxation. Public goods provided at the federal or regional level are typically assumed to be perfect substitutes.[31] Federal governments are assumed to provide their funds equally among the regions, in correspondence with the share each region's population has in the country's total size. Hence, each regional government incorporates only $\frac{1}{n}th$ of the impact its decision has on federal budgets, with the resulting vertical externality pointing towards inefficiently high taxation.[32] The efficiency of regional tax rates then depends on which effect (horizontal or vertical) dominates. An increase of overall welfare following a coordinated tax hike at the regional level implies that regional tax rates will be chosen inefficiently low in equilibrium. The reverse points towards inefficiently high regional tax rates and the dominance of vertical externalities.

The most widely recognised contribution considering welfare-maximising governments in the context of federal tax competition is by Keen and Kotsogiannis (2002) who consider a two-level government with n jurisdictions each inhabited by a single individual.[33] They conclude that whether or not the vertical or the horizontal externality will dominate, hinges on the relative appreciation for consumption of public and private goods, which follow the usual Inada-conditions. Furthermore, the result is driven by the elasticity of tax base with respect to the prevalent tax burden, that is, the interest elasticity of savings and capital demand with respect to the interest rate. It is shown that for inelastic savings, the horizontal externality will dominate and vice versa. Wilson (2003) pointed out that if only one region is considered at the lower level, with local and federal public goods being perfect substitutes, the first-best centrally planned optimum for consolidated tax rates can be achieved by the central government choosing T such that τ is efficient. For that to be the case, it is irrelevant whether the federal government acts as a Stackelberg leader or plays Nash. In a variation of the model by Keen and Kotsogiannis (2002), Madies (2008) examines capital taxation if a productive public good is provided. He finds that horizontal externalities may then result in inefficiently high provision, given that next to the well-known positive horizontal externality a tax hike in one region will trigger a negative horizontal externality in such that the resulting higher level of productive good provision may in turn attract capital into that federation and thereby reduce the other regions' tax base. If that latter effect dominates, the horizontal externalities point towards inefficiently high taxation, such that horizontal and vertical externalities point in the same direction and may aggravate each other.

[31] See, for example, Keen (1998), p. 478.

[32] For instance, be referred to Keen (1998) or Hindriks and Myles (2006), p. 579.

[33] Earlier approaches were formulated by Dahlby (1996) for commodity taxation or Sobel (1997) in a rather general essay on tax base overlap, where only one lower-level decision-maker is considered.

The degree of international capital market integration is considered by Wrede (2002), who examines the two polar cases of perfect integration as opposed to a closed economy. In the perfectly integrated small economy, where capital tax base is perfectly mobile and the net return on capital is defined over the world-market interest rate, strong bottom-up vertical externalities occur as opposed to the horizontal externalities, which vanish. For the reverse case of a closed economy, only horizontal and no vertical externalities occur, given that the capital stock is fixed within the federation. Wilson (2003) draws a line between these results and those by Keen and Kotsogiannis (2002), in such that the case of perfect capital market integration is similar to that of perfect elasticity of savings with respect to the interest rate. Keen and Kotsogiannis (2004) themselves extend their previous model to analyse how a variation in the number of regions within the federation influences the results. They find that, whichever the equilibrium outcome (inefficiently high or low tax rates, that is), an increase in the number of competing states will further intensify that inefficiency, such that welfare will be reduced.

Leviathan Governments

For Leviathan governments, policymakers again care only about their own revenues and thereby neglect the external tax base effect triggered by the chosen tax regime with the resulting externalities again pointing in opposite directions.

Flowers (1988) was the first to point towards possible inefficiencies resulting from a co-occupation of tax base between different levels of revenue-maximising governments. She stated that by abstracting from possible horizontal externalities, aggregate taxation will be too high. Wigger and Wartha (2004) also exclude horizontal externalities by considering only one government at each level. They examine moderate Leviathans and find that tax rates and public good provision will be inefficiently high, such that a drop in tax rates will raise tax revenues. The provision of public goods will be distorted in such that the government imposing the lower tax rate will have a greater incentive to overprovide the public good given that it underrates the MCF more than the other level government. Wrede (1996, 2002) examines whether a federation of Leviathans will always find itself in an equilibrium with inefficiently high tax rates if lower-level interregional competition is included. He concludes that a higher elasticity of the tax base and international competition for tax base then function by limiting the probability of the federation ending up on the negatively sloped side of the Laffer curve. He also examines the extinction of interregional tax competition through the creation of a tax cartel at the regional level. Equilibrium is then characterised by the respective vertical externalities only. Wrede (2000) considers Leviathan federations in which expenditures for a public production good are a means to expand the tax base. He finds that taxes will be too high, while expenditures will be too low if both levels of government

provide the public good.

In a widely recognised paper, Keen and Kotsogiannis (2003) characterise and identify the respective externalities triggered at each level. They show that for Leviathan governments, whether or not consolidated tax rates will be inefficiently high or low hinges on the elasticity of the tax base (which they endogenise with respect to the interest on savings) as well as the relative strategic interaction of federal and regional tax rates. Several variations of that approach consider how the intensity of interregional tax competition in a federal setting affects the equilibrium. Keen and Kotsogiannis (2003) themselves raise the number of regions in order to intensify tax competition. Referring to an earlier version of that paper, Wrede (1996) examines how the assumption of horizontally perfectly mobile capital changes the results. Flochel and Madies (2002) reduce international mobility costs for companies and further discuss the effect of a possible deductibility of regional tax loads from the federal tax burden as a limit to interregional capital mobility. All studies reach the same conclusion: Namely, that an increase in international tax competition will raise consolidated revenues. The intuition behind this result is the following: For intensified interregional tax competition, each single region's tax-setting power is reduced and converges to zero, such that the relative impact of the federal government's decisions rises. It will thus approach the outcome reached by a central planner, thereby maximising consolidated revenues through the appropriate choice of T.

Efficiency Gains

Various possible measures for efficiency gains in a federal setting have been examined. For one, following the result of inefficiently low tax rates at the regional level, regional budgets could be raised by a coordinated tax hike of all regions.[34] If the federal government can perfectly dispose of federal transfer schemes, it has a means to install the second-best efficient outcome.[35]

Overtaxation of a common tax base can be compared to the excessive usage of a common,[36] such that the application of a Pigouvian tax[37] or the definition of property rights[38]

[34]This will be a feasible solution from the perspective of a Leviathan government. If governments are benevolent and the federal tax base is elastic, the effect of collusion hinges on whether overall welfare could be raised by a hike in consolidated tax rates. See, for example, Wrede (2000) or Keen and Kotsogiannis (2002, 2003).

[35]See, for example, Keen (1998), Wrede (2002) or Wilson (2003). Boadway and Keen (1996) had previously pointed out that the explicit recognition of federal structure influences the design of a transfer scheme by possibly making transfers from the states to the federal level efficient, instead of the - typically assumed - other way around.

[36]See, for example, Keen and Kotsogiannis (2002).

[37]See Pigou (1947).

[38]See Coase (1960).

may be justified. In that respect, Dahlby (1996) recommends the right for the benevolent federal government to impose a tax on regional tax revenues, where the respective rate would be chosen in order for the MCF perceived by the regions to equal the SMCF. Sobel (1997) suggests for the regional governments to be given the exclusive right to tax, subject to the condition that a certain minimum level of revenues must be generated. He thereby sees the regions engage in competition for the tax base by choosing the most efficient tax system, rather than the lowest tax rates. Keen (1998) suggests that a property right for taxation of a common tax base could be attributed to one level of government,[39] with the obligation to distribute revenues across the federation, thereby realising the first-best solution of a central planner.

2.1.3 International Federal Tax Competition

Over the years, the literature on tax competition has produced a multitude of papers on the theoretical consequences of international competition for mobile capital, whose principles apply just as well to lower-level tax competition within a federation.[40] With the explicit recognition of (multiple-layer) federal structure, the inclusion of those findings into the international tax competition literature was only a small step.

In that respect, Wrede (2002)[41] has developed a general model of two identical Leviathan federations[42] engaging in Nash competition for internationally mobile tax base by choice of a (distortive) tax rate.[43] All levels of government in both countries are myopic and the worldwide provision of tax base is elastic. Within one federation the same vertical and horizontal externalities arise as described in the previous section. In addition, positive cross-national horizontal externalities are identified. That is, each country neglects that for a tax hike the other country's tax base will expand by capital relocating to where its net return is highest. Wrede (2002) then examines the revenue-effect of domestic in contrast to cross-national collusion. Cooperation agreements within the federation will then internalise the inner-federal externalities, but, obviously, not those across the borders. The revenue-effect of a coordinated reduction in the consolidated domestic tax essentially hinges on the strategic interaction of domestic and foreign tax rates. It will be positive if they are strategic substitutes or sufficiently weak complements.[44] Across-country cooperation consisting of

[39] The central level, that is, if several regions are subject to horizontal tax competition. If only one region is considered and no horizontal effects occur, that property right could be attributed to any of the levels.

[40] See section 2.1.1.

[41] In a subsection, but less extensive, also Wrede (1996).

[42] At some point of the analysis, for simplification purposes, one of the countries is assumed to be unitary.

[43] Notwithstanding that it abstains from the consideration of a specific tax, the approach can be easily applied to capital taxation.

[44] In the latter case, tax payers will also profit from such collusion.

coordinated tax hikes will be revenue-increasing if the worldwide tax base is sufficiently inelastic.[45]

For welfare-maximising competing federations, Wrede (1997, 2002) analyses an extention of the ZMW-model. Mutually myopic governments are assumed to choose tax rates and the amount of expenditures under tax base congruency and perfect substitutability of federal and regional public goods. The vertical externalities then tend to dominate within the federations. The further resulting cross-border horizontal externalities pointing towards inefficiently low tax rates will, however, dominate in total, such that world-wide tax rates and levels of public good provision will be inefficiently low.

Grazzini and Petretto (2007) consider an extention of the model developed by Keen and Kotsogiannis (2002)[46] in which a federal country competes with a unitary country. They develop a three-stage game in which the upper-level government in the federation acts as a Stackelberg leader with respect to the regions and simultaneously engages in Nash-competition with the national government in the unitary country.[47] Unlike Wrede (2002), they not only identify cross-national horizontal externalities, they also characterise cross-national vertical externalities from the national unitary government to the regions of the federation. They find that under specific assumptions regarding the strategic across-country relationship of national (and regional) tax rates, the consolidated tax rate in the federation will be inefficiently low and tax rates in the unitary state will be inefficiently high.[48]

Through the chosen tax rates, the relative size of vertical and horizontal fiscal externalities in a federation is dependent on the share of federal and regional expenditures for public goods.[49] Wilson and Janeba (2005) develop a model in which the degree of decentralisation serves as a strategic tool in competing for internationally mobile capital. The domestic country chooses the amount of centrally provided public goods, such that horizontal externalities are dominated by the vertical externalities. The consolidated tax rate will thus rise, which will shift the domestic reaction curve upwards, along the foreign country's reaction curve,

[45] If the worldwide tax base is fixed, the Leviathan governments will collude to choose the highest possible tax rate.

[46] See section 2.1.2.

[47] In the first stage of the game, national governments decide upon their tax rates. In stage two, the regions choose their tax rates in a Nash game, taking those of the upper-level governments as given, and in the third stage the citizens choose how much to save and where to invest their savings. Government revenues are then distributed among the citizens in the form of lump-sum transfers.

[48] These inefficiencies can be traced back to the decision-makers misjudging the degree of capital mobility and the sensitivity of the net return on capital to given tax changes. Neither of the national-level governments is assumed to anticipate the strategic reaction of the other national-level governments in response to a tax hike. The tax-induced loss of capital tax base is then overestimated as well as the reduction (increase) in the other country's tax rate, if the latter is a capital importer (exporter). The results are also essentially driven by the assumption that the unitary country neglects the tax rate responses at the federation's regional level.

[49] See, for example, Keen and Kotsogiannis (2002).

such that the foreign country's optimal tax rate will rise, and capital will again be attracted to the domestic country. The same reasoning holds for the foreign country, and it is shown that both countries' welfare will rise as a consequence of the mitigated underprovision of public goods.

2.2 Empirical Approaches

In the literature on federal tax competition, empirical work has particularly focused on the identification of strategic interaction between jurisdictions. While one strand focuses on the horizontal interaction between jurisdictions at the same institutional level, a more recent field of empirical work is driven by the theoretical implications of the explicit recognition of a country's federal structure and aims to identify the interdependence of tax setting across different levels of government. This section is setup by first giving a brief overview of the econometric methods and model specification issues regarding the identification of strategic tax interaction. Subsequently, the existing studies aiming to identify interregional competition between jurisdictions at the same level are reviewed, followed by a survey of studies that extend their scope to include vertical interdependencies - where these may either include both horizontal and vertical interaction or allow for only the latter.[50] The last subsection deals with another issue relevant for the analysis of federal tax competition, that is, the question whether governments can be perceived as Leviathans or as benevolent by characterising the approaches taken to identify Leviathan behaviour and discussing the generated results.

2.2.1 Estimating Federal Tax Competition

The empirical literature on interregional tax competition aims to identify correlations between the fiscal choice variables of different jurisdictions applying spatial econometrics methods. The empirical task is then to estimate reaction functions of a strategy variable (here: the chosen tax rate) in jurisdiction i with respect to the vector of tax rates chosen in other jurisdictions. Its slope then characterises the strategic interdependence of choices, with a positive coefficient implying a complementary relationship between the respective tax rates, while the reverse is the case for substitutability.

While a significant slope coefficient points towards the existence of horizontal interaction, the latter may be attributed mainly to two causes. For one, horizontal externalities are considered to arise as a consequence of tax base mobility. A jurisdiction is thus affected by the choice of a strategy variable in other jurisdictions in such that its tax base will

[50] Given that the existing empirical literature is not as abundant as the theoretical contributions, the focus is not restricted to studies on capital taxation, but instead those considering excise or personal income taxation are included as well.

change in response to that. In our case, capital investments will shift with respect to the tax burden prevalent in one jurisdiction. Other approaches, particularly based in the work by Salmon (1987) or Besley and Case (1995), relate the existence of externalities to informational asymmetries in a principal-agent setting. The yardstick competition literature sees the source of tax interactions in a government's attempt to maximise its chances of being re-elected by copying successful neighbours' policies.[51] In order to distinguish these two sources of tax mimicking behaviour, one might further control for whether jurisdiction i's tax base depends on the tax rate choices made in i as well as in all other jurisdictions, which would indicate for tax competition to trigger the observed effects. On the other hand, by controlling for an impact of tax rates on electoral outcomes, yardstick competition may be identified as the source of interdependencies.[52] Some authors specifically try to pinpoint which of the two effects their regression is likely to capture, while others simply test for the existence of tax mimicking behaviour. Restricting its attention to strategic interaction resulting from tax base competition, this survey will thus exclude those papers that specifically characterise yardstick competition as the driving force behind their results.

Evidence of vertical interdependence is sought by estimating the slope of the reaction function between upper- and lower-level tax rates. That relationship tends to be of relevance particularly for the interpretation of theoretical results, in which the question whether or not tax rates are set efficiently often hinges on whether federal and state tax rates are strategic complements or substitutes.[53]

Thus, the tax rate of one jurisdiction i is typically regressed on the tax rate of the other jurisdictions at the same level and, if vertical interdependence is also considered, on the federal tax rate. Jurisdictional fixed effects are typically controlled for as well as a set of socio-economic characteristics of jurisdiction i and a set of factors common across all jurisdictions.[54] Each of the other jurisdictions' tax rates is further assigned a specific weight, such that a central issue concerns the specification of the appropriate weight matrix, for which several approaches have been brought forward. The most widely used is a weighting scheme according to shared borders. Such a weight w_{ij} may be dichotomous,[55] with $w_{ij} = 1$ when region i and region j share a border and $w_{ij} = 0$ otherwise, or non-dichotomous in such that the total length of shared borders relative to a country's size is considered and then normalised to one. Recent contributions have formulated more elaborate weighting schemes. For instance, a multi-regional approach is applied to U.S. states by Rork and Wagner (2008),

[51] See also Case et al. (1993), Heyndels and Vuchelen (1998) or Bordignon et al. (2003). This literature is surveyed in Madies et al. (2004).

[52] Brueckner (2003) had pointed towards these identification problems. Building on that, Revelli (2005) devotes an entire survey to this issue.

[53] See, for example, Keen and Kotsogiannis (2002) or Grazzini and Petretto (2007).

[54] See, for example, Madies et al. (2004) for a more detailed overview.

[55] See Brueckner (2003).

who assign weights with respect to the population size of the competing state and also group certain states into regions. Weights are then further assigned under the assumption that cross-regional interactions will be different to those occuring within a region. Similarly, Gerard et al. (2010) apply a weighting scheme in which Belgian municipalities are sorted into regions and differing weights are assigned with respect to inner-regional or cross-regional border sharing.

Further issues stem from endogeneity problems. For one, given the mutual interdependence of the strategy variables, the vector of tax rates chosen by the other jurisdictions may itself be endogenous and thus correlated with the error term. The error term may further include spatially dependent omitted variables.[56] Typically, these issues are solved by the application of maximum-likelihood (ML) methods[57] or by the implementation of an instrumental variable approach as suggested by Kelejian and Robinson (1993) or Kelejian and Prucha (1998).[58]

The included vector of jurisdiction-specific characteristics may also be correlated with the error term. The arising endogeneity problems can be solved by appropriate specification of instruments for the respective control variables, or they may be circumvented by the use of panel data, which may also help to deal with spatial error dependence, as pointed out by Brueckner (2003). This approach was taken, for example, by Revelli (2001) or, more recently, Gerard et al. (2010).

2.2.2 Interregional Tax Competition

A vast array of literature on interregional tax mimicking behaviour has been produced, among which the majority of studies uses European datasets, with only some studies on the United States or Canada. Since excellent surveys of the previous literature have been given by Brueckner (2003) or Madies et al. (2004), the focus of this work lies on the more recent contributions.

Competition Over Tax Rates Within a Country

For American data, most studies focus on tax interaction between states or between local-level counties and municipalities. In earlier studies, Ladd (1992) or Brueckner and Saavedra (2001) have found evidence of positive tax interaction for municipal property tax rates in

[56] In that context, Revelli (2008) points towards the presence of correlated shocks, such as an increase in federal transfers to all regions, which incurs regional governments to reduce their tax rates, not to be confused with evidence of strategic interaction between regional decision-makers.

[57] These are applied, among others, by Solé-Ollé (2003), Allers and Elhorst (2005) or Rork and Wagner (2008).

[58] See, for example, Feld and Reulier (2009), Devereux et al. (2008) or Edmark and Agren (2008).

the United States. For panel data on the property and sales taxes in U.S. states between 1993 and 2003, Hill (2008) examines whether agglomeration has an impact on tax setting. He finds a complementary relationship between tax rates across states as well as evidence that agglomeration in fact leads to an overall higher tax burden and a lower likelihood of tax mimicking behaviour. Rork and Wagner (2008) examine interstate excise (cigarette and general sales) tax competition in the USA for the time from 1967 to 2002. They find significant coefficients for interstate tax interaction and further conjecture that the latter not only hinges on the mobility of tax base, but also on the structure of regional interrelations within the country. They specifically find that the direction and the degree of tax competition varies significantly over specific regions. Deskins and Hill (2010) survey panel data on several U.S. state taxes in an attempt to pinpoint whether the interdependence of state tax rates has varied over time. They confirm the existence of strategic complementarity of tax rates and find significant evidence that the interregional sensitivity of state personal income tax rates has in fact systematically diminished over time. They are, however, unable to generate evidence of such time trends for the corporate income tax. Crowley and Sobel (2010) analyse panel data for property taxation in municipalities, counties and school districts in Pennsylvania, in which the number of regions at the respective level serves as a proxy for its degree of decentralisation. They examine the interrelations of tax competition, revenue-maximising government behaviour and spatial interdependence of tax rates in municipalities and counties to find that decentralisation and thus a higher degree of interregional tax competition reduces tax rates. Their results for school districts, which are highly decentralised, however, provide evidence of strong interaction, yet significantly higher tax rates. The authors deduce that spatial correlation between tax rates as an indicator of tax competition between regions needs to be seen with caution, given that it might as well imply evidence of collusion activities, which might in turn drive taxation upwards.[59]

For a sample of Brazilian states between 1985 and 2001, deMello (2008) finds significant evidence of strategic complementarity in the choice of the value-added tax. He further finds that these interactions are more pronounced among states belonging to the same geographic region and that one state, namely, Bahia, in fact acts as a Stackelberg leader.

Various studies exist for Europe, given the richness of data and the variety of institutional reforms and individual countries' regulation. One strand of research is driven by the decentralised structure of European countries. Among the more recent contributions, Vandenbusschee et al. (2005) find evidence that Belgian regions compete over the effective corporate tax rate for a time period from 1993-2002. Geys (2006) examines Flemish tax setting for the year 2000. He argues that with respect to tax base mobility, the ratio of the tax level to the amount of government spending in one municipality rather than only the tax rate

[59] See also section 2.2.4.

may influence location choice. With a thus created index, he draws the conclusion that significant competition for tax base between municipalities does exist in such that a favourable tax-expenditure ratio of one municipality is likely to positively influence that ratio in other municipalities.[60] For a panel of Belgian municipalities, Gerard et al. (2010) explore the significance of interregional differences for interactions in setting local tax rate surcharges. They find that decision-makers react specifically towards property tax rate surcharges set by their closest neighbours rather than all other Belgian municipalities. Further, the results indicate that tax competition is more intense among municipalities within the Brussels region. Their findings validate the result of Belgian income tax rates as strategic complements established by Heyndels and Vuchelen (1998) and Richard, Tulkens and Verdonck (2002), but contradict these authors' positive results for the local property tax surcharge by detecting instead an inverse relationship.

For data on Swedish local income tax policies between 1993 and 2006, Edmark and Agren (2008) test for tax mimicking behaviour and explicitly try to verify whether their results are driven by yardstick competition or tax competition. They find strong evidence of tax rates being positively spatially correlated, driven by mobile tax base rather than possible election outcomes.

Feld and Reulier (2009) examine competition over income tax rates among Swiss cantons for panel data from 1984 and 1999. They find a positive relationship for income tax rate reactions between the cantons. Hereby, they support previous findings for Swiss data.[61]

Reulier and Rocaboy (2009) test for strategic complementarity in the setting of tax rates between French regions, specifically aiming to discriminate between yardstick- or tax base competition-driven behaviour. Their results suggest that tax mimicking between French regional governments exists and can be attributed to the former if the tax burden is carried by the voters, whereas it can be attributed to the mobility of tax base if the tax is imposed on firms. Charlot and Paty (2010) study the impact of agglomeration on tax competition in France for 2002 and find evidence of complementarity in tax rates, but do not detect a significant relationship between tax rates and the population density within a region. For urban jurisdictions, they further find a positive relation between the capital tax rate and the prevailing capital stock, which they attribute to a taxable agglomeration rent, as brought forward by new economic geography models.[62]

Relatively little evidence exists on tax competition in Germany. Buettner (1999, 2001)

[60] That result may also be seen as indicative of the relevance of laboratory federalism approaches outlined in section 1.2.

[61] See Feld and Kirchgaessner (2001, 2002) or Feld and Reulier (2005).

[62] Their findings contribute to a fairly extensive literature on French tax setting, whose earlier contributions, for example, by Jayet et al. (2002) or Feld et al. (2002), were affirmative of the tax competition hypothesis. See Madies et al. (2004) for more details.

examines business tax setting interactions between German municipalities for the time between 1980 and 1996, where he finds evidence of tax mimicking behaviour with larger regions setting higher tax rates on average. Subsequently, Buettner (2003) specifically tests for tax base mobility as a source of tax mimicking behaviour between German municipalities from 1980 till 2000 and confirms his hypothesis.

Competition Over Tax Rates Across Countries

Another strand of literature on European data is driven by the EU integration and enlargement process and aims to characterise strategic tax rate interactions among member states. For a data panel on 11 Western European states between 1970 and 1999, Redoano (2007) concludes that there is positive strategic interdependence between corporate tax levels and sees that European countries specifically interact with their large competitors, which they use as a point of reference. Further, tax mimicking appears to be particularly pronounced before joining the European Union, while it becomes less significant after membership is accomplished. Taking the EU enlargement as a point of departure, Cassette and Paty (2008) examine the relationship between the former EU-15 and Central and Eastern European countries (CEEC) for the period between 1995 and 2005. They find evidence of pronounced complementary tax interaction within Western European countries, but less pronounced strategic interaction among the CEEC. Their results also point towards interregional competition between East and West.

Finally, some authors have used the observed increase in international capital market integration to study international strategic tax interactions. Altshuler and Goodspeed (2003) examine European and U.S. tax setting to find evidence of tax competition, in which the United States act as a Stackelberg leader. They further conclude that tax competition among European countries has become less intense, while it has gained momentum between the U.S. and Europe. Devereux et al. (2008) aim to find proof of competition over corporate tax rates among OECD countries. They estimate upward-sloping reaction functions for OECD countries generated from a theoretical model showing that the mobility of tax base depends on an industry's relocation cost. They conclude that strategic interaction only takes place among open countries, in which relaxed capital controls, leading to increased competition for mobile tax base, trigger a reduction in tax rates. Kammas (2009) examines a 1982-2000 panel dataset for OECD countries to find a positive response of capital tax rates within the countries towards those set in other countries and a negative reponse of capital tax rates towards public investment spending.

Tax Base Mobility

In addition to the characterisation of tax reaction functions, some authors try to establish a relationship between the mobility of tax base and the level of tax rates prevailing in a jurisdiction. Interstate tax competition with respect to the degree of mobility of the tax base is examined by Rork (2003) for five major state tax instruments in the United States over a time period from 1967 through 1996. He supports the tax competition hypothesis with his results stating that the more mobile the tax base of a state (as, for example, motor fuel or tobacco sales and corporate income taxes as opposed to personal income and general sales taxes), the more sensitive its response towards a tax hike in the neighbouring regions will be. He further conjectures that there is evidence of complementarity for tax rates on mobile bases and indications of substitutability for immobile ones. Mintz and Smart (2004) use panel data on corporate taxation in Canadian provinces between 1986 and 1999. They find evidence of higher state tax rates reducing the respective tax base, and of firms with an opportunity for income shifting reacting significantly more elastically towards changes in tax rates. Carlsen et al. (2005) examine Norwegian municipalities and their strategic behaviour with respect to the mobility of firms. For that, the degree of firm mobility at the local level is explicitly incorporated into an approach developed and later published by Devereux et al. (2008).[63] They establish an inverse relationship between the mobility of tax base and the level of infrastructure fees imposed on firms at the regional level. Using OECD panel data, Winner (2005) concludes that for the time period of 1965-2000, an increase in capital mobility pushes labour taxation upwards, while having an inverse effect on capital taxation. He further finds that the larger a country, the more likely it is to have an overall higher tax level. The integration of capital markets and its impact on EU wealth and tax levels for the time period between 1970 and 1996 is scrutinised by Mendoza and Tesar (2005) within a macroeconomic framework. Their evidence implies that while capital tax rates were only slightly driven downwards (except in the UK, where the reduction was somewhat more pronounced), labour tax rates were subject to sharp increases (except in the UK, where it changed only marginally). The impact of monetary and economic EU integration on corporate tax competition is also examined by Karkalakos and Makris (2008) for a time span between 1975 and 2005. A positive correlation is observed between corporate tax rates and economic integration, while the former is negative for monetary integration. Davies and Voget (2009) ask whether the recent EU enlargement has in fact intensified tax competition for unbalanced panel data over a time period from 1980 through 2005. They conclude that tax competition among EU members is more intense than between members and other states.

[63] See above.

2.2.3 Federal Tax Competition

Given the theoretically driven explicit recognition of federal structure, it was only a matter of time until its results were sought to be empirically verified by aiming to detect an interaction of upper- and lower-level tax rates.

Vertical Tax Rate Interaction Within a Country

The earliest empirical study can be found in Besley and Rosen (1998). They examine the interaction of federal and state level gasoline tax rates in the United States over a time period from 1975 till 1989. Their approach only accounts for vertical interactions and does not allow for possible horizontal effects among the lower-level governments. The generated results point towards a positive relationship between federal and state taxes. Various subsequent papers have analysed gasoline and cigarette taxation at the U.S. federal and state level. Devereux et al. (2007) consider panel data from 1977-1997 controlling for the elasticity of tax base and cross-border shopping. For the taxation of cigarettes, they find a significant positive and large horizontal effect, while the vertical effects are insignificant. Gasoline tax rates are driven upwards by vertical tax interaction, while horizontal interaction is not significant. These results correspond with the predictions from their theoretical model arguing that the vertical externality is likely to be more significant, the more elastic the tax base. They refer to empirical evidence suggesting that this is the case for gasoline rather than cigarettes. For a panel from 1975-2001, Fredriksson and Mamun (2008) examine U.S. cigarette taxation. While the regression results covering the entire period are insignificant, their results on the time between 1982-2001 suggest that states are likely to react inversely towards a tax rate hike at the federal level. Miyamoto (2009) estimates reaction functions for gasoline and cigarette tax rates. He finds very little evidence of horizontal tax competition and on average a moderate positive relationship between federal and state level for both taxes. The results on vertical interaction are somewhat more pronounced for cigarette taxation and the sign and magnitude of the slopes of the reaction functions differ across states.

Esteller-Moré and Solé-Ollé (2001) examine personal income and general sales taxation at the state and federal level in the United States over a time period between 1987 and 1996 and find a significant positive interdependence of both state level tax rates with federal taxes. Wu and Hendrick (2009) examine property tax rates set in municipalities (lower level) and in counties or school districts (upper level) in Florida between 2000 and 2004. Their results confirm the existence of horizontal and vertical tax interactions. Namely, they find positive horizontal interactions at the municipal level and an inverse reaction of municipal-level tax rates towards county-level tax rates, while the latter is positive with respect to school district-level tax rates.

Rizzo (2010) develops an approach to estimate vertical and horizontal tax interaction

effects for general sales and tobacco excise tax rates in the United States and Canada between 1984 and 1994. He finds evidence of complementarity between upper and lower level tax rates. His results further indicate that an increase in the federal tax rate may be efficiency-enhancing and might offset the tax competition effects at the lower level by reducing the sensitivity of lower-level tax rate responses to horizontal tax competition. Using a proxy for excise taxation of production goods derived from a dataset between 1970 and 1997, Crisan (2007) examines vertical and horizontal tax competition effects in Canadian provinces. His results strongly support the existence of vertical externalities and complementarity between federal and provincial tax rates. The evidence on horizontal tax competition is mixed, with the slopes of the provincial-level reaction functions being either positive or negative, and not all of them being significant. He does, however find highly significant indications that all provinces react positively towards the tax rate chosen in the province of Alberta, pointing towards a somewhat leading function within the Canadian provinces.

The regional pattern of municipal corporate property tax rates within British Columbia is examined by Brett and Pinkse (2000). They find evidence of horizontal tax competition and note further that their results point towards the existence of vertical interdependencies with the state tax rates being driven downwards by a federal tax hike. For Canadian federal and provincial corporate income tax rates from 1963 through 1996, Hayashi and Boadway (2001) estimate reaction functions and find evidence of vertical and horizontal effects. Precisely, they find an inverse relationship between federal and provincial tax rates and complementarity for provincial-level tax rates. They further conclude that the results for the province of Ontario are peculiar in such that tax setting is neither affected by the other provinces nor by the federal level. Instead, federal taxation exhibits a positive relationship towards the tax level in Ontario. Finally, Esteller-Moré and Solé-Ollé (2002) estimate an upward-sloping reaction function of Canadian provincial personal income tax rates towards other provinces' and federal tax rates for data from 1982 through 1996.

Among the studies considering data from the EU, Revelli (2001) examines property tax setting in non-metropolitan districts in England for panel data in the 1980s. He is able to confirm spatial interaction between districts, but finds no evidence of vertical interdependence of tax rates. Municipal and department level setting of the local business tax in France in 1995 is explored by Goodspeed and LePrince (2003). Their estimates point towards an upward-sloping reaction function of the municipalities towards the departments. LePrince et al. (2007) characterise department (intermediate level) and regional (upper level) government tax reactions for the case of business taxation by use of a French cross-section from 1995. Their results suggest that vertical tax interactions are not significant, while horizontal tax interactions at the department level are. They further point out that there is no evidence of the upper-level tax choices offsetting the inefficiencies created at the lower level. For data on

Swedish local and regional personal income taxation derived from a 1981 - 1990 panel data set, Andersson et al. (2004) find an inverse relationship between tax rates. They further test for whether the upper-level government is able to internalise the inefficiencies triggered at the lower level and conjecture that this is not the case for local and regional tax rate choices. Bruelhart and Jametti (2006) use a Swiss panel data set for selected years between 1985 and 2001. Starting from the theoretical result that tax rates at the state level will decline with an increase of fragmentation if the horizontal externalities dominate at the state level, and vice versa, they analyse the interdependence of canton-level and municipal-level personal and corporate tax rates for all of the 26 Swiss cantons with respect to the degree of fragmentation. Their evidence suggests that on average vertical externalities dominate the horizontal externalities among the municipalities in each of the Swiss cantons.

Vertical Tax Rate Interaction Across Countries

Goodspeed (2000) aims to identify horizontal and vertical tax competition effects for data on 13 OECD countries between 1975 and 1984. He finds that state-level governments react towards an income tax hike at the federal level by reducing their tax rates. As a proxy for the mobility of tax base and, thus, international tax competition, he uses state poverty rates and finds a positive relationship between those and the level of income tax rates, which confirms the classical tax competition results. Goodspeed (2002b) supports and enriches his previous results by further specifying the existence of interaction of vertical and horizontal effects. He points out that the vertical externality increases with a greater equality of tax bases across regions, that is, with a lower degree of tax base mobility and, thus, horizontal tax competition.

2.2.4 Efficiency Enhancing Tax Competition

The evaluation of decentralisation or tax competition differs significantly depending on whether governments are assumed to be revenue or welfare maximisers.[64] This section aims to give an overview of the existing studies seeking to empirically validate the assumption of Leviathan behaviour.

Most of the respective contributions aim to establish a link between the size of government and the degree of decentralisation.[65] Decentralisation will lead to a reduction in the size of government under the assumption that it reduces the ability of governments to maximise their own budgets through better possibilities to control the policymakers. Typically, the degree of decentralisation is proxied by means of one jurisdictional level's share of expenditure (revenue)

[64] See section 2.1.

[65] Other approaches, which will also be discussed further on, examine whether decentralisation has an effect on public sector efficiency or whether elements of direct democracy will reduce public sector size.

in total government expenditures (revenues) or the total number of jurisdictions at one level.[66] Competing views regarding the effect of fiscal decentralisation call for a careful specification of the respective regressions. For one, while fiscal decentralisation will most likely reduce central and raise local government budgets, the aggregate effect remains open. Brennan and Buchanan (1980) suggested for Leviathan governments to be restrained by horizontal competition for mobile tax base, such that decentralisation will raise welfare by reducing the overall size of government. On the other hand, their 'collusion hypothesis' implies that this need not be the case. In fact, upper and lower level Leviathan governments have an incentive to collude and transfer taxation power to the central level in order to circumvent the restraining tax competition effects, while only expenditures remain decentralised. The collusion hypothesis thus calls for the careful consideration of expenditure as opposed to revenue decentralisation. Several studies[67] further control for collusion activities by taking into account the prevalence of federal transfer schemes. In contrast, with reference to an idea by John Wallis, Oates (1985) asserted that decentralisation may lead to inefficiently high local and also aggregate expenditures given that taxpayers are better able to exert influence on their local in contrast to federal-level incumbents, such that the former may feel more inclined to pursue local projects leaving lower-level expenditures inefficiently high. Hence, an increase of aggregate expenditures following fiscal decentralisation neither confirms nor denies the Leviathan hypothesis.

Empirical studies thus need to analyse the expenditure and the revenue side of different levels of government as well as the aggregate level and carefully account for the contrasting views and implications of the Leviathan hypothesis, the collusion hypothesis and the Oates-Wallis hypothesis.

Decentralisation Within a Country

Oates (1985) first attempted to empirically verify the existence of a Leviathan government for cross-sectional data on U.S. state and local level governments in 1977 as well as international data from 43 countries. Including both state revenue and expenditures as a share of total government revenue (expenditures) and the number of local jurisdictions to measure the degree of decentralisation, he establishes no evidence of Leviathan behaviour. For the same dataset, after varying the measures of the degree of decentralisation and accounting for heterogeneous preferences across the states, Nelson (1987) finds a moderately negative relationship between the size of government and decentralisation. Eberts and Gronberg (1988) observe a reduction in public sector size as a consequence of fiscal decentralisation for 1977

[66] Other measures, such as the degree of fragmentation or tax competition, have also been developed, which will be pointed out with regard to the respective studies.

[67] See, for example, Lalvani (2002) or Chen (2004).

data on the U.S. county and metropolitan level. For U.S. county cross-sectional data, Forbes and Zampelli (1989) conclude that public sector size expands with a higher degree of decentralisation, which they perceive as contradicting the Leviathan hypothesis. Zax (1989) finds evidence in favour of the Leviathan hypothesis for a cross-sectional dataset of U.S. municipalities from 1982. He states that local level government budgets will be reduced if decentralisation raises tax competition, while the opposite will be the case if it incurs a loss of scale economies. With data on the U.S. state level, Marlow (1988) performs a time-series regression for 1946-1985 with results pointing towards decentralisation reducing the size of government. Joulfaian and Marlow (1991) measure the impact of the level of decentralisation on government budgets for U.S. state, local and federal spending in 1983-1985 to confirm the Leviathan hypothesis for federal revenues.[68] Using Data Envelopment Analysis to determine the efficiency of Minnesotan counties, Nold Hughes and Edwards (2000) find evidence in favour of the Leviathan hypothesis. They use aggregate county property values as a proxy for public sector efficiency. That approach was suggested by Brueckner (1982), who showed that the Samuelson condition for efficient public good provision is consistent with the maximisation of aggregate communal property values. That same proxy is applied by Bates and Santerre (2006), who support the Leviathan hypothesis for cross-sectional data on municipalities in Connecticut for 1998. They generate the result that public sector efficiency is reduced with higher market power. Stansel (2006) examines municipal-level U.S. data from 1962 through 1992. For municipal government spending growth over three time periods (1962-1992, 1962-1982 and 1982-1992), he concludes that it will be limited by more intense competition. Crowley and Sobel (2010)[69] analyse panel data for property tax rates in municipalities, counties and school districts in Pennsylvania between 1995 and 2005 to find that decentralisation intensifies interjurisdictional competition and abates tax rates. They further find evidence of collusion activities between school districts raising the level of tax rates. Their evidence overall verifies the Leviathan hypothesis and points towards the recognition of collusion activities not only across levels of government, but also at the same level.

For a panel dataset on Indian state and local governments for selected time periods between 1990 and 1998, Lalvani (2002) concludes that decentralisation yields a smaller total and upper-level government size, while it raises that of subnational governments. She further finds evidence of collusion activities triggering an increase in expenditures at all levels of government. Chen (2004) examines fiscal decentralisation at the provincial level in China for

[68] Marlow (1988) had suggested that the inclusion of the national level in order to examine the revenue effects of decentralisation was of high relevance and had been neglected so far. Joulfaian and Marlow (1991) argue that while central government may not be subject to Tiebout competition and some of its public goods may not be possible to provide at the local level, it is just that monopolistic power that is likely to be quite relevant in testing the Leviathan hypothesis.

[69] See also section 2.2.2.

a dataset from 1987 through 2000. The generated results imply that provincial expenditures will rise as a consequence of stronger fiscal decentralisation, which is perceived as a confirmation of the Oates-Wallis hypothesis.[70] Chen (2004) also finds evidence that provincial and central governments are more likely to engage in collusion activities with a higher degree of decentralisation, which in turn is seen as supportive of the collusion hypothesis.

Several studies exist that examine panel data on Swiss cantons. For the time between 1980 and 1998, Feld and Matsusaka (2003) find that direct democracy in the form of referendums significantly reduces the amount of government expenditures, a result which may be seen as a confirmation of the Leviathan hypothesis. For selected years between 1985 and 2001, Bruelhart and Jametti (2007) find that a higher degree of decentralisation within a canton entails a reduction of municipal tax rates, concluding that this may be indicative of tax competition having a restraining effect on Leviathan governments. Feld and Schaltegger (2009) examine the impact of government fragmentation on revenue and expenditure size between 1980 and 1998. They find that cabinet size is positively related to government revenues and spending, which may be seen as supportive of the Leviathan hypothesis. They further find that direct democracy is a means to reduce the size of government. For the same dataset, Feld et al. (2010) find, among other things, that government budget will shrink with more intense interregional tax competition. The decentralisation of revenue power leads to a reduction of tax revenues, while user charges will increase.

Decentralisation Across Countries

Among the studies focusing on international datasets, Anderson and van den Berg (1998) examine a worldwide sample of 45 countries, but are unable to establish results in favour of the Leviathan hypothesis. For panel data on 32 developing and industrial countries from 1980-1994, Jin and Zou (2002) examine how decentralisation affects subnational, national and consolidated government sector size and find evidence in favour of the Leviathan hypothesis, while also accounting for the Oates-Wallis hypothesis. Their results point towards expenditure decentralisation culminating in a reduction of central government size and an increase of subnational and aggregate budgets. Greater subnational but reduced national and compound budgets are found to result from revenue decentralisation. Finally, the existence of intergovernmental grant schemes raises government budgets at national and subnational level. Rodden (2003) also stresses the need to specifically account for whether expenditure decentralisation is accompanied by tax revenue autonomy. For an international panel dataset from 1978 through 1999 on 29 countries, the combined decentralisation of expenditures and revenues points towards a reduction of total government size, while the isolated decentralisation of expenditures will lead to its expansion. For 16 OECD countries, Santolini (2009)

[70] See Oates (1985).

examines balanced cross-sectional time series data between 1978 and 1997 testing for the effect of decentralisation and of the legislature's monopoly power on government size. The results imply that fiscal decentralisation will constrain Leviathans, while the same holds for high legislative monopoly power, which runs counter to the Brennan and Buchanan hypothesis. She further tests for the joint effects of decentralisation and legislative control to conclude that Leviathan can be tamed by austere legislative control, or weak controls of the legislature in combination with a high degree of sub-national taxation autonomy. Martinez-Vazquez and Yao (2009) scrutinise the relationship between public sector employment and decentralisation between 1985 and 2005 for over 100 countries. They find that a higher degree of decentralisation entails higher local level public sector employment, which more than offsets the downsizing of central level public sector employment. To detect how decentralisation affects government budgets at the national, the subnational and the aggregate level, Cassette and Paty (2010) examine panel data on the EU-15. They find that the resulting increase in subnational expenditures more than offsets the reduction in central level expenditures, such that aggregate budgets will be higher with a stronger degree of decentralisation. The existence of intergovernmental transfers is found to raise the size of government at all levels.

2.3 Summary

Federal taxation is characterised by the co-existence of vertical and horizontal externalities triggered by one jurisdiction neglecting the impact its own choice of tax rate has on other jurisdictions at the same or another level. Early theoretical approaches saw federations as a number of independent regions with a passive federal government. Only horizontal externalities that distort regional tax policies will then occur.[71] In sum, they point towards a tendency of inefficiently low taxation and public good provision. That downward pressure may be attenuated if regions are not assumed to be symmetric, for example, if they differ in size, if one region can take advantage of agglomeration rents or is able to differentiate itself from competitors via the provided public good.

If a central government acts as an active player, additional vertical tax externalities occur. While for each region the tax base is elastic, the elasticity of the federal tax base depends, for instance, on the degree of the country's openness to international capital markets or the elasticity of capital supply with respect to the net interest rate prevailing in the federation. Both levels of government may neglect the impact their decisions have on budgets at the other level, which may be a consequence of myopic behaviour or differing objective functions.

[71] These can be divided into indirect positive externalities resulting from the interregional reallocation of mobile capital tax base and direct negative externalities that may result from a change in the federal net return on capital.

These (bottom-up or top-down) vertical externalities point towards tax rates being set higher than in the centrally planned second-best optimum.

The vertical and horizontal externalities resulting from federal structure thus point in opposite directions. The relative strength of vertical and horizontal externalities may hinge on various factors: a high interest rate elasticity of capital supply, a low interest rate elasticity of capital demand and a strong degree of international capital market integration point towards a dominance of vertical over horizontal externalities.

To evaluate the efficiency of equilibria, the decision-makers' intentions are of concern: For benevolent governments, inefficient levels of taxation or public good provision imply a loss of welfare. For Leviathan governments, dominating vertical externalities, such that consolidated tax rates are too high, point towards the relevance of the Laffer paradoxon. Inefficiently low tax rates may be perceived as welfare enhancing by restraining the Leviathan's revenue-maximisation policies.

International capital tax competition adds another layer of externalities: Positive cross-national horizontal (and vertical) externalities between the federations may attenuate the vertical externalities within a federation by pointing towards inefficiently low tax rates from a global perspective. By exerting additional downward pressure on tax rates, international tax competition implies for the vertical externality to be less relevant for the overall level of tax rates. Or, put differently, federal structure driving consolidated tax rates upwards within the federation may function by offsetting the downward pressure on tax rates arising from international tax competition.

The majority of empirical studies seems to be affirmative of the hypothesis of interregional across- and within-country tax competition implying a complementary relationship between tax rates. Particularly the more recent studies convey a more differentiated picture accounting for the significance of regionalism and agglomeration effects within a country as well as individual regional characteristics that shape the detected strategic interaction. The evidence is further supportive of the EU integration and enlargement process having (had) an impact on tax rate choices, while the respective results as to how exactly that strategic interaction can be characterised differ across studies. In any case, the results are affirmative of the hypothesis that increased international capital market integration intensifies interregional tax competition.

By including vertical tax interactions, the evidence becomes rather mixed, with a slight tendency of studies supporting a complementary relationship between upper- and lower-level tax rates. What is more, given some results on Canadian data,[72] it seems likely that a region may take the role of a Stackelberg leader and that federal as well as same-level jurisdictions' tax rates react to such leading regions. With respect to the ability of the federal policymakers

[72]See Hayashi and Boadway (2001) and Crisan (2007).

to internalise the inefficiencies created at the regional level, the evidence is mixed and, if at all, not in the affirmative.

The evidence on Leviathan government behaviour is far from clear and its existence can neither be denied nor confirmed. While it is straightforward to test for the Leviathan hypothesis in the context of decentralisation, the testable hypotheses as well as the resulting implications are difficult to interpret. The existing studies may be seen as indicative of efficiency-raising or -deteriorating effects of decentralisation. It is more likely to raise efficiency if reforms include revenue instead of solely expenditure decentralisation. Whether this may be attributed to Leviathan behaviour is not necessarily clear. More work thus needs to be done in order to clarify the specific channels in which the presence of Leviathan becomes manifest. In any case, it is fair to say that the assumption of revenue-maximising behaviour within a model may be justified to a certain extent and the evaluation of policies needs to be cautious as to what behaviour one is more inclined to assume.

The fear of the negative impact of globalisation on welfare and tax revenues substantially shapes fiscal policies, as outlined in section 1.1. Indeed, some of the early theoretical contributions on international tax competition support this view of globalised capital markets. The standard theory developed by Zodrow and Mieszkowski (1986) and Wilson (1986) sees that policymakers have incentives to reduce tax rates on capital as the latter becomes increasingly mobile. A zero equilibrium tax rate on mobile capital is even found to result by Bond and Samuelson (1989) or Razin and Sadka (1991). Notwithstanding that they have been reshaped and specified in the succeeding literature,[73] these results appear to remain influential in the collective conscience. The empirical studies on tax revenue levels cited in section 1.1 further point towards a more differentiated view of the consequences of globalisation. The explicit consideration of federal design (with federal tax setting possibly being driven in a direction opposite to that predicted by the standard interregional tax competition literature) as well as the recognition of the contrasting evaluation of results when policymakers are assumed to be either revenue or welfare maximisers in the context of international tax competition further enhance the discussion. What is more, theoretical results point towards a differentiated view of the challenges of globalisation in such that countries do in fact have means to distinguish themselves from their competitors in various ways, thereby circumventing the downward pressure on tax rates. The heterogeneity of jurisdictions as well as of citizens' and firms' preferences entails such possibilities, as was already pointed out by Salmon (2008).

Regarding the worldwide trend towards decentralisation, policy recommendations need to bear in mind that the empirical evidence suggests for the efficiency-enhancing effects of decentralisation to become obsolete if the latter is restricted to expenditure rather than rev-

[73] See section 2.1.1.

enue autonomy.[74] A global trend towards fiscal decentralisation may nonetheless culminate in growing numbers of countries actually adapting federal tax systems, such that the recognition of the consequences of tax base overlap becomes even more relevant.

With the arguments brought forward so far, for the evaluation of possible tax policies, some key questions need to be answered. For one, a more differentiated view of horizontal tax competition seems to be in place. Beyond that, the federal framework of the respective countries is highly relevant. It is further necessary to be aware of whether a country's policies are more likely to have been shaped by revenue-maximising rather than welfare-maximising intentions in the setting of tax rates. The explicit recognition of the competing countries, particularly their federal design, is also relevant. With respect to the European Union, policymakers need to be aware of the difference between the perspective of the European Union as an economic entity in competition with other states, in contrast to the perspective of a single member country. With an integrated Europe actually becoming more deeply rooted in the decision-making process of each member state, this last aspect will be increasingly important. Finally, worldwide decentralisation trends need to be evaluated cautiously with respect to expenditure as opposed to revenue decentralisation.

As described in section 1.1, the worldwide trend towards fiscal decentralisation combined with international capital market integration makes the recognition of a country's federal framework essential for economic policy design and evaluation. In that respect, research can still be extended. So far, the theoretical models examining the degree of international capital tax competition and its impact on tax setting within a federation, have done so either by assuming that the country finds itself in one of the boundary cases of perfect integration or a closed economy or by varying that degree indirectly, for example over the number of competing states. No approach exists so far that explicitly considers the supply of capital with regard to a country's degree of international capital market integration. Furthermore, not much work has been done with respect to just how the federal structure of a country influences its position in the international competition for capital tax base. A few studies in that respect exist,[75] yet there is no systematic discussion of the change in outcomes with two countries competing for mobile capital with a differing federal setup within one distinct setting.

The following two chapters aim to fill some of these gaps concerning a country's federal framework and its degree of openness with regard to capital mobility and thereby further validate the key questions outlined in the previous paragraph.

[74] See section 2.2.4.
[75] See section 2.1.3.

Chapter 3

Federal Tax Competition and Capital Market Integration

This chapter aims to explicitly incorporate a federation's degree of integration into international capital markets to the consideration of efficiency of tax rates.

The joint effects of vertical and horizontal tax externalities in the context of capital income taxation have been studied by Keen and Kotsogiannis (2002).[1] In their model, the supply of capital is determined by life-cycle savings. It is demonstrated that whether the horizontal tax externality dominates the vertical one or vice versa essentially hinges on the elasticity of savings with respect to the interest rate. If savings are inelastic, the horizontal externality dominates the vertical one and tax rates of lower level jurisdictions are too low. For elastic savings, the opposite holds true.

The approach taken in the following chapter is complementary to that of Keen and Kotsogiannis. Rather than considering life-cycle savings, it relates the supply of capital to the level of international capital market integration. The key element of the framework established in this paper is a concept that allows to parameterise the degree of international capital market integration, which is then incorporated into an efficiency-oriented analysis of capital taxation in a federation. It is shown that if the degree is low, that is, if the economy has only limited access to the international capital market, the horizontal externality will dominate the vertical one at the state level, whereas the opposite will hold true if the degree is large. This result implies that in a federal system with limited access to the international capital market there will be undertaxation of capital income, whereas in a federal system with extensive access there will be overtaxation by lower level jurisdictions. It is further shown that the efficiency of federal taxation essentially hinges on the assumptions about the strategic behaviour of the federal government and on the relative behaviour of state and federal taxes. The generated results establish a link with the results by Keen and Kotsogiannis (2002) in such that the

[1] See section 2.1.2.

degree of capital market integration works the same way as the interest elasticity of savings. That is, a high degree of international capital market integration functions by reducing the relative importance of the horizontal externality as opposed to the vertical externality, given that capital tax base can be shifted more flexibly abroad. It is further shown that for a specific degree of international capital market integration, vertical and horizontal externalities may offset each other.

The chapter is set up as follows: The next section establishes the analytical framework and sketches the international interdependencies of capital movements and capital taxation. Section 3 analyses the possible vertical and horizontal externalities. Attention is first paid to the efficiency of state level taxation, followed by an efficiency-oriented analysis of federal level taxation. With the help of a numerical example, section 4 will illustrate the theoretical results generated in the preceding section. Section 5 concludes.

3.1 The Model

The analytical framework is outlined in the proceeding section. The examined federation is a small country, whose public sector consists of a federal government and n identical states.

3.1.1 Households

In order to factor out equity considerations, let each state $i = 1, \ldots, n$ be populated by a single representative consumer endowed with one unit of capital. Utility of the consumer in state i is determined by

$$u(c_i, g_i, G) = c_i + \Gamma(g_i, G), \tag{3.1}$$

where c_i is private consumption of consumer i, g_i is the amount of a local public good provided in state i and G is federal spending per state. $\Gamma(g_i, G)$ is a felicity function measuring the utility from local public good provision and federal spending, which satisfies the usual monotonicity and concavity assumptions. An individual's private consumption is constrained to

$$c_i = \rho + (1 - \theta)\pi_i, \tag{3.2}$$

in which ρ denotes the net return on capital (which will be seen to be equalised across states). Each state raises an (exogenous) tax rate $\theta \in [0, 1]$ on each unit of rental income π_i an individual living in i generates from an immobile factor.

3.1.2 Production

A constant returns to scale production function is considered, which is identical in all states and at least twice continuously differentiable. It displays diminishing returns to scale in its mobile input factor, capital. Production in state i, denoted as y_i, is then determined by

$$y_i = f(k_i) = f'(k_i)k_i + \pi_i, \tag{3.3}$$

where k_i is the amount of capital employed in state i. Assuming that firms are profit maximisers, $f'(k_i)k_i$ is then the income of capital invested in state i.

3.1.3 Capital Mobility

Consumers can choose to invest their capital either in the state in which they live, in some other state of the federation, or they can invest in the international capital market. While capital mobility within the federation comes at no cost, it is assumed that international capital mobility is costly. More precisely, the corresponding cost function is defined as

$$C\left(\sigma, \left|n - \sum_i k_i\right|\right) = \frac{1}{2}\sigma\left(n - \sum_i k_i\right)^2, \quad \text{with } \sigma \in [0, \infty), \tag{3.4}$$

where $\sum_i k_i$ denotes the total capital employed in the federation. The capital available in the federation is given by n. If n falls short of the total amount of capital employed in the federation, the country is a net importer of capital.

σ measures the degree of international capital mobility. It may be interpreted as a risk-premium demanded for international investment projects.[2] It is assumed that σ is the same across countries.[3] For $\sigma = 0$, the country is a small economy perfectly integrated into the international capital market. For $\sigma \to \infty$, the economy is closed and has no access to the international capital market.

The cost of international capital mobility is depicted by Figure 3.1. The higher the degree of capital market integration, the lower is a country's cost of investing abroad. The cost of international capital mobility increases progressively with the difference between the total capital available and the total capital employed in the federation, which can be grasped intuitively by the assumption that the inherent risk of investing abroad will be the higher, the more capital is already employed in a country. Assume that the most attractive, or safest, investment opportunities will be seized first. Thus, with a mounting intensity of investment activity, suppliers of capital may be obliged to resort to other, possibly more risky, projects.

[2] For the use of a similar term in the context of foreign indebtedness, see van der Ploeg (1996).

[3] Note that this symmetry assumption may be dropped without further changing the analytical results, provided that the characteristic cost function is differentiable at all points. The analysis would, however, be rendered unnecessarily complicated.

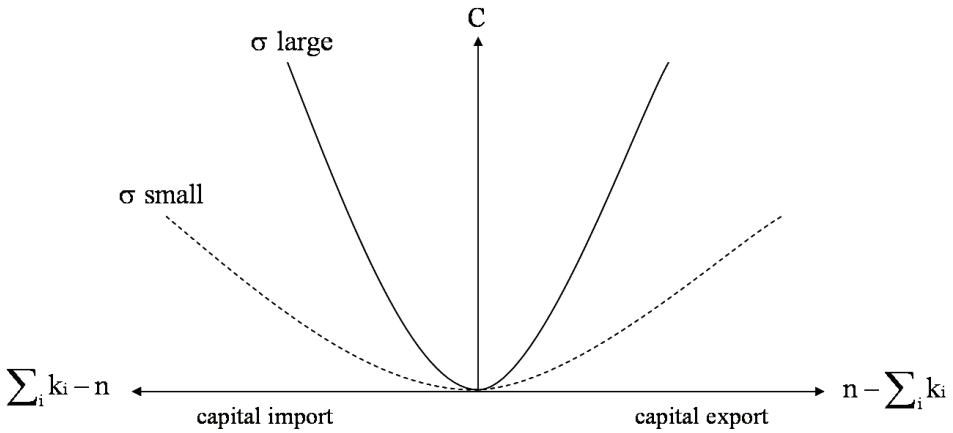

Figure 3.1: Cost of International Capital Mobility

The possibility of interstate and international investment gives rise to two non-arbitrage conditions. The interstate non-arbitrage condition is given by

$$\rho = f'(k_i) - \tau_i \quad \forall i, \tag{3.5}$$

in which $f'(k_i)$ is the marginal return on capital and $\tau_i = t_i + T$ is the aggregate tax burden imposed on the residents of one state by the local (t_i) and the federal (T) authorities. It can be inferred from (3.5) that the net return on capital will be the same for interstate investments, irrespective of what state an individual decides to invest in. Given decreasing returns to scale, rent-seeking investors will arbitrage away differences in net return on capital between states, that is, capital will move between jurisdictions until ρ is equal across all states.

The cost per additional unit of capital invested outside the federation amounts to $\sigma(n - \sum_i k_i)$. The international non-arbitrage condition can then be denoted as

$$\rho = \overline{r} + \sigma\left(1 - \frac{n}{\sum_i k_i}\right) \quad \forall i, \tag{3.6}$$

where $\overline{r}$ is the world market interest rate and $\frac{n}{\sum_i k_i}$ is the ratio between domestic capital endowment and capital employment. If the amount of capital employed in the federation is exceeded by its capital endowment ($\frac{n}{\sum_i k_i} > 1$), that is, if the country is a capital exporter, the net return on capital prevailing in the federation will fall short of the world market interest rate. It will only be beneficial to invest abroad as long as the world market interest net the cost of international investment exceeds the net return on capital generated from domestic investment.[4] In equilibrium,

$$f'(k_i) - \tau_i = \overline{r} + \sigma(1 - \frac{n}{\sum_i k_i}) \quad \forall i.$$

[4]It is a valid objection to wonder why in a small country in which the world market interest is exogenous,

Hence, all possibilities of arbitrage will be extinct and an investor will be indifferent between investing abroad or at home.

Two benchmark cases of international capital mobility shall now be established, which will be useful throughout the further analysis.

Lemma 1 Let τ_i be finite for all $i = 1, \ldots, n$. Provided that $f'(k_i)$ is a bijective function of k_i, then:

i. $k_i = (f')^{-1}(\overline{r} + \tau_i)$, if $\sigma = 0$

ii. $\sum_i k_i = n$, if $\sigma \to \infty$

Proof:

i. Obvious from (3.5) and (3.6).

ii. The proof is by contradiction. To start with, assume that $\sum_i k_i \geq constant > n$ if $\sigma \to \infty$. Then, as τ_i is finite and as $f'(k_i) - \tau_i = \overline{r} + \sigma(1 - \frac{n}{\sum_i k_i})$ for all i, it follows that $f'(k_i) \to \infty$ for all i. As $f'' < 0$, this necessarily requires $k_i \to 0$ for all i, which contradicts $\sum_i k_i \geq constant > n$ for all i. Now assume that $\sum_i k_i \leq constant < n$ if $\sigma \to \infty$. Then, as τ_i is finite, it follows that $f'(k_i) \to -\infty$, which contradicts $f' > 0$. *Q.E.D.*

Figure 3.2 summarises the above discussion. The international net return on capital is depicted as a linear function increasing in $\sum_i k_i$. Interstate net return on capital is a decreasing function of k_i. Arbitrage-seeking individuals will now have an incentive to invest inside the federation, as long as the interstate net return on capital exceeds the international one, and vice versa. Hence, for a given world market interest rate and a specific tax burden in every state of the federation, a certain total amount of capital (for example $(\sum_i k_i)_0 < n$, implying that the country is a net exporter of capital) will be employed inside the federation. Consequently, $n - (\sum_i k_i)_0$ of domestic capital will be employed abroad, which will redound to a specific equilibrium net return on capital ρ_0.

Now, a tax hike will trigger a drop in the equilibrium net return on capital, yet that decrease in ρ will be disproportionately small. Assume first, for simplicity, that the federal

the individual investor's choice would influence the net return on capital. Yet the latter can be solved by arguing that each individual, when facing the decision where to locate capital, will choose the most attractive opportunity first. For each additional unit of capital provided, a less 'attractive' investment opportunity will be taken up, such that the implicit cost for each investor will in fact vary with each individual's investment decision.

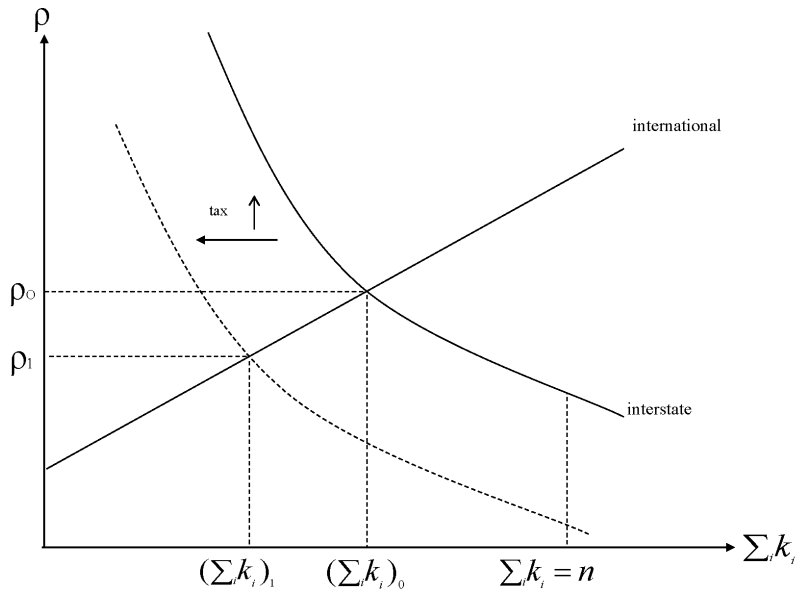

Figure 3.2: Non-Arbitrage Equilibrium

tax is raised, which [via (3.5)] will lead to a simultaneous decrease in the net return on capital in every state of that federation. As a consequence, investors in the federation will have an incentive to remove their capital and invest abroad instead. Although that rise in international investment activity has no impact on $\overline{r}$, for each additional unit of capital located outside the federation, the incurred cost will increase (such that ρ falls). In the same time, marginal productivity of capital inside the federation will again approach the initial level and domestic investment will again pick up. In conclusion, the arbitrage opportunities arising due to the federal tax hike will lead to a new equilibrium in which a larger share of total domestic capital is employed internationally and the net return on capital settles at a lower level than before. Note that if a single state decides to raise its tax, not only will international investment become more attractive, investors will also have an incentive to relocate their capital into the other states of the federation. In both cases, the drop in net return on capital will be disproportionately small in comparison to the change in tax burden.

Figure 3.3 displays the benchmark cases of $\sigma = 0$ and $\sigma \to \infty$ graphically. In the first case, an individual will incur no cost of relocating investments between countries. The amount employed inside the federation will then be such that the equilibrium net return on capital equals the world market interest. In the latter case, all domestic capital is employed inside the federation and no capital will enter the country, such that $\sum_i k_i = n$, irrespective of

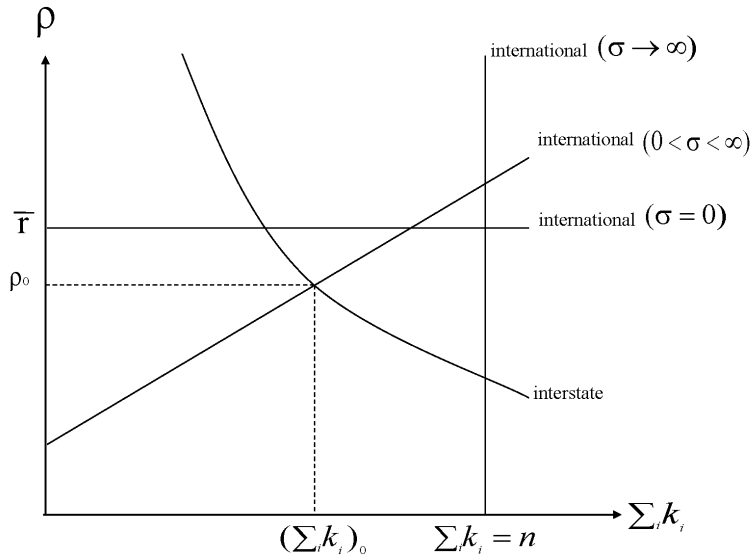

Figure 3.3: Non-Arbitrage Equilibrium - Benchmark Cases

national tax policies or capital productivity.

3.1.4 Policy Implications

As outlined in the previous section, the net return on capital is influenced by the tax regime in the federation. Furthermore, the rental income an individual generates also depends on the aggregate tax burden in each state.

Equation (3.5) implicitly defines k_i as a function $k_i = k_i(\rho + \tau_i)$, with $k_i'(\rho + \tau_i) = \frac{1}{f_i''}$,[5] in which $f_i'' := f''(k_i)$. Then, equation (3.6) implicitly defines ρ as a function $\rho = \rho(\tau_1, \ldots, \tau_n)$ and (applying the implicit function theorem)

$$\frac{\partial \rho}{\partial \tau_i} = \frac{\sigma \frac{n}{(\sum_i k_i)^2} \frac{1}{f_i''}}{1 - \sigma \frac{n}{(\sum_i k_i)^2} \sum_i \frac{1}{f_i''}},$$

and for $\tau_1 = \tau_2 = ... = \tau_n = \tau$

$$\frac{\partial \rho}{\partial \tau} = \frac{\sigma}{nk^2 f'' - n\sigma} \leq 0, \tag{3.7}$$

[5]Provided again that $f'(k_i)$ be a bijective function of k_i.

with $\frac{\partial \rho}{\partial \tau} = 0$, as $\sigma = 0$, and $\frac{\partial \rho}{\partial \tau} \to -\frac{1}{n}$, as $\sigma \to \infty$.

Let each individual receive a rental income π_i from the possession of a fixed factor defined by

$$\pi_i = f(k_i) - f'(k_i)k_i,$$

which then denotes the amount by which the capital product exceeds its remuneration. In it, $k_i = k_i(\rho + \tau_i)$, which implies that $\pi_i = \pi_i(\rho + \tau_i)$, with $\pi_i' = -k_i$. Thus,

$$\frac{\partial \pi_i}{\partial \tau_i} = -k_i(\frac{\partial \rho}{\partial \tau_i} + 1).$$

Hence, the change in rental income due to a shift in τ_i is given by the effect of that shift on k_i and by the impact of the tax-induced change in ρ on k_i.

3.1.5 Government Objectives

A two-levelled federation is considered, in which the federal government is complemented by state-level governments. Both are assumed to be benevolent.

The n states compete for mobile tax base, therein engaging in Nash competition. The benevolent state tries to maximise the welfare of its constituents, irrespective of the possible impact its actions may have on citizens of other states. Consequently, each state i maximises

$$u_i = \rho + (1 - \theta)\pi_i + \Gamma(g_i, G),$$

subject to

$$g_i = t_i k_i + \theta \pi_i$$

and

$$G = \frac{1}{n} T \sum_i k_i$$

by choice of t_i and the resulting level of g_i. Each state government derives its revenue from the taxation of capital (k_i) and rents (π_i). It redistributes that revenue among its constituents by means of the supply of the state public good.

The benevolent and omniscient federal government maximises welfare of all consumers in all states $i = 1, \ldots, n$ across its jurisdiction subject to the respective budget constraints by choice of G and the corresponding level of T. It derives revenue from the taxation of the total amount of capital employed in the federation and redistributes tax revenues evenly across all states.

3.2 Horizontal and Vertical Externalities

The model gives rise to vertical as well as horizontal externalities. With each local government neglecting the impact its tax decisions have on the budget of the other local entities, it triggers a horizontal externality. A vertical externality arises from perfect tax base overlap. With an omniscient federal government, only a bottom-up vertical externality will occur, given that each state underestimates the loss of tax revenue the federal government incurs due to a rise in taxation at the state level.

The analysis is carried out as follows: First, the state level is considered. It is examined whether under the outlined structure, states will excessively tax capital. Proceeding to the federal level, the same question is asked, allowing for the federal government to either engage in Nash competition or act as a Stackelberg leader. Throughout the analysis, reference is made to the benchmark cases outlined in Lemma 1.

3.2.1 Are State Taxes Too High or Too Low?

Each lower level government intends to maximise its inhabitant's utility by choice of its tax rate. Assuming that states engage in Nash competition, the resulting equilibrium is characterised by each state i setting the optimal tax given the decision of all other states. Equilibrium is then defined by symmetric strategies, so that from the maximisation problem as outlined in section 2.5., each state's first-order condition is given by:

$$\begin{aligned}\frac{\partial u}{\partial t} = \frac{\partial \rho}{\partial \tau} &+ \Big(1-\theta\Big)\pi'\Big(\frac{\partial \rho}{\partial \tau}+1\Big) \\ &+ \Gamma_g\Big[k + \Big(tk' + \theta\pi'\Big)\Big(\frac{\partial \rho}{\partial \tau}+1\Big)\Big] \\ &+ \Gamma_G \frac{1}{n} Tk'\Big(n\frac{\partial \rho}{\partial \tau}+1\Big) = 0.\end{aligned} \tag{3.8}$$

From (3.8), it can be inferred that the change in utility of a representative consumer due to a rise in capital taxation in one state depends on the responsiveness of net return on capital to a shift in capital taxation ($\frac{\partial \rho}{\partial \tau}$). As shown in (3.7), the latter is negative (or zero) and will be the closer to zero, the more integrated into the international capital market a country is. A state government accounting for this effect for its constituents tends to neglect that the citizens of every other jurisdiction will be subject to the same drop in ρ, which points to state taxes being too high. On the other hand, capital will be relocated for a given tax hike, such that the other jurisdictions' tax base will rise, which each regional decision-maker does not account for. That positive horizontal externality points towards state taxes being too low. Equation (3.8) is further influenced by the drop in after-tax rental income of a representative

consumer due to a capital tax increase $[(1-\theta)\pi'(\frac{\partial \rho}{\partial \tau}+1)]$, which is in turn a function of the amount of capital employed in the state.

Γ_G and Γ_g denote the marginal valuation of federal and state spending respectively. Diminishing marginal utility leads to them being the smaller, the higher the prevailing level of the respective public good supply. In the case of state public good provision (depicted by the first term in squared brackets), the state government bears in mind the increase in utility as a consequence of a higher level of public good provision due to the additional revenues from the higher tax rate as opposed to the loss of tax base as a consequence of the arbitrage-seeking behaviour of individuals. That is, it accounts for the resulting tax income as opposed to the tax base effect upon evaluating the change in utility derived from regional public good provision. The tax base reduction will be the greater, the higher the rise in state tax, while it is in the same time (less than fully) offset by the resulting overall drop in net return on capital. The utility derived from federal public good supply is affected in such that the federal tax base, which is equivalent to the sum of all states' capital tax base, will diminish due to the state tax hike by capital not only shifting within the federation, but also relocating abroad. The federal tax base will thus decrease, which, in turn, reduces federal expenditures. Each state only accounts for the negative impact of the resulting reduction in federal expenditures with regard to the welfare of its own citizens, which depicts the vertical externality triggered by state policies pointing towards inefficiently high regional tax rates. Since the federal government equally divides its expenditures between the states, only $\frac{1}{n}$th of the federal tax base reduction is incorporated by each state.

That is, an increase in capital taxation in one of the states will trigger several effects. The state government anticipates the impact the higher tax burden has on its citizens' rental income and utility derived from state public good supply. Meanwhile, it neglects the potential effects in other states, thereby triggering a horizontal externality, which points to inefficiently low taxation. In the same time, the optimising state government does not fully account for the drop in federal public good supply caused by the decrease in federal tax base, such that taxation tends to be inefficiently high, as depicted by the second term in (3.8). To understand whether Nash competition among the states leads to inefficient equilibrium taxation, it is considered how a coordinated tax hike by all states affects welfare within the federation. Starting from the described symmetric Nash equilibrium, taxes are simultaneously increased in all states to have

$$\begin{aligned}\frac{\partial u}{n\partial t} = n\frac{\partial \rho}{\partial \tau} + \Big(1-\theta\Big)\pi'\Big(n\frac{\partial \rho}{\partial \tau}+1\Big) \\ + \Gamma_g\Big[k + \Big(tk' + \theta\pi'\Big)\Big(n\frac{\partial \rho}{\partial \tau}+1\Big)\Big] \\ + \Gamma_G T k'\Big(n\frac{\partial \rho}{\partial \tau}+1\Big).\end{aligned} \tag{3.9}$$

The sign of (3.9) is now of interest. If it is zero, it indicates that state taxation is in fact efficient. If it is positive, the horizontal externality is likely to be dominant, whereas (3.9) being less than zero points towards a dominant vertical externality. Subtract (3.8) from (3.9) to have

$$\begin{aligned}\frac{du}{dt} = \frac{\partial u}{n\partial t} - \frac{\partial u}{\partial t} = \overbrace{\Big[1 + \big(1-\theta\big)\pi' + \Gamma_g\big(tk' + \theta\pi'\big)\Big]\big(n-1\big)\frac{\partial \rho}{\partial \tau}}^{\text{horizontal externality}} \\ \underbrace{+\,\Gamma_G T k'\big(n-1\big)\Big(\frac{\partial \rho}{\partial \tau} + \frac{1}{n}\Big)}_{\text{vertical externality}}.\end{aligned} \tag{3.10}$$

With the horizontal externality pointing towards state taxes being too low and the vertical externality pointing towards state taxes being too high, the sign of (3.10) is ambiguous. In order to gain some further insight, the two benchmark cases established in Lemma 1 will again be referred to. Assume first for σ to be zero. As a consequence, (3.7) will be zero, so that (3.10) becomes

$$\frac{du}{dt} = \Gamma_G T k' \frac{n-1}{n} < 0,$$

implying that for a given tax hike, the utility of the representative consumer will fall. Hence, in the case of perfect integration into the international capital market, the vertical externality dominates the horizontal externality.

This result can be easily grasped intuitively: If capital is perfectly mobile, non-arbitrage leads to an increase in state taxes having no impact on rental income of the constituents in the entire federation. Given that the cost of international capital mobility is equal to zero, the reduction in net return on capital due to an increased tax burden can be simply offset by relocating capital abroad, thereby generating returns at the exogenous rate $\overline{r}$. The withdrawal of capital will in the meantime increase capital productivity in the states up to a point at which the net return on capital settles again where it is equal to the world market interest. That is, if capital is perfectly mobile, ρ will equal the world market interest $\overline{r}$ in all states of the federation. Thus, the tax policy in state i has no impact on the net return

on capital and, subsequently, no impact on tax revenue of state j. As a consequence, the horizontal externality will vanish and the vertical externality triggered by capital relocating abroad remains. This dominant bottom-up vertical externality is why the state tax level is inefficiently high in the case of perfect capital market integration. It will be the stronger, the greater k', that is, the greater the tax base reduction due to the increase in capital taxation.

The second case is that of a closed economy, in which capital supply equals capital demand, which implies that all the effects of a tax hike will be fully incurred within the federation. Hence, $\sigma \to \infty$, which implies that $\frac{\partial \rho}{\partial \tau} \to -\frac{1}{n}$ and $k = 1$. It then follows that (3.9) will be equal to $\frac{\partial u}{n \partial t} = -1 + \Gamma_g$, where Γ_g is the elasticity of consumer utility with respect to regional spending. The horizontal externality will then dominate if $\Gamma_g > 1$. So when is this the case?

It follows from (3.8) that

$$\Gamma_g = \frac{1 + (1-\theta)(n-1)}{n + (\frac{t}{f''} - \theta)(n-1)}.$$

Therefore, provided that $n + (\frac{t}{f''} - \theta)(n-1) > 0$, it follows that $\Gamma_g > 1$ if and only if $1 + (1-\theta)(n-1) > n + (\frac{t}{f''} - \theta)(n-1)$. From this inequality it can be inferred that $\Gamma_g > 1$ if $t > 0$, such that, consequently, $\frac{\partial u}{n \partial t} = -1 + \Gamma_g > 0$. Hence, the horizontal externality will dominate if the country is isolated from the international capital market and if $t > 0$. The intuition behind this is straightforward: Given that $\sigma \to \infty$ implies that the economy is closed, the federal tax base becomes independent of the taxes raised by the states, such that the vertical externality will approach zero. With respect to the tax burden, it can be inferred that t will be positive if the tax rate on rental income is sufficiently small. This aspect can be easily grasped by the fact that if rental income is not taxed at all, state governments must raise a tax on capital in order for sufficient income to be generated for the provision of public goods. Under the assumption of decreasing marginal utility of public good provision, the utility derived from the first supplied unit will approach infinity, such that states will always have an incentive to provide at least a certain amount of public goods.

Now, as the preceding discussion showed, for $\sigma = 0$, the vertical externality dominates the horizontal externality, and for $\sigma \to \infty$, the horizontal externality dominates the vertical one. Hence, assuming that σ is continuous, there must exist some optimal degree of integration into the international capital market, such that both externalities offset each other. It can be concluded:

Proposition 1 *Consider a Nash equilibrium with symmetric strategies of the states. Then:*

i. *The vertical externality will dominate the horizontal externality (there will be overtaxation at the state level) if the federation is strongly integrated into the international capital market (σ small).*

ii. *The horizontal externality will dominate the vertical externality (there will be undertaxation at the state level) if σ is large and if state taxes satisfy $t > 0$.*

iii. *There is some $\hat{\sigma} \in [0, \infty)$, such that both externalities will offset each other, if $\sigma = \hat{\sigma}$.*

Remark: $t > 0$ if θ is small.

With reference to Keen and Kotsogiannis (2002), who find that the horizontal externality will dominate the vertical externality at the state level if rental income is fully taxed and $t > 0$, it can be further examined how the discussion will change if the states fully tax rental income in this setting. Substracting n times (3.8) from (3.9) and setting $\theta = 1$ yields

$$\frac{\partial u}{n\partial t} - n\frac{\partial u}{\partial t} = (1-n)\Gamma_g t k' > 0, \tag{3.11}$$

which will obviously be the case only if $t > 0$. Hence, the same result is generated as in Keen and Kotsogiannis (2002), that for fully taxed rents the horizontal externality will dominate the vertical externality at the state level if revenue generated from rental income taxation is not sufficient to finance the provision of a public good.

Proposition 2 *Let states fully tax rental income ($\theta = 1$). Then:*

i. *The horizontal externality dominates the vertical externality if $t > 0$.*

3.2.2 Are Federal Taxes Too High or Too Low?

Similar to the state governments, the federal government intends to maximise the welfare of all individuals within its jurisdiction. If it decides to increase taxes, this will have a direct impact on aggregate taxation in every state, which will in turn each affect the utility of any individual within the federation. Thus, given state taxation as set in a Nash game, the federal government's first order condition is depicted by

$$\begin{aligned}\frac{\partial u}{\partial T} = n\frac{\partial \rho}{\partial \tau} &+ \Big(1-\theta\Big)\pi'\Big(n\frac{\partial \rho}{\partial \tau}+1\Big) \\ &+ \Gamma_g\Big(tk' + \theta\pi'\Big)\Big(n\frac{\partial \rho}{\partial \tau}+1\Big) \\ &+ \Gamma_G\Big[k + Tk'\Big(n\frac{\partial \rho}{\partial \tau}+1\Big)\Big] = 0.\end{aligned} \tag{3.12}$$

Just as before, horizontal and vertical effects point in opposite directions. With state-level taxation as established in the preceding section, two cases can now be distinguished with respect to the assumed strategic behaviour of the federal government.

In the first case, the federal government plays Nash. It will then maximise the utility of each individual by choosing its best-response T, taking the equilibrium state taxes as given. That is, given the shortcomings of state tax-setting, the federal government will impose an optimal capital tax rate.

The second case is characterised by the assumption that the federal government has a first-mover advantage. State and federal governments will then engage in a sequential game, with the latter choosing an optimal T, allowing for the states to subsequently set their taxes in a Nash game while taking T as given. The federal decision-makers must then choose T with respect to $t = t(T)$, which is implicitly defined by the first-order-conditions of the states. They will thus maximise the utility $u = u[T, t(T)]$ of a representative individual by setting

$$\frac{du}{dT} = \frac{\partial u}{\partial t} t'(T) + \frac{\partial u}{\partial T} = 0. \tag{3.13}$$

In (3.13), the first term on the right-hand side denotes the change in utility an individual incurs due to a shift in optimal-response state taxes triggered by a variation in federal taxation. The second term denotes the direct change in utility due to a federal tax hike as depicted by (3.12). Aiming for (3.13) to be fulfilled, the decision-makers might deem it optimal to set a tax by deviating from the optimality condition given by (3.12). The question is then, whether the federal government has an incentive to deviate from its optimal tax rate as defined in (3.12) by choosing a higher or lower level of taxation. In fact, federal tax rates will be chosen lower than in the Nash equilibrium, such that $\frac{\partial u}{\partial T} > 0$ in order for (3.13) to be fulfilled, if $\frac{\partial u}{\partial t} t'(T) < 0$, and vice versa. In other words: If states engage in Nash competition and the federal government acts as a Stackelberg leader, it can be inferred that there is overtaxation (undertaxation) at the federal level if $\frac{\partial u}{\partial t}$ and $t'(T)$ are of opposite (equal) signs. More precisely, if federal and state taxes are strategic substitutes $[t'(T) < 0]$, then federal taxes will be set lower (higher) than in the Nash equilibrium if state taxes are too low (too high). The reverse is the case if state and federal taxes are strategic complements.[6] These results can be easily grasped intuitively: Assuming that state taxes are too low, the optimising federal government will aim to offset the state-induced inefficiencies by choosing a higher (lower) federal tax than in the Nash equilibrium if state and federal taxes are strategic complements (substitutes) with the goal to provide an incentive for states to subsequently set their tax rates such that the consolidated tax burden will be efficient.

Propositions 3 and 4 summarise the discussion:

Proposition 3 *Let federal and state taxes be strategic substitutes [ie. $t'(T) < 0$]. Then, in a Stackelberg equilibrium with symmetric strategies of the states:*

[6] Note for the sake of completeness that federal taxation will be chosen efficiently as in the Nash equilibrium if state taxes are efficient ($\frac{\partial u}{\partial t} = 0$).

i. *Federal taxes are higher than in a Nash equilibrium, if the vertical externality dominates the horizontal externality at the state level (state taxes being too high).*

ii. *Federal taxes are lower than in a Nash equilibrium, if the horizontal externality dominates the vertical externality at the state level (state taxes being too low).*

Proposition 4 *Let federal and state taxes be strategic complements [ie. $t'(T) > 0$]. Then, in a Stackelberg equilibrium with symmetric strategies of the states (ie. $t_i = t$ for all i):*

i. *Federal taxes are higher than in a Nash equilibrium, if state taxes are too low (the horizontal externality dominates the vertical externality).*

ii. *Federal taxes are lower than in a Nash equilibrium, if state taxes t_i are too high (the vertical externality dominates the horizontal externality).*

3.2.3 Numerical Example

The results generated in the previous sections are now illustrated with the help of a numerical example. Let

i. $f(k) = k^{\alpha}$,
   such that $f' = \alpha k^{\alpha-1}$ and $f'' = \alpha(\alpha-1)k^{\alpha-2}$

ii. $\pi = (1-\alpha)k^{\alpha}$

iii. $\dfrac{\partial \rho}{\partial \tau} = \dfrac{\sigma}{n\alpha(\alpha-1)k^{\alpha-1} - n\sigma}$

iv. $\Gamma(g, G) = \beta(lng + lnG)$
   such that $\Gamma_g = \frac{\beta}{g}$ and $\Gamma_G = \frac{\beta}{G}$.

Let further $\alpha = 0.25,\ \beta = 0.1,\ n = 10,\ r = 0.125.$

Simulation of a symmetric Nash equilibrium yields the numerical results as depicted in Table 1.[7] The simulation distinguishes three cases with respect to capital market integration, that is, the two benchmark cases of perfect integration ($\sigma = 0$) and an isolated country (with $\sigma = 10^9$), as well as the case of 'optimal' capital market integration, in which the proposed value for σ is realised for which the externalities offset each other.

[7]Note that in Table 1 an asterisk denotes the best response in Nash competition, while the superscript 'opt' denotes the optimal values the parameters should take for an efficient solution to be reached.

σ	k^*	t^*	T^*	k^{opt}	t^{opt}	T^{opt}
0	1.176	0.054	0.042	1.352	0.037	0.037
$0.02 = \hat{\sigma}$	0.980	0.066	0.066	0.980	0.066	0.066
10^9	1.000	0.068	0.100	1.000	0.100	0.100

Table 3.1: Nash Simulation

Table 1 shows that $k = 1$ for a high value of σ. That is, if the economy is closed, all capital will be employed inside the federation. In comparison to the optimal values, state taxes will be too low. By contrast, if the country is perfectly integrated into the international capital market ($\sigma = 0$), the country is a net importer of capital and state taxes will be excessively high. In both cases, the federal government is assumed to play Nash and set its tax optimal given state taxation. If σ takes its optimal value, the federation is a net exporter of capital and the realised taxes coincide with their optimal values.

If the federal government acts as a Stackelberg leader, the simulation will yield the results as displayed in Table 2, distinguishing the same three cases for σ as above.[8]

σ	t^*	T^*	$T^s(sub)$	$T^s(com)$	t^{opt}	T^{opt}
0	0.054	0.042	0.052	0.037	0.037	0.037
$0.02{=}\hat{\sigma}$	0.066	0.066	0.066	0.066	0.066	0.066
30	0.067	0.094	0.068	0.095	0.094	0.094

Table 3.2: Stackelberg Simulation

States are assumed to play Nash by setting t^*. Further, T^* depicts the choice of tax rate for the federal government in a Nash game. If the federal government has a first-mover advantage and state and federal taxes act as strategic substitutes, the realised federal tax will fall short of its optimal value T^*, if states are excessively low, and vice versa. On the contrary, in the case of strategic complementarity, federal taxation will be (slightly) too high, if state taxes are excessively low, and vice versa.

The results correspond with what the theoretical model suggested. That is, the likely effects of fiscal externalities are largely dependent on the assumptions about the strategic behaviour of state and federal governments as well as on the assumptions about the relative behaviour of federal and state taxes. The degree of international capital market integration

[8]Note that in Table 2 the superscript 'S' refers to the solution for the federal government acting as a Stackelberg leader. The extension '(sub)' refers to the case of strategic substitutability of state and federal taxes, while the extension '(com)' denotes that federal and state taxes are strategic complements. For reference, the optimal and the Nash solutions are given as well.

functions by curbing the extent to which a change in τ causes a vertical or a horizontal externality respectively.

3.3 Summary

The previous discussion showed that the inefficiencies of taxation in a federal system are potentially related to the extent to which a country is integrated into the international financial market. It was shown that a strong degree of integration will lead to the vertical externality dominating the horizontal one at the state level. State taxes will thus be too high. The horizontal externality will, on the other hand, dominate at the state level, if the economy has only limited access to the international capital market. That is, a high degree of integration into international capital markets functions by reducing the relative impact of the horizontal externality in such that the net return on capital is determined more directly by the exogenous world market interest. At the same time, the vertical externality will become increasingly important by tax base being shifted more flexibly abroad, thereby reducing the federal tax base. By endogenising the degree of capital market integration it was shown that there exists a specific value for which both externalities offset each other. Hence, a policy balance with respect to the openness of an economy may in fact incur an overall efficient level of taxation. Given that the model is a variation of Keen and Kotsogiannis (2002), the results demonstrate that the recognition of the degree of international capital market integration functions the same as the interest rate elasticity of savings.

The results can be further specified with respect to the assumptions about the strategic behaviour of the federal government. That is, given the above results, a Nash federal government will choose tax rates efficiently given state taxation. If the federal government has a first-mover advantage, the result hinges on the efficiency of state taxes as well as on the characterisation of federal and state taxes as strategic substitutes or complements. In the former case, an inefficiently low state capital tax implies that federal taxation will be lower than in the Nash equilibrium, and vice versa. In the latter case, federal taxes will be higher than in the Nash equilibrium if the rate at which the states tax capital is inefficiently low.

The applied model yields a concise depiction of the impact of international capital market integration on optimal taxation strategies of state and federal governments. Obviously, the analysed structure is subject to some limitations, especially given the simplified model world economy considered.

For one, the model does not allow for any heterogeneity among the citizens. The consideration is limited to a single representative consumer, which allows for efficiency considerations only. The federal government does not differentiate with respect to indigence or structural

differences. Yet, heterogeneity in preferences and needs within a state or a federation[9] may distort the results in such that the federal government distributing its wealth evenly across the states may itself create inefficiencies. Not allowing for heterogeneity in fact enables for some simplifying assumptions made in the model. The same holds for the recognition of heterogeneity across states. What is more, by dropping the assumption of symmetric cost functions, an analysis of the interaction of high and low risk regions could be a topic for further model specification.

An assumption in the discussion of federal taxation is the prevalence of complete and perfect information of all players. The extension of the model to decisions under uncertainty might yield meaningful results. Moreover, how would the situation change if the states did not simply take the federal decision as given, but had a chance to react to the tax set by the federal government? The overall structure of the tax system is kept fairly concise. More complex tax instruments, such as the possibility of tax deductibility or earned income tax credits, which could be of some relevance to the real world, are not considered.

While possible interactions of the different federal levels are incorporated into the model, the latter is restricted to a single-economy analysis. No attention is paid to possible policy changes abroad triggered by a change in capital taxation at home. An extension to the model could stem from the analysis of a two- or multiple-economy world, into which the strategic interaction between countries is incorporated. The federal government itself could thus react to tax competition with other countries, thereby triggering another horizontal externality. It is this last set of objectives which the subsequent chapter is going to address.

[9] As modeled by Rizzo (2005), for example.

Chapter 4

Tax Competition and Federal Design

A multitude of papers exists assessing the effects of horizontal competition in terms of several unitary states engaging in competition with each other. Papers assessing federal taxation have mainly focused on the interrelation of vertical and horizontal externalities within one country, while only a few approaches characterise the interaction of two federal states or a federal and a unitary state.[1] What appears to be missing is an integrated approach that systematically compares within one distinct setting, how a change in the institutional design of two countries competing for mobile tax base influences tax rate choices. The intention is to thereby give a systematic overview of the occuring changes that are not affected by differences in the model specifications.

In that respect, the approach pursued in this chapter is the following: Instead of adding another layer to the existing models of federal taxation, it gives an overview of how tax rates set by two countries competing for mobile capital will change with different federal structures. The aim is to strip the applied model of all unnecessary complexity, in order to keep it as simple as possible and to add clarity to the results. A sequential-move game with revenue-maximising Leviathan governments[2] is examined, which, to the best of knowledge, has not been treated in the existing literature. A baseline scenario of two unitary states competing over mobile capital is first considered, where, obviously, only horizontal effects occur. The model is then extended to a second scenario in which one country is unitary and another is a federation. In a third step, the analysis is carried out for the case of two federations interacting in the very same setting as before. The aim is to verify the classic

[1] These approaches each differ in their model specifications, such as the assumptions with regard to the extent to which each jurisdictional level sees through the intentions of its competitors. See section 2.1.3 for more detail.

[2] The consideration of a Leviathan-government as opposed to a welfare-maximising decision-maker is, of course, subject to discussion. See section 2.2.4 for further detail. From a theoretical point of view, the Leviathan approach yields a relatively easy to handle model with fairly clear-cut results, which makes it quite attractive, particularly with regard to the multiple-layer interactions depicted by two competing federations.

result of Leviathan governments being restrained by tax competition with other countries and to describe the respective externalities at work in each setting and the efficiency of chosen tax rates.[3] The impact of a tax hike in one jurisdiction on revenues in other jurisdictions is taken into consideration as well as that of coordinated tax hikes on individual and consolidated revenues.

The relevance of this study becomes apparent by considering the European Union, as discussed in the introduction. With free capital mobility between member states, it is a relevant question whether it will make a difference for a country such as Germany to be competing in tax rates with another federal country or a unitary country such as France. From a different perspective, with respect to a possible further enlargement, it might be a different thing for Germany or France when new member states join the European Union with an institutional structure that is unitary or federal. What is more, the political reality frequently sees member states acting as independent entities aiming to maximise their own revenue, while neglecting to a large degree the effect their own choices have on other member states. That is, another relevant question to ask with respect to the European Union is whether EU-wide budgets would profit from further integration and coordination between member states, and what role intensified capital tax competition plays in that context.

This chapter is setup as follows: The next section gives a general overview of the model, while sections 4.2, 4.3, and 4.4 deal with the analysis of the three cases outlined above, that is, two unitary countries (4.2), a unitary and a federal country (4.3) and two federal countries (4.4) competing over capital tax base. Section 6 concludes by summarising and discussing the results and possible policy implications.

4.1 The Model

A very brief overview of the basic model will now be given, which will be further specified in each of the following sections. The analytical framework is set up by two countries A and B competing for mobile capital with each other. Country A (B) is inhabited by n (m) individuals, who are immobile and each endowed with one unit of perfectly mobile capital.[4] Individuals choose to invest either in country A or country B, while no cost is faced for

[3] The efficiency of tax rates, that is, in such that from the perspective of a Leviathan government, a tax will be optimal if it maximises revenues. Obviously, it will be inefficiently high, if revenues rise by a drop in the respective tax rate, or too low in the reverse case. See section 2.2.4 for further detail.

[4] These two assumptions apply to the case of the European Union, where capital moves freely between member states. The mobility of citizens is - by law - also granted (except for the recently joined member states, where labour market protectionism led to the mobility of the labour force being somewhat limited, at least until 2014 [see European Union (2009)], yet given language and (to some extent) cultural barriers, labour mobility is significantly less pronounced, which corresponds with the assumptions of the model.

international investment.

The capital available in each jurisdiction is used for production, where a constant returns to scale production function is considered, which is identical in all jurisdictions and at least twice continuously differentiable. It displays diminishing returns to scale in its mobile input factor, capital. Per-capita production in country $C = A, B$, denoted as y_{iC}, is then determined by

$$y_{iC} = f(k_{iC}) = f'(k_{iC})k_{iC} + \pi_{iC},$$

where k_{iC} is the per-capita amount of capital employed in country C. Assuming that firms are profit maximisers, $f'(k_{iC})k_{iC}$ is then the capital income per head in country C. π_{iC} denotes the rental income accruing to each consumer i living in C from an immobile factor. Hence, in country C

$$\pi_{iC} = f(k_{iC}) - f'(k_{iC})k_{iC},$$

from which follows that

$$\pi'_{iC} = -k_{iC}. \tag{4.1}$$

Each individual derives utility from consumption financed by individual rental income π_i taxed at the exogenous rate θ[5] and the return on capital investments, which is taxed at a specific rate by each jurisdiction. Hence, they aim to maximise the net return on capital investments $\rho = f'(k_{iC}) - \tau_{iC}$, where $f'(k_{iC})$ is the marginal product of per-capita capital invested in each country C and τ_{iC} is the total tax burden imposed on capital in each jurisdiction, which will all be further specified in the proceeding sections. It follows that the amount of investments in each country is a function of the net return on capital and the capital tax rate each jurisdiction chooses. That is, $k_{iC} = k_{iC}(\rho + \tau_{iC})$, such that, applying the implicit function theorem,

$$k'_{iC} = \frac{1}{f''(k_{iC})} < 0.$$

4.2 Two Unitary Countries

The case of two unitary countries A and B[6] competing for capital will first be considered. The setup is solved by backward induction as a two-stage game in which both governments act

[5] θ may be divided into a regional (δ) and a federal (Δ) share, such that $\theta = \delta + \Delta$ in a federation.

[6] Here, obviously, $n = 0$.

as Nash players simultaneously choosing their tax rate taking that of the other jurisdiction as given, while the individuals subsequently make their investment decisions. Each of the following subsections characterises one particular stage of the game. Production is defined as in section 4.1.

4.2.1 Capital Investment

Each individual has the option of investing capital at home or abroad, facing a net return given by

$$\rho = f'(K_C) - T_C,$$

in which $f'(K_C)$ denotes the marginal product of capital invested and T_C is the corresponding tax rate levied within the jurisdiction of country A or B respectively. Given perfect capital mobility, non-arbitrage will lead to the net return on investment being equal across both countries, such that

$$\rho = f'(K_A) - T_A = f'(K_B) - T_B$$

implying that $\rho = \rho(T_A; T_B)$. Total capital supply is given by

$$n + m = K_A(\rho + T_A) + K_B(\rho + T_B)$$

with $\rho = \rho(T_A; T_B)$, from which follows that:

$$\frac{\partial \rho}{\partial T_A} = -\frac{\frac{\partial K_A}{\partial T_A}}{\frac{\partial K_A}{\partial \rho} + \frac{\partial K_B}{\partial \rho}} < 0 \qquad \in [-1; 0),$$

$$\frac{\partial \rho}{\partial T_B} = -\frac{\frac{\partial K_B}{\partial T_B}}{\frac{\partial K_A}{\partial \rho} + \frac{\partial K_B}{\partial \rho}} < 0 \qquad \in [-1; 0).$$

That is, the net return on capital in one jurisdiction will fall for a corresponding tax hike. It will fall less than one-to-one (except if capital supply is fixed), given that the reduction in capital investment due to the lower net return will be accompanied by a higher productivity of capital investments, just as described in section 3.1.3.

4.2.2 Government Objectives

For country A, the objective can be described the following way:

$$\max_{T_A} \; R_A = T_A K_A(\rho + T_A) + \theta \pi_A(\rho + T_A),$$

that is, it aims to maximise revenues R_A generated from the taxation of capital and rental income by choice of the tax levied on capital within its jurisdiction. Each government plays Nash, that is, upon choosing its tax rate, it takes the other country's tax as given. Bearing in mind that $\rho = \rho(T_A; T_B)$ the first-order condition of country A's government is described by

$$\frac{\partial R_A}{\partial T_A} = K_A(\rho + T_A) + T_A K'_A(\frac{\partial \rho}{\partial T_A} + 1) + \theta \Pi'_A(\frac{\partial \rho}{\partial T_A} + 1) = 0. \tag{4.2}$$

That is, A will take into account that its tax rate choice will have a direct tax income effect, as depicted by the first term on the right hand side of (4.2). The second and the third term imply that the government will also incur a change in tax base. For one, capital tax base will be reduced by investors withdrawing capital and investing elsewhere instead as a consequence of the higher tax burden. On the other hand, the resulting shift in overall net return on capital (due to higher tax rates and the resulting reduction in capital productivity in the other region triggered by the relocation of investment) will again attenuate the capital tax base effect. The same applies to the reduction in rental income. Yet, each government accounts for these effects only insofar as its own tax base is concerned, while not taking into account that it triggers a positive horizontal externality affecting the tax base by the neighbouring country. For simplicity, using (4.1), equation (4.2) can be rewritten as

$$\frac{\partial R_A}{\partial T_A} = K_A(\rho + T_A) + (T_A K'_A - \theta K_A)(\frac{\partial \rho}{\partial T_A} + 1)] = 0, \tag{4.3}$$

where the first term on the right hand side is the tax revenue effect and the second term is the tax base effect. Given that country A's optimal choice of tax rates implicitly depends on the tax rate chosen by the other country's government (and the same reasoning holds for the government in country B), equilibrium is characterised by $T_A = T_A(T_B)$ and $T_B = T_B(T_A)$, such that $\rho = \rho(T_A(T_B); T_B(T_A))$. In order to determine whether from the perspective of the Leviathan government tax rates thus chosen will be too high or too low in equilibrium, a coordinated tax hike of both countries is considered, whose effect on A's revenues is given by

$$\frac{\partial R_A}{\partial (T_A + T_B)} = K_A(\rho + T_A) + (T_A K'_A - \theta K_A)(\frac{\partial \rho}{\partial T_A} + \frac{\partial \rho}{\partial T_B} + 1)]. \tag{4.4}$$

To gain insight on the sign of (4.4), equation (4.3), which is zero, is substracted from (4.4) to have

$$\frac{\partial R_A}{\partial(T_A + T_B)} - \frac{\partial R_A}{\partial T_A} = (T_A K'_A - \theta K_A)(\frac{\partial \rho}{\partial T_B}) > 0. \tag{4.5}$$

The analogous expression holds for country B. That is, revenues could be increased by a coordinated tax hike in both countries, given that governments do not take into account the horizontal effects triggered by their choice of tax rates. That corresponds with the classic result that horizontal competition restrains Leviathan governments in their revenue-maximising intentions.

4.3 Unitary and Federal Country

With the interaction of a unitary and a federal country the situation becomes slightly more complex. Country A is divided into n regions each inhabited by a single consumer endowed with one unit of capital. Country B is unitary and inhabited by m individuals possessing one unit of capital each.[7] Inhabitants are assumed to be evenly distributed across their home jurisdiction. The situation is analysed by backward induction in a three-stage game. First, the governments at the federal level set their tax rates. They act as a Stackelberg leader towards the regional governments while engaging in Nash competition with each other. Subsequently, the regional governments in country A choose their tax rates as Nash players, bearing in mind the tax rates set by the federal governments. Finally, the individuals decide where to invest the capital available to them.

4.3.1 Capital Investment

Individuals derive utility from consumption, which is financed by the net return on investment plus the after-tax rental income. The utility maximising individual living in country A then has the choice of investing at home, in any other region of the federation or abroad (in country B, that is). Likewise, each inhabitant of country B chooses to invest inside his home country or abroad, in any of A's regions. Hence, total capital supply in one region of country A is given by

$$k_{Ai} = k_{AiNAT} + k^*_{iB},$$

[7] To be precise: For symmetry reasons, B is assumed to be divided into m regions each inhabited by one individual, yet the taxation of capital is centralised, such that one uniform national tax rate is levied.

where $i = 1, \ldots, n$ stands for each region in country A, k_{AiNAT} denotes the amount of capital available in A that is actually invested in region i, k^*_{iB} depicts the amount of capital available in B that is invested in region i of country A.

Total capital supply in any of B's regions[8] is given by

$$k_B = k_{BNAT} + k^*_A,$$

where k_{BNAT} denotes the amount of capital available in B that is actually invested in country B per region, k^*_A depicts the amount of capital available in A that is invested in each region of country B. Total investments in B can be described by $K_B = nk_B$.

All capital invested inside region i of country A will be subject to the consolidated tax rate $\tau_{Ai} = t_{Ai} + T_A$, where the former denotes the tax levied by region i and the latter denotes the tax levied by the federal government in country A.[9] All capital invested inside country B will be taxed at rate T_B. Hence, the investment decisions for one individual living in A or B respectively can be described the following way:

$$\begin{aligned}
\rho_{ANAT} &= f'(k_{Ai}) - \tau_{Ai}, \\
\rho_{AINT} &= f'(k_B) - T_B, \\
\rho_{BNAT} &= f'(k_B) - T_B, \\
\rho_{BINT} &= f'(k_{Ai}) - \tau_{Ai},
\end{aligned}$$

in which ρ_{ANAT} denotes the net return to capital an individual living in country A generates by investing in A, ρ_{AINT} is the net return an individual living in A generates from investing abroad, that is, in country B. Analogously, ρ_{BNAT} is the net return to an individual living in B from investing inside his home country and ρ_{BINT} is the net return for an individual from B investing abroad. Capital invested in a region of A will then earn its marginal product, which depends on the total amount of capital supplied in that region, that is, $f'(k_{Ai})$, net the tax burden applicable, that is, τ_{Ai}. Capital invested in B will earn its marginal product depending on the total amount invested in B net the respective tax, which is T_B. Given decreasing returns to scale, non-arbitrage must lead to the net return on capital being equal across regions[10] and countries, such that $\rho = f'(k_{Ai}) - \tau_{Ai} = f'(k_B) - T_B$, which implies that $\rho = \rho(t_{i=1,\ldots,n}; T_A; T_B)$.

[8] Given that these are assumed to be symmetric and only subject to a uniform central-level tax, it is possible to abstain from an index for each region.

[9] We assume that the federal government will set one uniform tax across its jurisdiction (which does not have to be the case, as Wrede (2002) points out).

[10] Which is also why it is possible to write ρ_{ANAT} without an index in the first place.

Total capital supply is given by

$$n + m = \sum k_{Ai}(\rho + \tau_{Ai}) + K_B(\rho + T_B),$$

with $\rho = \rho(t_{i=1,\dots,n}; T_A; T_B)$, from which follows that:

$$\frac{\partial \rho}{\partial t_{Ai}} = -\frac{\frac{\partial k_{Ai}}{\partial t_{Ai}}}{\sum \frac{\partial k_{Ai}}{\partial \rho} + \frac{\partial K_B}{\partial \rho}} \qquad \in [-1; 0),$$

$$\frac{\partial \rho}{\partial T_A} = -\frac{\sum \frac{\partial k_{Ai}}{\partial T_A}}{\sum \frac{\partial k_{Ai}}{\partial \rho} + \frac{\partial K_B}{\partial \rho}} \qquad \in [-1; 0),$$

$$\frac{\partial \rho}{\partial T_B} = -\frac{\frac{\partial K_B}{\partial T_B}}{\sum \frac{\partial k_{Ai}}{\partial \rho} + \frac{\partial K_B}{\partial \rho}} \qquad \in [-1; 0),$$

for which the same reasoning holds as in the previous section and where from the first two it can be inferred that

$$\frac{\partial \rho}{\partial T_A} = n \frac{\partial \rho}{\partial t_{Ai}}. \tag{4.6}$$

4.3.2 Government Objectives

The Leviathan governments in each jurisdiction aim to maximise tax revenues by choice of the respective tax rate, while taking into account the likely tax base reactions to given tax policies.

State Level

The state governments $i = 1, \dots, n$ in country A hold the following objectives:

$$\underset{t_{Ai}}{max} \; r_i = t_{Ai} k_{Ai}(\rho + \tau_{Ai}) + \delta\pi(\rho + \tau_{Ai})$$

Each state will set its tax rate taking those of all other states and the national jurisdictions (that act as Stackelberg leaders) as given, such that $t_{Ai} = t_{Ai}(t_{j \neq i=1,\dots,n-1}; T_A; T_B)$. Using (4.1), each state's first-order-condition is given by

$$\frac{\partial r_{Ai}}{\partial t_{Ai}} = k_{Ai}(\rho + \tau_{Ai}) + b'_{iA}(\frac{\partial \rho}{\partial t_{Ai}} + 1) = 0. \tag{4.7}$$

where $b'_{iA} = (t_{Ai}k'_{Ai} - \delta k_{Ai}) < 0$ denotes the change in regional tax base due to a respective tax hike, which follows the same argumentation as in the previous section. It can be inferred from (4.7) that each regional government will again account for the direct tax revenue effect generated by choice of its tax rate (as depicted by the first term on the right hand side) as well as the tax base effect depicted by the second term in (4.7). It neglects that the latter will raise revenues in the other jurisdictions, thereby triggering a positive horizontal externality. Each state government further neglects that the federal tax base will possibly be negatively affected by capital not only relocating from one region to another within the federation, but also being shifted to country B. Thereby, the local entities will trigger a vertical externality which points towards state taxes being inefficiently high with respect to consolidated revenues. The setup of the states implies that equilibrium will be characterised by a symmetric solution in which all states set the same tax. The effect of a coordinated tax hike of all states on local government revenue is depicted by

$$\frac{\partial r_A}{n\partial t_A} = k_A(\rho + \tau_A) + b'_A(n\frac{\partial \rho}{\partial t_A} + 1). \tag{4.8}$$

In order to gain insight on the sign of (4.8), equation (4.7) is substracted from (4.8), which yields

$$\begin{aligned} \frac{dr_A}{dt_A} = \frac{\partial r_A}{n\partial t_A} - \frac{\partial r_A}{\partial t_A} &= k_A(\rho + \tau_A) + t_A k'_A(n\frac{\partial \rho}{\partial t_A} + 1) \\ &\quad - \delta k_A(n\frac{\partial \rho}{\partial t_A} + 1) - k_A(\rho + \tau_A) \\ &\quad - t_A k'_A(\frac{\partial \rho}{\partial t_A} + 1) + \delta k_A(\frac{\partial \rho}{\partial t_A} + 1) \\ &= b'_A(n-1)\frac{\partial \rho}{\partial t_A} > 0. \end{aligned} \tag{4.9}$$

That is, state revenues would increase as a consequence of a coordinated tax hike. This points towards state taxes being set inefficiently low (that is, not revenue-maximising) from the prespective of the regional Leviathan governments. It is in line with the results from section 4.2 and implies that the tax base effect from investors relocating their capital abroad is offset by the revenue effect.

Federal Level

Given the symmetric state equilibrium, the first-mover federal government's objective in A is

$$\underset{T_A}{max}\ R_A = n[T_A k_A(\rho + \tau_A) + \Delta\pi_A(\rho + \tau_A)].$$

It bears in mind that regional governments will make their tax choice dependent on what rate was previously set at the federal level and takes the tax rate of the federal government in B as given. It follows that

$$\rho = \rho(t_{i=1,\ldots,n}(t_{j\neq i=1,\ldots,n-1}; T_A; T_B); T_A; T_B)$$

and its first-order condition will be given by

$$\frac{\partial R_A}{\partial T_A} = n[k_A(\rho + \tau_A) + B'_A(\frac{\partial \rho}{\partial T_A} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial T_A} + 1 + \frac{\partial t_A}{\partial T_A}) = 0, \tag{4.10}$$

in which $B'_A = (T_A k'_A - \Delta k_A) < 0$ is the change in A's federal tax base due to a respective tax hike, analogous to the previous section. It follows from (4.10) that the federal government in A will perfectly anticipate how its tax will affect the optimal choice of its regional governments and the corresponding impact on its tax base. It neglects the positive effect on tax base in B, thereby triggering a horizontal externality, which will become apparent further down.

Country B's government aims to satisfy

$$\underset{T_B}{max}\ R_B = n[T_B k_B(\rho + T_B) + \theta\pi_B(\rho + T_B)],$$

for which also $\rho = \rho(t_i = 1, \ldots, n(t_{j\neq i=1,\ldots,n-1}; T_A; T_B); T_A; T_B)$. That is, it will perfectly anticipate that its own tax has an impact on the tax rate set by the regions in the neighbouring country.[11] The first-order-condition is given by

[11] Within the existing literature on fiscal federalism, the assumptions made with respect to the extent to which one jurisdiction takes into account its competitors' reaction functions differ between the models and are subject to discussion. Of course, they essentially drive the generated results. In an early contribution, Keen (1998) examines taxation in a single federation where both levels of government are myopic. In a later paper, Keen and Kotsogiannis (2002) model a federation in which the decision-makers at each level are perfectly aware of the budget constraints at the other level. In a setting where two federations compete with each other, Wrede (2002) assumes for both levels in each federation to ignore the budget constraint of the other jurisdictions. Grazzini and Petretto (2007) analyse the interaction of a federal and a unitary country, where the federal-level government in one country is assumed to be perfectly aware of the impact its own tax rate has on the taxes set by its regions. Also, the government in the unitary country takes into account the tax rate set at the neighbouring country's federal level, but is ignorant of the interdependence with regional tax rates in that country. (See also section 2.1 for further detail on the respective models.) From this study's perspective, it is, however, just as likely that governments of one country do take the tax rates

$$\frac{\partial R_B}{\partial T_B} = n[k_B(\rho + T_B) + B'_B(\frac{\partial \rho}{\partial T_B} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial T_B} + 1 + \frac{\partial t_A}{\partial T_B})] = 0, \tag{4.11}$$

where $B'_B = (T_B k'_B - \theta k_B) < 0$ is the change in B's federal tax base and works the same way as (4.10).

Equilibrium is characterised by $T_A = T_A(t_{i=1,\dots,n}(t_{j\neq i=1,\dots,n-1}; T_A; T_B); T_B)$ and $T_B = T_B(t_{i=1,\dots,n}(t_{j\neq i=1,\dots,n-1}; T_A; T_B); T_A)$, and further

$$\rho = \rho[t_{i=1,\dots,n}(t_{j\neq i=1,\dots,n-1}; T_A; T_B); T_A(t_{i=1,\dots,n}(\circ); T_B); T_B(t_{i=1,\dots,n}(\circ); T_A)] \tag{4.12}$$

In order to find out whether both governments will set their tax rates too high or too low in equilibrium, a coordinated tax rate hike between the two federal governments is again considered, which yields for country A:

$$\frac{\partial R_A}{\partial(T_A + T_B)} = n[k_A(\rho + \tau_A) + B'_A(\frac{\partial \rho}{\partial T_A} + \frac{\partial \rho}{\partial T_B} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial T_A} + 1 + \frac{\partial t_A}{\partial T_A})]. \tag{4.13}$$

In order to determine the sign of (4.13), equation (4.10), which is zero, is substracted from (4.13) to gain

$$\frac{\partial R_A}{\partial(T_A + T_B)} - \frac{\partial R_A}{\partial T_A} = n[B'_A\frac{\partial \rho}{\partial T_B}] > 0. \tag{4.14}$$

That is, given the setup, federal revenues would increase following a coordinated tax hike at the federal level. Since the federal governments perfectly anticipate the reactions at the regional level, the result generated here is equivalent to that when only two unitary countries are competing. Unlike the case where only one isolated federal state is analysed,

of neighbouring 'foreign' regions into account, irrespective of the jurisdictional level at which this rate is set. Take the case of corporate taxation in France and Germany: it is straightforward to argue that the French government, if it takes German corporate tax rates into account, will be aware of the effective tax burden and not limit its view to the federal level. What is more, the French government may be even more aware of the tax rates set in the different regions, particularly in those sharing borders with France. This model may be restricted to symmetric equilibria across regions, yet the previous point still contributes to the validity of the discussed assumption. Hence, while in general it may be a somewhat valid assumption for governments to be entirely ignorant of tax reactions in other jurisdictions, this approach is built on the perception that if governments are assumed to be aware of each other's tax rates, then it must be mutually corresponding and should not be restricted to decisions taken at the same level. This reasoning will be applied in what follows. Note, however, that possible third- or higher-order interactions in tax rates are assumed to be negligible.

the optimising Stackelberg federal government neglects the horizontal effect triggered by its own tax rate on the neighbouring country's tax revenues. Hence, the federal governments in their turn cause a horizontal externality leading to tax rates being chosen such that they are not revenue-maximising. The same holds, obviously, from the perspective of government B.

4.3.3 Cross-Jurisdictional Effects

What is interesting with respect to the analysis of government behaviour in this setting are the effects triggered by a tax hike in one jurisdiction, as discussed earlier, on revenues at other levels or in other countries. In order to characterise these, the approach taken by Grazzini and Petretto (2007) and also suggested by Wrede (2002) is followed. That is, the impact of a tax hike in one jurisdiction on revenues of another jurisdiction can be determined by assessing the change in equilibrium responses of that other jurisdiction. For the state level, $t_{Ai} = t_{Ai}(t_{j\neq i=1,\ldots,n-1}; T_A; T_B)$ for all i in the federation. Using (4.12), the effect of a change in the tax rate at the federal level on regional budgets is then given by

$$\frac{dr_A}{dT_A} = n\frac{\partial t_A}{\partial T_A}k_A(\rho+\tau_A) + b'_A(\frac{\partial \rho}{\partial T_A} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial T_A} + 1 + n\frac{\partial t_A}{\partial T_A}). \tag{4.15}$$

Here, it can be seen that a tax hike at the federal level in A will in turn affect the optimal choice of tax rates at the regional level ($\frac{\partial t_A}{\partial T_A}$). That will have an impact directly on tax revenues as denoted by the first term on the right hand side of (4.15). Its sign depends on the assumptions made with respect to the strategic relationship between regional and federal tax rates. By assuming complementarity (ie. $\frac{\partial t_A}{\partial T_A} > 0$), it will be positive, and negative otherwise.[12] The second term denotes the tax base effect triggered by the tax hike at the federal level. Given that b'_A is clearly negative, its sign hinges on the last term in brackets. On the one hand, the tax base will be reduced as a consequence of the higher consolidated tax rate triggered by the federal hike and the resulting shift in optimal tax rates at the regional

[12]The strategic relationship between tax rates of different jurisdictions is of course subject to discussion. The reaction curve estimated for horizontal interaction tends to be upward-sloping (see section 2.2.2), such that for cross-national and horizontal effects it is a fair approach to assume strategic complementarity. In a federal setting, it is, however, not unlikely for the federal government to set its tax rate optimal given state taxation, which might include lowering its tax as a response to a state-level tax hike in order for a consolidated tax burden not to be exceeded - especially if the federal government bears the federation's relative position to other countries in the international context in mind. That would point towards the assumption of federal and regional governments being strategic substitutes. The empirical evidence for federal interaction is mixed, as discussed in section 2.2.3. In this case, with the consideration of revenue-maximising Leviathan governments focusing only on their own budgets, the assumption of strategic complementarity might be sensible. In what follows, the focus will lie on the case of strategic complementarity, but the implication of different assumptions will be highlighted where applicable.

level $(1 + n\frac{\partial t_A}{\partial T_A})$. On the other hand, these shifts will each reduce the overall net return on capital, which will attenuate the direct negative tax base effect due to the tax hikes. That is, the impact of a federal tax increase on regional revenues is not necessarily negative. It depends on the strategic interaction of regional and federal tax rates. The obvious effect is the negative top-down externality resulting from the loss of regional tax base due to the higher consolidated tax burden. Then again, if, as a response to the federal hike, the regions choose to raise their tax rates (that is, if $\frac{\partial t_A}{\partial T_A}$), they will generate a positive tax revenue effect and at the same time further augment the tax base effect. The relative size of these two will then drive the sign of (4.15). If it is greater than zero, it points towards federal tax rates being inefficiently low. If it is less than zero, it points towards the vertical externality leading to federal tax rates being inefficiently high from the perspective of the revenue-maximising regional Leviathan government. In order to determine the sign of (4.15), applying (4.6), it can be rewritten as

$$\frac{dr_A}{dT_A} = \frac{\partial t_A}{\partial T_A} k_A(\rho + \tau_A) + b'_A(\frac{\partial \rho}{\partial T_A}(1 + \frac{\partial t_A}{\partial T_A}) + 1 + n\frac{\partial t_A}{\partial T_A}). \tag{4.16}$$

Here, it becomes clear that the last term in brackets will be unambiguously greater than zero, if tax rates are strategic complements, given that $0 < \frac{\partial \rho}{\partial T_A} < -1$ and $1 + n\frac{\partial t_A}{\partial T_A} > 1 + \frac{\partial t_A}{\partial T_A}$. Hence, the two terms on the RHS of (4.16) have opposite signs, such that the total effect depends on the relative magnitude of the tax income effect generated from the shift in regional level tax rates, as opposed to the tax base effect triggered from the reaction of investors to the changed investment conditions in the respective jurisdiction. That is, depending on whether the reaction of tax rates is assumed to be more elastic than the reaction of the tax base towards a change in net return on capital, one effect will outweigh the other.

A coordinated tax hike by the regions in A, as considered in section 4.3.2, will affect equilibrium federal revenue as follows, bearing in mind that $T_A = T_A(t_{i=1,\dots,n}(t_{j\neq i=1,\dots,n-1}; T_A; T_B); T_B)$ and $T_B = T_B(t_{i=1,\dots,n}(t_{j\neq i=1,\dots,n-1}; T_A; T_B); T_A)$:

$$\begin{aligned}\frac{dR_A}{dt_A} = n[&k_A(\rho + \tau_A)\frac{\partial T_A}{\partial t_A} \\ &+ B'_A(n\frac{\partial \rho}{\partial t_A} + n\frac{\partial \rho}{\partial T_A}\frac{\partial T_A}{\partial t_A} + n\frac{\partial \rho}{\partial T_B}\frac{\partial T_B}{\partial t_A} + 1 + \frac{\partial T_A}{\partial t_A})],\end{aligned} \tag{4.17}$$

from which it can be inferred that the equilibrium responses of national tax rates in both countries will change as a consequence of a coordinated tax rate hike at the regional level ($\frac{\partial T_A}{\partial t_A}$ and $\frac{\partial T_B}{\partial t_A}$). A's change in federal tax rate will have a direct income effect, depending on the strategic relationship between national-level and regional-level tax rates, as depicted

by the first term in squared brackets. The tax base effect will again be driven by the tax increase at the regional level and the resulting shift in the optimal federal tax rate. Further, investors will relocate their investments due to a change in net return to capital, which is triggered by the tax hike at the regional level as well as by the change in optimal tax rates set at the federal level in A and in B. The sign of the latter is in turn driven by the strategic relationship of T_A and T_B with t_A and will either augment the impact of the regional tax on ρ (if $\frac{\partial T_A}{\partial t_A} > 0$ and $\frac{\partial T_B}{\partial t_A} > 0$) or otherwise attenuate it. Assuming again for tax rates to be strategic complements, it becomes apparent that the sign of the tax base effect and, thus, the sign of (4.17), will again hinge on the magnitude of the reduction in net return on capital in contrast to the tax hikes at the federal and regional level. Rewriting (4.17) yields

$$\begin{aligned}\frac{dR_A}{dt_A} = n[&k_A(\rho+\tau_A)\frac{\partial T_A}{\partial t_A} \\ &+ B'_A(\frac{\partial \rho}{\partial T_A}(1+n\frac{\partial T_A}{\partial t_A})+1+n\frac{\partial T_A}{\partial t_A}+n\frac{\partial \rho}{\partial T_B}\frac{\partial T_B}{\partial t_A})].\end{aligned} \tag{4.18}$$

It can be seen that given $-1 < \frac{\partial \rho}{\partial T_A} < 0$, it follows that $\frac{\partial \rho}{\partial T_A}(1+n\frac{\partial T_A}{\partial t_A})+1+n\frac{\partial T_A}{\partial t_A}$ will be greater than zero, such that the sign of the tax base effect is ambiguous. It will be negative, such that (4.18) becomes positive, if the elasticity of the federal tax rate in B as a response to the tax regime change in A is sufficiently large for the total effect on the tax base in A (triggered by tax rises on both levels and attenuated by the corresponding drop in the net return on capital) to be offset. Otherwise, the tax base effect will be negative, such that the sign of (4.18) depends on the relative magnitudes of the tax base effect and the direct tax income effect in A. Now, what this tells us is that if regions in A agree upon a revenue-increasing tax hike, on the one hand, for assumed strategic complementarity of tax rates, the federal government will realise an increase in tax income, which may be named a positive bottom-up vertical externality. On the other hand, the coordinated hike will cause a reduction in tax base due to the higher tax burden and the lower net return to capital, which might be called a first-order negative vertical externality. What is more, that effect will be enhanced by the complementary reaction of federal tax rates in A, but on the other hand offset to a certain degree by the complementary reaction of national tax rates in B (due to which country A becomes in turn more attractive for investors). The relative magnitude of these last two effects drives the sign of the total tax base effect.[13] Consider the (possibly more likely) case where the government's reaction in B is not sufficiently strong for the tax base effect of the coordinated hike and the resulting rise at the federal level to be offset: Then the impact of

[13]That is, the across-country vertical externality resulting from a regional-level tax increase may act by limiting the reduction of federal revenues in A. Put differently, by raising taxes, A's regional governments could attenuate the horizontal externalities triggered by across-border tax competition at the federal level.

a coordinated regional tax increase on federal revenues in A in turn depends on whether the tax income effect realised by the federal government is sufficiently large to outweigh the tax base reduction, which again hinges on how elastically capital owners react towards a given change in tax regime.[14]

With respect to the cross-national effects of tax hikes, the impact of a higher federal tax in B on regional budgets in A is given by

$$\frac{dr_A}{dT_B} = n\frac{\partial t_A}{\partial T_B}k_A(\rho + \tau_A) + b'_A(\frac{\partial \rho}{\partial T_B} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial T_B} + \frac{\partial t_A}{\partial T_B}). \tag{4.19}$$

Here, obviously, the tax base effect tends to be positive, albeit it is at least alleviated by the triggered shift in optimal regional tax rates, if strategic complementarity is assumed. The impact is further amplified by the corresponding tax income effect. Depending on how pronounced that reaction in A will be, the positive tax base effect may even be inverted, such that the overall sign would then again hinge on the relative size of tax revenue and tax base effect. Notwithstanding the interesting implications, this would, of course, call for quite extreme reactions by the Leviathan governments in A. Yet such an effect is theoretically possible. With respect to the magnitude of tax rate reactions, it is further interesting to note that $\frac{\partial t_A}{\partial T_B}$ is likely to be rather small. In any case, compared to (4.16), it seems reasonable to assume that the cross-national elasticities differ from the inner-national elasticities (ie. $\frac{\partial t_A}{\partial T_B} \neq \frac{\partial t_A}{\partial T_A}$). For example, German 'Länder' might react differently to a higher tax rate at the federal level as opposed to a tax rate hike of national tax rates in France. Not only may this be due to the fact that the awareness of tax base reactions may not be the same across nations. What is more, depending on the regional proximity to France, some regions may be quite directly affected by tax rates set in France (take Saarland or Baden-Württemberg, for example), while others (such as Saxonia or Schleswig-Holstein) are not. These former regions' tax bases will then again be directly affected by different tax regimes in France, to which they might have an incentive to react. On the other hand, they will still be competing with other German regions, which, for their part, might have no intention of directly reacting towards taxes set in France, given that the impact on their tax base is rather limited. Hence, cross-national elasticities may differ across regions within one country and, on average, be lower than inner-national elasticities. This would, of course, make a case for the consideration

[14]Obviously, one might argue that the assumption of strategic complementarity of tax rates across all jurisdictions does not make much sense. The federal government might rather choose to react towards a coordinated hike at the regional level by lowering its tax rate in order for a more favourable international position to be achieved. The model does give the necessary tools to analyse such behaviour at the federal level, but the discussion of all possible types of reactions would be beyond the scope of this study and is left to the interested reader.

of non-symmetric equilibria, yet in the same time corroborates the assumption of a difference in 'average' sensitivity with respect to foreign national tax rates.

Likewise, the impact of an isolated tax hike in B on the federal budget in A is described by

$$\begin{aligned}\frac{dR_A}{dT_B} = n[&k_A(\rho+\tau_A)\frac{\partial T_A}{\partial T_B} \\ &+ B'_A(\frac{\partial \rho}{\partial T_B} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial T_B} + \frac{\partial \rho}{\partial T_A}\frac{\partial T_A}{\partial T_B} + \frac{\partial T_A}{\partial T_B} + \frac{\partial t_A}{\partial T_B})],\end{aligned} \tag{4.20}$$

for which similar argumentations regarding the direct revenue and the tax base effect hold as for (4.19), except that the triggered change in federal tax rates *and* the change in tax rates set by the following regions further attenuate the latter. Hence, cross-national strategic reactions will in both cases lead to the positive impact of a tax hike in B on revenues in the respective jurisdictional level in A to be depleted by the strategic reaction of A's jurisdictions.[15]

The impact of a federal tax hike in A on revenues in B is given by

$$\begin{aligned}\frac{dR_B}{dT_A} =&n[k_B(\rho+T_B)\frac{\partial T_B}{\partial T_A} \\ &+ B'_B(\frac{\partial \rho}{\partial T_A} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial T_A} + \frac{\partial \rho}{\partial T_B}\frac{\partial T_B}{\partial T_A} + \frac{\partial T_B}{\partial T_A} + n\frac{\partial T_B}{\partial t_A}\frac{\partial t_A}{\partial T_A})],\end{aligned} \tag{4.21}$$

which basically follows the same line of argumentation as (4.20), except that it might again be possible that $\frac{\partial t_A}{\partial T_A} \neq \frac{\partial t_A}{\partial T_B}$, such that (4.20) and (4.21) might differ.

4.3.4 Total Revenue Effects

Assume that the Leviathan governments of a country are required to provide a certain share of their revenues to the citizenship, which will be used for the provision of public goods. Then, the inhabitants of that country will be positively affected by the chosen policies and the question whether any tax reform will maximise total revenues within the entire federation becomes relevant. The total effect of a coordinated tax hike by the regions in A is given by

$$\begin{aligned}\frac{dR_A}{dt_A} + \frac{dr_A}{dt_A} = n[&k_A(\rho+\tau_A)\frac{\partial T_A}{\partial t_A} \\ &+ B'_A(\frac{\partial \rho}{\partial T_A}(1 + n\frac{\partial T_A}{\partial t_A}) + 1 + n\frac{\partial T_A}{\partial t_A} + n\frac{\partial \rho}{\partial T_B}\frac{\partial T_B}{\partial t_A})] \\ &+ b'_A(n-1)\frac{\partial \rho}{\partial t_A},\end{aligned} \tag{4.22}$$

[15] With assumed strategic substitutability of tax rates, of course, the question to be asked would be whether the negative direct revenue effect thus triggered could be offset by the further amplification of the tax base effect.

in which the effect on regional budgets (third line) is clearly positive and that on federal budgets (first two lines) is ambiguous. Whether or not the entire term becomes positive, depends on the elasticity of the tax regime in B with respect to the tax rate chosen in the regions of country A. If the latter is sufficiently large, the total effect is positive and consolidated revenues will rise following a tax hike at the regional level. If it is not, the sign of (4.22) hinges on the relative magnitudes of the tax base effect as opposed to the income effect generated from the tax hike as well as that of the (positive) effect on revenues in the regions. (4.22) can be rewritten as

$$\begin{aligned}\frac{dR_A}{dt_A} + \frac{dr_A}{dt_A} = n[&k_A(\rho + \tau_A)\frac{\partial T_A}{\partial t_A} \\ &+ B'_A(\frac{\partial \rho}{\partial T_A}(1 + n\frac{\partial T_A}{\partial t_A}) + 1 + n\frac{\partial T_A}{\partial t_A} + n\frac{\partial \rho}{\partial T_B}\frac{\partial T_B}{\partial t_A}) \\ &b'_A(\frac{1}{n} - \frac{1}{n^2})(\frac{\partial \rho}{\partial T_A})],\end{aligned} \tag{4.23}$$

where it can be seen that for n sufficiently large, the third line becomes zero, such that the sign of (4.23) is defined in the same way as (4.18) and hinges on the relative size of the generated tax income and tax base effect. These are in turn driven by the strategic interactions of tax rates and the elasticity of the tax base.

The effect of a federal tax hike on consolidated revenues is depicted by

$$\begin{aligned}\frac{dR_A}{dT_A} + \frac{dr_A}{dT_A} = n[&B'_A\frac{\partial \rho}{\partial T_B}\frac{\partial T_B}{\partial T_A}]+ \\ &\frac{\partial t_A}{\partial T_A}k_A(\rho + \tau_A)+ \\ &b'_A(\frac{\partial \rho}{\partial T_A} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial T_A} + 1 + \frac{\partial t_A}{\partial T_A}),\end{aligned}$$

which can also be expressed as

$$\begin{aligned}\frac{dR_A}{dT_A} + \frac{dr_A}{dT_A} = n[&B'_A\frac{\partial \rho}{\partial T_B}\frac{\partial T_B}{\partial T_A}]+ \\ &\frac{\partial t_A}{\partial T_A}k_A(\rho + \tau_A)+ \\ &b'_A(\frac{\partial \rho}{\partial T_A}(1 + \frac{\partial t_A}{\partial T_A}) + 1 + \frac{\partial t_A}{\partial T_A}),\end{aligned} \tag{4.24}$$

where, if strategic complementarity is assumed throughout, the first two lines will be clearly positive, while the third line will be negative. Whether or not the total effect is positive depends on whether the reduction of regional tax base in A (due to the higher consolidated

tax rate and the corresponding reduction in net return to capital) can by offset by the tax revenue gain at the regional level, which results from the higher regional tax rates and the increase in federal tax base triggered by the tax rate hike in B as a response to the federal tax hike in A. That is, a clear prediction of whether a tax hike at the federal level would raise total revenues in A cannot be given.

4.4 Interaction of Two Federal States

The next case considered is that of two federations competing for mobile tax base. The basic setup is the same as in the previous section, except that now, country B also has a federal structure, such that in every country, each region's inhabitant has the choice of investing capital in any region $i = 1, \ldots, n$ of country A or in any region $g = 1, \ldots, m$ of country B with capital tax rates set at both levels in both countries. The three stages of decision-making are characterised the following way: Both federal governments choose their tax rates first. Subsequently, the regional governments in A and B choose their tax rates taking the taxes set previously at the federal level as given. Then, the inhabitants of every region choose where to invest their capital.

4.4.1 Capital Investment

The investment decisions by each individual are characterised in line with those in section 4.3.1, except that the federal structure of country B is now also explicitly recognised. That is, capital supply in each of B's regions is given by

$$k_{Bg} = k_{BgNAT} + k^*_{gA},$$

where $g = 1, \ldots, m$ stands for each region in B, k_{BgNAT} denotes the amount of capital available in B that is actually invested in region g, k^*_{gA} depicts the amount of capital available in A that is invested in region g of country B.

All capital invested inside region g of country B will be subject to the consolidated tax rate $\tau_{Bg} = t_{Bg} + T_B$, where the first is the tax rate levied by region g and the latter denotes the tax rate levied by the federal government in B. Capital provision and taxation in country A is defined the same way as in section 4.3.1. Investment decisions will be such that

$$\rho_{ANAT} = f'(k_{Ai}) - \tau_{Ai},$$
$$\rho_{AINT} = f'(k_{Bg}) - \tau_{Bg},$$
$$\rho_{BNAT} = f'(k_{Bg}) - \tau_{Bg},$$
$$\rho_{BINT} = f'(k_{Ai}) - \tau_{Ai},$$

which follows the same lines as in section 4.3.1.

Non-arbitrage will again lead to the net return on capital being equalised across jurisdictions, such that total capital supply is now given by

$$n + m = \sum k_{Ai}(\rho + \tau_{Ai}) + \sum k_{Bg}(\rho + \tau_{Bg}),$$

with $\rho = \rho(t_{Ai=1,\dots,n}; T_A; T_B; t_{Bg=1,\dots,m})$, from which follows that:

$$\frac{\partial \rho}{\partial t_{Ai}} = -\frac{\frac{\partial k_{Ai}}{\partial t_{Ai}}}{\sum \frac{\partial k_{Ai}}{\partial \rho} + \sum \frac{\partial k_{Bg}}{\partial \rho}} < 0 \qquad \in [-1; 0),$$

$$\frac{\partial \rho}{\partial T_A} = -\frac{\sum \frac{\partial k_{Ai}}{\partial T_A}}{\sum \frac{\partial k_{Ai}}{\partial \rho} + \sum \frac{\partial k_{Bg}}{\partial \rho}} < 0 \qquad \in [-1; 0),$$

$$\frac{\partial \rho}{\partial t_{Bg}} = -\frac{\frac{\partial k_{Bg}}{\partial t_{Bg}}}{\sum \frac{\partial k_{Ai}}{\partial \rho} + \sum \frac{\partial k_{Bg}}{\partial \rho}} < 0 \qquad \in [-1; 0),$$

$$\frac{\partial \rho}{\partial T_B} = -\frac{\sum \frac{\partial k_B}{\partial T_B}}{\sum \frac{\partial k_{Ai}}{\partial \rho} + \sum \frac{\partial k_{Bg}}{\partial \rho}} < 0 \qquad \in [-1; 0),$$

which is analogous to section 4.3.1. It also follows that

$$\frac{\partial \rho}{\partial T_A} = n \frac{\partial \rho}{\partial t_{Ai}} \tag{4.25}$$

and

$$\frac{\partial \rho}{\partial T_B} = m \frac{\partial \rho}{\partial t_{Bg}}. \tag{4.26}$$

4.4.2 Government Objectives

State Level

The government decisions will be analysed for country A, given that the federal setup of both A and B is such that the effects will be the same regardless of the perspective taken. Each region aims to maximise revenues by choice of its tax rate, while taking taxes set in the other regions (also those of country B) and federal tax rates as given, such that $t_{Ai} = t_{Ai}(t_{Aj\neq i=1,\dots,n-1}; T_A; T_B; t_{Bg=1,\dots,m})$. The objective is again

$$\underset{t_{Ai}}{max}\ r_i = t_{Ai}k_{Ai}(\rho + \tau_{Ai}) + \delta\pi_{Ai}(\rho + \tau_{Ai}),$$

where $\rho = \rho(t_{Ai=1,\dots,n}; T_A; T_B; t_{Bg=1,\dots,m})$ and each state's first-order-condition is given by

$$\frac{\partial r_{Ai}}{\partial t_{Ai}} = k_{Ai}(\rho + \tau_{Ai}) + b'_{Ai}(\frac{\partial \rho}{\partial t_{Ai}} + 1) = 0, \tag{4.27}$$

from which the same conclusions as in section 4.3 can be drawn. The analogous objective holds for regional budgets in B, such that

$$t_{Bg} = t_{Bg}(t_{Bh\neq g=1,\dots,m-1}; T_A; T_B; t_{i=1,\dots,n}).$$

Hence, equilibrium will be characterised by the tax choices of every region in A as well as in country B, which will each affect the net return on capital, such that

$$\begin{aligned}\rho = \rho[&t_{Ai=1,\dots,n}(t_{Aj\neq i=1,\dots,n-1}; T_A; T_B; t_{Bg=1,\dots,m}(\circ)); T_A; T_B;\\ &t_{Bg=1,\dots,m}(t_{Bh\neq g=1,\dots,m-1}; T_A; T_B; t_{Ai=1,\dots,n}(\circ))].\end{aligned}$$

It will further be characterised by symmetric strategies not only of the states in A but also of those in B.

In order to find out whether or not tax rates established in the one-shot Nash game will be too high or too low from the perspective of the revenue-maximising Leviathan, a coordinated tax hike at the regional level is again considered. The equilibrium effect of a coordinated hike in A on regional budgets in A is given by

$$\frac{\partial r_A}{n\partial t_A} = k_A(\rho + \tau_A) + b'_A(n\frac{\partial \rho}{\partial t_A} + m\frac{\partial \rho}{\partial t_B}\frac{\partial t_B}{\partial t_A} + 1). \tag{4.28}$$

That is, the budget is not only affected by the reduction in the net return on capital due to the tax hike in A. That hike also triggers an adaption of chosen tax rates in all of B's

regions, which will in turn affect the net return on capital, thereby reducing the loss of tax base following the hike in A. The optimising regional government does not take these horizontal effects into account. Substracting (4.27) from (4.28) yields

$$\frac{\partial r_A}{n\partial t_A} - \frac{\partial r_A}{\partial t_A} = b'_A[(n-1)\frac{\partial \rho}{\partial t_A} + m\frac{\partial \rho}{\partial t_B}\frac{\partial t_B}{\partial t_A}]. \tag{4.29}$$

Hence, the sign of (4.29) hinges on the assumed relationship between regional taxes in the two countries, that is, $\frac{\partial t_B}{\partial t_A}$. Assuming strategic complementarity, the total effect will be clearly positive, which is in accordance with the standard result[16] stating that the Leviathan government would profit from a rise in tax rates.[17] That would point towards tax rates being set inefficiently low from the perspective of the revenue-maximising regional Leviathan government. In contrast, if tax rates are strategic substitutes, the revenue effect depends on the elasticity of tax rates in B towards those set in A ($\frac{\partial t_B}{\partial t_A}$) as well as on the relative size of both countries. The larger B is compared to A, the more likely its reaction towards tax hikes in A will be to offset the revenue-increasing effect of that tax hike for A.

If there was a chance for binding across-country agreements, the effect of a coordinated hike of all regions both in A and in B on the budget of a representative region in A would be given by:

$$\frac{\partial r_A}{\partial(nt_A + mt_B)} = k_A(\rho + \tau_A) + b'_A(n\frac{\partial \rho}{\partial t_A} + m\frac{\partial \rho}{\partial t_B} + 1), \tag{4.30}$$

where the difference to (4.29) is that $\frac{\partial t_B}{\partial t_A} = 1$. Substracting (4.27) from (4.30) yields

$$\frac{dr_A}{dt_A} = \frac{\partial r_A}{\partial(nt_A + mt_B)} - \frac{\partial r_A}{\partial t_A} = b'_A[(n-1)\frac{\partial \rho}{\partial t_A} + m\frac{\partial \rho}{\partial t_B}] > 0. \tag{4.31}$$

That is, regional budgets in A (and B) would clearly increase following a coordinated tax hike in both countries. Hence, horizontal tax competition again seems to restrain Leviathan governments in their revenue-maximising ambitions.

Federal Level

The federal government in country A chooses its own tax rate taking that of the other country's federal decision-maker as given. It is aware of the fact that the lower-level tax

[16] See, for example, Keen and Kotsogiannis (2003).

[17] From (4.29) it becomes apparent that, under the assumption of strategic complementarity of regional tax rates across countries, it would always be revenue-enhancing for the Leviathan government to raise tax rates. That is, even if regional governments in one country do not have any across-country tax agreements, they can still profit from a unilateral tax rise within their own jurisdiction if the strategic reaction of the other country is complementary. Obviously, such behaviour would not lead to an equilibrium.

rates are set as functions of all the other tax rates, which it will perfectly anticipate, not only for all of its own regions, but also for all regions of country B. The federal government in B faces the same situation, from which it can be inferred that

$$\begin{aligned} T_A = T_A[&t_{i=1,\dots,n}(t_{j\neq i=1,\dots,n-1}; T_A; T_B; t_{g=1,\dots,m}); T_B; \\ &t_{g=1,\dots,m}(t_{h\neq g=1,\dots,m-1}; T_A; T_B; t_{i=1,\dots,n})] \end{aligned}$$

and

$$\begin{aligned} T_B = T_B[&t_{i=1,\dots,n}(t_{j\neq i=1,\dots,n-1}; T_A; T_B; t_{g=1,\dots,m}); T_A; \\ &t_{g=1,\dots,m}(t_{h\neq g=1,\dots,m-1}; T_A; T_B; t_{i=1,\dots,n})]. \end{aligned}$$

The objective of the federal government in A can thus be described by

$$\max_{T_A} \; R_A = n[T_A k_A(\rho + \tau_A) + \Delta\pi(\rho + \tau_A)], \tag{4.32}$$

and its first order condition is given by

$$\begin{aligned} \frac{\partial R_A}{\partial T_A} =& n[k_A(\rho + \tau_A) \\ &B'_A(\frac{\partial \rho}{\partial T_A} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial T_A} + n\frac{\partial \rho}{\partial t_B}\frac{\partial t_B}{\partial T_A} + 1 + n\frac{\partial t_A}{\partial T_A})] = 0. \end{aligned} \tag{4.33}$$

That is, the federal government in A will take into account the reaction at the regional level in response to its chosen tax rate. It will, however, neglect the fact that its tax regime affects the optimal choice of tax rate at the federal level in B. Hence, in equilibrium

$$\begin{aligned} \rho = \rho[&t_{i=1,\dots,n}(t_{j\neq i=1,\dots,n-1}; T_A; T_B; t_{g=1,\dots,n}(\circ)); \\ &T_A(t_{i=1,\dots,n}(\circ); T_B; t_{i=1,\dots,n}(\circ)); \\ &T_B(t_{i=1,\dots,n}(\circ); T_A; t_{i=1,\dots,n}(\circ)); \\ &t_{g=1,\dots,n}(t_{h\neq g=1,\dots,n-1}; T_A; T_B; t_{i=1,\dots,n}(\circ))] \end{aligned} \tag{4.34}$$

and the equilibrium reaction in response to a tax hike in A is depicted by

$$\begin{aligned} \frac{\partial_e R_A}{\partial_e T_A} =& \; n[k_A(\rho + \tau_A) \\ &+ B'_A(\frac{\partial \rho}{\partial T_A} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial T_A} + m\frac{\partial \rho}{\partial t_B}\frac{\partial t_B}{\partial T_A} + \frac{\partial \rho}{\partial T_B}\frac{\partial T_B}{\partial T_A} + 1 + n\frac{\partial t_A}{\partial T_A})]. \end{aligned} \tag{4.35}$$

Substracting (4.33) from (4.35) to find out the sign of the latter yields

$$\frac{dR_A}{dT_A} = \frac{\partial_e R_A}{\partial_e(T_A)} - \frac{\partial R_A}{\partial T_A} = n[B'_A \frac{\partial \rho}{\partial T_B} \frac{\partial T_B}{\partial T_A}]. \tag{4.36}$$

Equation (4.36) captures the horizontal externality triggered by a tax hike at the federal level in A. Its sign essentially hinges on the assumption regarding the strategic relationship between federal tax rates in the two countries. Again, for strategic complements the horizontal externality will be positive, pointing towards tax rates being inefficiently low from the perspective of the revenue-maximising Leviathan government. If they are strategic substitutes, it will be negative.

If federal governments in both countries had an incentive to cooperate, the effect of a coordinated tax hike at the federal level in both countries on federal revenues in A would be characterised by

$$\begin{aligned} \frac{\partial R_A}{\partial(T_A + T_B)} =& n[k_A(\rho + \tau_A) + \\ &+ B'_A(\frac{\partial \rho}{\partial(T_A + T_B)} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial(T_A + T_B)} \\ &+ m\frac{\partial \rho}{\partial t_B}\frac{\partial t_B}{\partial(T_A + T_B)} + 1 + n\frac{\partial t_A}{\partial(T_A + T_B)})]. \end{aligned} \tag{4.37}$$

Again, equation (4.33) is substracted from (4.37) to find out the sign of the latter, which yields

$$\begin{aligned} \frac{dR_A}{dT_A + T_B} =& \frac{\partial R_A}{\partial(T_A + T_B)} - \frac{\partial R_A}{\partial T_A} = \\ & n[B'_A(\frac{\partial \rho}{\partial T_B} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial T_B} + m\frac{\partial \rho}{\partial t_B}\frac{\partial t_B}{\partial T_B})]. \end{aligned} \tag{4.38}$$

Assuming for tax rates at the regional level in both countries to be strategic complements with respect to the tax rate set at the federal level in B, (4.38) will be greater than zero. On the other hand, if they were strategic substitutes, the sign would hinge on the elasticity of regional tax rates in both countries with respect to federal tax rates in B as opposed to the effect on net return to capital triggered by the federal tax hike in B. That is, by dropping the assumption of tax rates being strategic complements, the revenue-increasing effect of a coordinated hike across countries is no longer clear.

4.4.3 Cross-Jurisdictional Effects

In order to determine the effects triggered by a tax hike at the federal or regional level on revenues generated at the other levels, the impact of the resulting changes in the equilibrium

choices of tax rates on revenues is again considered. For a tax hike at the regional level in A, the effect on A's federal revenues is characterised by

$$\begin{aligned}\frac{dR_A}{dt_A} =& n[k_A(\rho+\tau_A)\frac{\partial T_A}{\partial t_A} \\ & B'_A(n\frac{\partial \rho}{\partial t_A}+m\frac{\partial \rho}{\partial t_B}\frac{\partial t_B}{\partial t_A}+\frac{\partial \rho}{\partial T_A}\frac{\partial T_A}{\partial t_A}+\frac{\partial \rho}{\partial T_B}\frac{\partial T_B}{\partial t_A}+1+\frac{\partial T_A}{\partial t_A})],\end{aligned}$$

which, using (4.25) and (4.26), can be rewritten as

$$\begin{aligned}\frac{dR_A}{dt_A} =& n[k_A(\rho+\tau_A)\frac{\partial T_A}{\partial t_A} \\ & B'_A(\frac{\partial \rho}{\partial T_A}(1+\frac{\partial T_A}{\partial t_A})+1+\frac{\partial T_A}{\partial t_A}+\frac{\partial \rho}{\partial T_B}(\frac{\partial t_B}{\partial t_A}+\frac{\partial T_B}{\partial t_A}))].\end{aligned} \tag{4.39}$$

That is, the impact of a change in tax regime at the regional level in A on the budget of the federal government in A is driven by the elasticity of the reaction of tax rates at both levels in B to the change in tax regime in A. Equation (4.39) follows the same lines as (4.18) in the case of a federation competing with a unitary state, except that an additional vertical across-country effect results from the state level governments in B reacting in their optimal response tax rates to the choices made by A's regional governments, thereby having an impact on federal revenues. In the case of strategic complementarity, the reactions at both levels in country B will attenuate the tax base effects resulting from the tax rate increase in A. Not only will investors be faced with a reduction in net return to capital for investments due to the higher tax in A, they will also encounter less favourable investment conditions in the other country as a result of the strategic interaction in A and B, which in turn reduces their incentive to relocate investments. That is, the cross-national effects at both levels will make it more likely for the tax hike at the regional level to raise federal revenues.

In order to assess the effect of a federal tax increase on regional budgets, the resulting change in equilibrium tax choices can be characterised by:

$$\begin{aligned}\frac{dr_A}{dT_A} =& k_A(\rho+\tau_A)\frac{\partial t_A}{\partial T_A} \\ & + b'_A(\frac{\partial \rho}{\partial T_A}+n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial T_A}+m\frac{\partial \rho}{\partial t_B}\frac{\partial t_B}{\partial T_A}+1+\frac{\partial t_A}{\partial T_A}),\end{aligned} \tag{4.40}$$

which, using (4.25) and (4.26), can be rewritten as

$$\begin{aligned}\frac{dr_A}{dT_A} =& k_A(\rho+\tau_A)\frac{\partial t_A}{\partial T_A} \\ & + b'_A(\frac{\partial \rho}{\partial T_A}(1+\frac{\partial t_A}{\partial T_A})+1+\frac{\partial t_A}{\partial T_A}+m\frac{\partial \rho}{\partial t_B}\frac{\partial t_B}{\partial T_A}).\end{aligned} \tag{4.41}$$

The sign of (4.41) essentially hinges on the magnitude of $m\frac{\partial\rho}{\partial t_B}\frac{\partial t_B}{\partial T_A}$. Assuming again strategic complementarity of tax rates, that term will be negative. Just as in section 4.3.3, the rest of the second line of (4.41) will be positive. Hence, if that last effect is sufficiently large (that is, if regional tax rates in B react sufficiently elastically towards a tax hike in A to outweigh the total impact on the tax base triggered by the changes in regional and federal tax rates in A), the tax base effect and, hence, (4.41) will be positive, pointing towards federal taxation being inefficiently low for the regional Leviathans.[18] Otherwise, the same argumentation holds as in section 4.3.3. That is, in contrast to the case of a federal country competing with a unitary state, if two federations interact, the horizontal competition effect is made more significant by means of the additional reaction of state governments in country B. In consequence, just as before, a tax hike at the federal level becomes more likely to increase regional revenues, given that the corresponding reaction in B's regions may alleviate the loss of tax base. That implies that the existence of vertical externalities that leads to inefficiently high federal tax rates is made less significant through the across-country effects arising at both levels of B.

The impact of a federal tax hike in B on regional revenues in A can be discerned by

$$\begin{aligned}\frac{dr_A}{dT_B} =& k_A(\rho+\tau_A)\frac{\partial t_A}{\partial T_B} \\ &+ b'_A(\frac{\partial\rho}{\partial T_B}+n\frac{\partial\rho}{\partial t_A}\frac{\partial t_A}{\partial T_B}+n\frac{\partial\rho}{\partial t_B}\frac{\partial t_B}{\partial T_B}+\frac{\partial t_A}{\partial T_B}),\end{aligned} \tag{4.42}$$

for which the same reasoning holds as for (4.19), except that the positive effect on A's regional tax base is further intensified by the strategic reaction at the regional level in B.

The change in A's federal budgets following a shift in tax regime in country B can be described by

$$\begin{aligned}\frac{dR_A}{dT_B} =& n[k_A(\rho+\tau_A)\frac{\partial T_A}{\partial T_B} \\ &+ B'_A(\frac{\partial\rho}{\partial T_B}+n\frac{\partial\rho}{\partial t_A}\frac{\partial t_A}{\partial T_B}+\frac{\partial\rho}{\partial T_A}\frac{\partial T_A}{\partial T_B}+n\frac{\partial\rho}{\partial t_B}\frac{\partial t_B}{\partial T_B}+\frac{\partial T_A}{\partial T_B}+\frac{\partial t_A}{\partial T_B})].\end{aligned} \tag{4.43}$$

Here, the same conjectures hold as for (4.20), except that the tax base reduction is further attenuated by the possible change in the optimal choice of tax rates at the regional level of country B, which in turn leads to the total effect being more likely to be positive. Likewise, the impact of a tax hike at the regional level in B on federal revenues in A is given by

[18] The magnitude of $m\frac{\partial\rho}{\partial t_B}\frac{\partial t_B}{\partial T_A}$ is also affected by the elasticity of the net return to capital with respect to B's regional tax rate as well as B's relative size compared to A (ie. m opposed to n).

$$\begin{aligned}\frac{dR_A}{dt_B} =& n[k_A(\rho+\tau_A)\frac{\partial T_A}{\partial t_B} \\ &+ B'_A(n\frac{\partial \rho}{\partial t_B} + n\frac{\partial \rho}{\partial t_A}\frac{\partial t_A}{\partial t_B} + \frac{\partial \rho}{\partial T_A}\frac{\partial T_A}{\partial t_B} + \frac{\partial \rho}{\partial T_B}\frac{\partial T_B}{\partial t_B} + \frac{\partial t_A}{\partial t_B} + \frac{\partial T_A}{\partial t_B})],\end{aligned} \tag{4.44}$$

which follows the same argumentation as (4.43).

4.4.4 Total Revenue Effects

The effect of a federal tax hike in A on total revenues within the federation is described by

$$\begin{aligned}\frac{dR_A}{dT_A} + \frac{dr_A}{dT_A} =& n[B'_A(\frac{\partial \rho}{\partial T_B}\frac{\partial T_B}{\partial T_A})] + k_A(\rho+\tau_A)\frac{\partial t_A}{\partial T_A} \\ &+ b'_A(\frac{\partial \rho}{\partial T_A}(1+\frac{\partial t_A}{\partial T_A}) + 1 + \frac{\partial t_A}{\partial T_A} + n\frac{\partial \rho}{\partial t_B}\frac{\partial t_B}{\partial T_A}),\end{aligned} \tag{4.45}$$

which will be greater than zero, if the elasticity of tax rates in the neighbouring regions is sufficiently high, such that the overall tax base effect will be positive. Otherwise, the sign of (4.45) depends on the relative magnitudes of the tax base effect at the federal level (resulting from the tax response in B) and the tax revenue effect at the regional level (which are both positive) in contrast to the (negative) tax base effect at the regional level. These are in turn essentially driven by the relative magnitudes of the strategic reactions of tax rates in A and B, respectively. The total impact of a regional tax hike in A is depicted by

$$\begin{aligned}\frac{dR_A}{dt_A} + \frac{dr_A}{dt_A} =& n[k_A(\rho+\tau_A)\frac{\partial T_A}{\partial t_A} \\ &+ B'_A(n\frac{\partial \rho}{\partial T_A}(1+\frac{\partial T_A}{\partial t_A}) + 1 + \frac{\partial T_A}{\partial t_A} + \frac{\partial \rho}{\partial T_B}(\frac{\partial t_B}{\partial t_A} + \frac{\partial T_B}{\partial t_A})] \\ &b'_A[(n-1)\frac{\partial \rho}{\partial t_A} + n\frac{\partial \rho}{\partial t_B}\frac{\partial t_B}{\partial t_A}],\end{aligned} \tag{4.46}$$

which will clearly be greater than zero, if the elasticity of tax rates at the federal and regional level in B is sufficiently high. Otherwise, it depends on the relative magnitude of the tax base effect in A's regions and the revenue effect at the federal level (which are both positive) in contrast to the tax base effect at the federal level (which will then be negative).

4.5 Summary

The aim of this chapter was to enhance the discussion of efficient capital taxation in the light of international capital market integration by examining the impact of a change in a

country's federal framework on tax setting. The model is restricted to a very basic setup. Notwithstanding its simplicity, it helps to specify each relative effect of a tax regime change on revenues in one particular jurisdiction. While the total impact of the specified effects is ambiguous, the results can be summarised as follows:

In the reference case of two competing unitary states, governments would profit from a coordinated tax hike, which points towards tax rates being set inefficiently low in equilibrium. This follows from the broadly discussed horizontal externalities caused by each government neglecting the positive effect their own tax rate choice might have on another country's tax base.

With the introduction of a federal layer in one of the countries, the upper-level as well as the lower-level governments will be subject to horizontal tax competition and tend to set tax rates inefficiently low, that is, not revenue-maximising from their perspective, in equilibrium. The 'standard' negative vertical externality triggered by tax-setting at different levels of government within a federation (which points towards regional tax rates being set ineffciently high from the point of view of the federal Leviathan and vice versa) is then accompanied by positive cross-national vertical externalities from the regions of the federation to the upper-level unitary government (which point towards regional tax rates being set inefficiently low from the perspective of the foreign country) and vice versa. While it is easily validated that their own tax rates will be set inefficiently low from the perspective of each revenue-maximising Leviathan government, the results regarding the cross-jurisdictional revenue effects and thus also the impact of a tax hike in one jurisdiction on consolidated revenues, are ambiguous. If one jurisdiction increases taxes, it triggers a tax base effect and a tax revenue effect in the other jurisdictions. The tax base effect is driven by the respective externalities just outlined. It tends to be negative for two jurisdictions at different levels within the same country. It tends to be positive for cross-national revenue effects of tax regime changes. The sign in each case hinges on the elasticity of the net return on capital and the elasticity of the other governments' tax rate response to a given tax rate change. The latter is incurred by the fact that the equilibrium tax rate for one jurisdiction will change given a tax hike in another jurisdiction, which may further augment or attenuate the tax base effect. That strategic reaction in tax rates also feeds into the tax income effect, which will be positive if considered tax rates are strategic complements, and negative otherwise. Tax base effect and tax income effect tend to have opposite signs, such that the total impact of a tax reform in one jurisdiction on revenues in another jurisdiction (and, thus, the answer to the question whether the respective tax rates will be too high or too low from the perspective of the other jurisdiction) is ambiguous and essentially hinges on the relative elasticity of tax rates in contrast to the elasticity of the net return on capital to a given tax rate.

If both countries considered have a federal setup, the results change in such that another

layer of cross-national effects will be incurred by a tax hike. For one, horizontal competition is intensified across borders at the regional level. The revenue-increasing effect of a coordinated tax hike within one country is then either attenuated or augmented depending on the assumed strategic reaction of regional tax rates in the other country. The federal-level governments are still subject to horizontal competition and tend to set taxes inefficiently low. The impact of a tax reform in one jurisdiction on revenues in other jurisdictions of other levels is again ambiguous. Basically, the same argumentation holds as in the previous case, except that the cross-national tax competition effects are now augmented by the strategic reaction of regions in the second federation.

In summary, the recognition of international tax competition functions by cross-national reactions at the central level attenuating the upward pressure on consolidated tax rates resulting from a country's federal structure. If both countries are federations, these cross-national effects are further intensified by tax interactions at the regional level.

The model may be extended to yield further meaningful results by including heterogeneity among lower-level regions. A variation in the order of tax rate choices (such that one of the competing countries moves first with the other one following) may make the setup more realistic. What is more, notwithstanding some empirical support, the discussion in every section made it clear that it is far from satisfying to assume that all tax rates will be set as strategic complements. While this may be valid for the case of cross-country interactions, it need not be for the strategic interaction of federal and state level governments within one country. Furthermore, the magnitude of the tax rate responses, which drives the sign of the total effect, may also differ between jurisdictions. Given that the empirical evidence on the strategic interaction between different levels of government is mixed, it may be wise to try and depict the impact of tax regime changes bearing very carefully in mind the respective situation.

Nonetheless, the model provides an opportunity to have a rough estimate of the revenue effects triggered by a possible tax regime change, while allowing for very specific individual assumptions with respect to the strategic interaction of tax rates between different levels of government and countries to be made.

Chapter 5

Conclusion

The aim of this study was to set out the current state of research on international federal tax competition and to add further insight to the discussion in two ways: By analysing how the degree of integration into international capital markets affects chosen tax rates and by examining how the federal framework of a country affects its position in the competition for an internationally mobile capital tax base. In what follows, the derived results will again be summarised and their possible implications for tax policy evaluation will be discussed.

5.1 Summary of Results

The existing theoretical literature suggests that horizontal tax competition leads to inefficiently low levels of taxation. That tendency may for example be offset by accounting for possible asymmetries between regions or agglomeration rents. The consideration of tax base overlap between different levels of government points towards inefficiently high tax rates. Which of these dominates is subject to a variety of aspects. The vertical externality is likely to dominate if a country is strongly integrated into international capital markets, if capital supply is very elastic with regard to the net interest prevalent in one region or if the reverse is the case for capital demand. By including tax competition between federations, the resulting cross-national externalities point towards inefficiently low tax rates, such that the inner-national vertical externality is less likely to dominate. The evaluation of resulting equilibria also hinges on the assumption with regard to policymakers being benevolent or Leviathans.

The empirical evidence is affirmative of horizontal tax interaction, while a trend towards a more differentiated view recognising agglomeration effects and regionalisation has enriched the results. The evidence on vertical tax interaction differs significantly across countries and approaches.

Chapters 3 and 4 extend the small existing literature on federal taxation with a par-

ticular focus on the internationalisation of capital tax competition. Chapter 3 develops an approach in which the intensity of competition for mobile capital tax base is explicitly modelled and incorporated into the analysis. It establishes the result that a federation's degree of international capital market integration functions by reducing the relative importance of the horizontal externality as opposed to the vertical externality, given that capital tax base can be shifted more flexibly abroad. It is further shown that for a specific degree of international capital market integration, vertical and horizontal externalities may offset each other.

Chapter 4 takes a more detailed look at international competition for a mobile tax base with regard to a country's federal structure. It analyses the impact of tax regime changes on individual and consolidated revenues by giving a detailed overview of the specific effects triggered in each jurisdiction. In summary, by considering two competing countries, the tax choices taken at each distinct level not only affect revenues within the country, but also across the borders. Next to the immediate impact on revenues due to tax base reactions, tax regimes in the neighbouring country may change as a consequence of a tax hike at home. That is, for a federation competing with a unitary country, the first-mover central level governments become subject to horizontal competition and subsequently tend to set taxes inefficiently low. The vertical externalities triggered by one government at the regional level feed back not only to its own central-level incumbent (negative vertical externality), but also to that of the other country (positive vertical externality). In the reverse case, the regional government in one country is also subject to vertical externalities not only generated by the federal government at home, but also by that abroad, each pointing in opposite directions. The introduction of a two-levelled government in both countries further intensifies the horizontal tax competition effects in each jurisdiction. That is, next to the cross-national effects triggered by the upper-level governments, the regions in both countries now each cause the sketched externalities. These cross-national interactions work by potentially counteracting the vertical tax externalities triggered within one federation. The explicit recognition of another competing country hence points towards the relevance of vertical tax externalities as a source of inefficiently high tax rates being reduced. The extent to which this occurs essentially hinges on the relative strategic relationship between tax rates in the respective jurisdictions, the sensitivity of that relationship and the relative size of the two countries considered.

From a different perspective, chapter 4 also implies that two competing unitary countries will find themselves in equilibria with inefficiently low tax rates.[1] With the consideration of competing federations, the probability of inefficiently low taxation will be reduced from the perspective of the individual federation as well as from an aggregate view.[2] As such, the results by chapter 4 have two dimensions: In contrast to the standard result of taxation

[1] See section 4.2.

[2] See sections 4.3 and 4.4.

within one isolated federation,[3] the recognition of another competing country points towards the probability of the vertical externality dominating the horizontal externality being reduced. In contrast to the standard tax competition result, chapter 4 indicates for the probability of inefficiently low tax rates in equilibrium to be reduced by taking into account the federal structure of a country.

With regard to the first aspect derived from chapter 4, the results derived in chapters 3 and 4 indicate that the consideration of capital market integration points in the opposite direction to the recognition of cross-national interactions. That is, in a country with a high degree of openness, the vertical externality resulting from federal structure will be more likely to dominate, while the interdependence of a federation with another country will result in the vertical externality being less likely to dominate as a consequence of tax rate interaction and tax base effects. The results have been generated from two distinct models considering revenue-maximisers in one case and welfare-maximisers in the other, and need to be directly compared with caution.[4] They may nonetheless point towards a more differentiated view of globalisation and EU integration, as will be discussed in the following section.

5.2 Policy Implications

The introduction has outlined the following main fields of policy relevance for this study: (i) the worldwide integration of capital markets and a resulting higher degree of capital mobility; (ii) EU integration and enlargement, with the consequence of competition within its borders between several countries of different federal frameworks; (iii) the increasing role of the European Union as an active player in its own right competing with other economic regions and the possible introduction of an EU-level tax; (iv) a worldwide trend towards decentralisation. The implications of the derived results with regard to these issues shall be outlined in this section.

In a synthesis of the existing literature, four key aspects, as formulated in chapter 2.3, need to be borne in mind with regard to the evaluation of tax policies. For one, horizontal tax interactions ought to be accounted for with regard to the heterogeneity of competing regions. Next to possible asymmetries across regions, a country's federal composition as well as that of the competing countries significantly shapes how it is affected by tax competition. It is further useful to analyse whether or not the considered tax policies are more likely to be shaped by revenue or welfare maximising intentions of a decision-maker. Finally,

[3] See section 2.1.2.

[4] In that respect, Wrede (1996, 2002) has pointed towards the fact that the Leviathan approach may be seen as equivalent to a benevolent government in the limit if the marginal valuation of public spending approaches infinity.

worldwide decentralisation trends need to be evaluated cautiously with respect to expenditure as opposed to revenue decentralisation.

Chapters 3 and 4 further validate the mentioned questions relevant for the analysis of tax policies in light of an internationalisation of capital investments. The respective results support the argument that the perception of the consequences of globalisation need not necessarily be characterised by reductions in revenues or welfare of the citizens. The results are relevant for a single EU member state as well as for the consideration of the European Union as one economic institution whose overall welfare ought to be maximised. In the context of the recent financial crisis with resulting concerted activities by all member states, such a perception may be of high relevance.

The worldwide integration of capital markets has a significant impact on the consequences of a country's federal framework for tax rate choices, as shown in chapter 3. That is, the better integrated into international capital markets a federation is, the more likely it is to be subject to inefficiently high consolidated tax rates. The fear of tax competition triggering welfare losses as a consequence of the resulting downward pressure on tax rates thus need not be justified. In fact, within the framework of chapter 3, welfare is more likely to be raised by tax rate reductions. It further concludes that a federation may find itself in a state of 'optimal' integration into capital markets with vertical and horizontal externalities offsetting each other, such that consolidated tax rates will be efficient. That is, by striking a balance between openness and closedness with regard to capital markets, a federation competing for mobile capital may end up with efficient levels of taxation. Put differently, the derived results suggest that the regulation of capital markets need not necessarily lead to welfare or efficiency losses, which may be of particular relevance in the context of current debates in the aftermath of the recent financial crisis. From the perspective of the EU, perfect capital mobility within the Union implies that with countries characterised by federal revenue structures, such as Austria, Belgium or Germany, the welfare effects of observed tax rate reductions in the course of capital market integration need not necessarily be negative from an aggregate perspective. This view also corresponds with the results by Becker and Fuest (2010),[5] who observe a reduction in German 'Länder' tax rates with revenues that remain stable.

With respect to the federal setup, chapter 4 shows that competition from another country may function by offsetting the tendency towards inefficiently high taxation possibly arising from a country's federal structure, thereby raising welfare. To what extent this occurs hinges, among other things, on how elastically the competing countries react towards possible tax rate variations with their own chosen tax rates as opposed to the change in the net return on capital prevalent in the country.[6] In that respect, a federal structure may thus be seen

[5] See section 1.1.

[6] That elasticity may be further validated in the empirical literature.

as improving a country's position in competing with other countries through the prevalent inefficiencies it initially created. It is further implied that for the evaluation of tax policies, it is essential for one country to anticipate the likely reactions in tax choices by its competitors. The results can be applied to cross-national tax competition within the EU or global tax interaction. It may further be concluded that possible tax base overlap resulting from the introduction of an EU-level tax might improve the position of the Union in competition with other regions.

From a different perspective, it is demonstrated that a federal structure may be found to act by attenuating the impact of horizontal competition effects across countries. That is, for a unitary EU member state, the trend towards inefficiently low tax rates resulting from tax competition between unitary countries may be offset by federal structure. Possible tax base overlap arising from an EU-level tax thus need not be negative in the light of international tax competition. From that perspective, the introduction of a genuine EU revenue source may be seen as beneficial by dampening the horizontal competition effects within the Union as well as by attenuating the competition member states are facing from outside the Union.

Obviously, with the described trend towards worldwide decentralisation, the outlined results may just as well apply to a global perspective if that trend implies revenue rather than expenditure decentralisation. The former has also been associated with efficiency gains in the context of the empirical Leviathan literature. For the evaluation of resulting equilibria it is of course of further relevance to account for whether a country's policies are likely to be driven by revenue or by welfare maximisation. As a current example, take the reform of fiscal structure in Italy referred to in the introduction. Notwithstanding that this reform may have been politically driven by the demand of the wealthy Northern Italian regions in opposition to the South, it may yet raise efficiency if one considers the arguments made in the empirical Leviathan literature. It may further be an interesting subject of analysis regarding the implications of the results derived in this study.

The observed stability of revenues despite a reduction of tax rates outlined in the introduction suggests for the welfare-enhancing effects of tax competition to be indeed relevant. In view of the derived results, these may be driven by Leviathan behaviour being thus restrained or, possibly, by tax competition reducing overall tax rates, which may have been inefficiently high due to federal structure previously.

Given that the results derived in chapters 3 and 4 point in opposite directions, the respective consequences ought to be seen with cautiousness. Regarding the European Union, two things are worth mentioning: For one, the prevalent perfect mobility of capital may be indicative of the vertical externality being dominant within the federal member states, such that aggregate tax levels are inefficiently high. Yet the consequences of capital market integration may be offset by considering strategic tax interactions across countries. As such,

it may be argued that a highly mobile tax base need not be harmful if the EU as a whole is considered. On the other hand, regarding the introduction of an EU-level tax, which may be characterised by possible tax base overlap, the same may hold from the perspective of the EU as a whole in competition with other economic regions.

In summary, this study has contributed to the wide range of literature on tax competition by including the federal structure of a country in a systematic analysis and by scrutinising the impact a federation's degree of openness has on chosen tax rates. It has thereby derived tools to consider in depth the policy implications of capital market integration and a worldwide trend towards decentralisation and regionalisation, particularly with regard to the European Union. Notwithstanding that the trade-off in results between these two strands ought to be borne in mind, the results may contribute to a more differentiated view of the consequences of globalisation.

Chapter 6

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Eidesstattliche Erklärung

Ich versichere wahrheitsgemäß, die Dissertation bis auf die in der Abhandlung angegebenen Hilfe selbständig angefertigt, alle benutzten Hilfmittel vollständig und genau angegeben und genau kenntlich gemacht zu haben, was aus Arbeiten anderer und aus eigenen Veröffentlichungen unverändert oder mit Abänderungen übernommen wurde.

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