Essays on Policy Competition

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Ferdinand Mittermaier

Referent: Prof. Dr. Andreas Haufler
Korreferent: Prof. Dr. Michael Pflüger
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Ferdinand Mittermaier

Munich, September 2009

To my parents

Pro captu lectoris habent sua fata libelli.
Terentianus Maurus

Contents

List of Figures

List of Tables

Preface

Ongoing international economic integration has without any doubt been one of the most formative societal trends in the last few decades, and it is expected that it will continue and even accelerate. If any more evidence of this was needed, the financial crisis, culminating in the collapse of the investment bank Lehman Brothers in September 2008 and the ensuing recession hitting economies - both developed and developing - around the globe simultaneously, is a tragic and living proof of this statement. Governments, supranational institutions and central banks around the world saw the need to take unprecedented action, both in scope and nature of the measures. In the United States and the United Kingdom, e.g., record new government debt to finance economic stimulus packages give the state a role it has not had in decades. The crisis, contradicting the hope many economists have had that globalization served as an insurance as a crisis in one region would typically be next to prosperity in other economic areas, has called to mind how interrelated economies are today. What it also has made immediately clear is the big role the state as an economic actor plays. Now that the burden of governments' reaction to the crisis has to be carried in a time when labor markets are strained, the whole issue of governments' tax-raising possibilities is high on the agenda of both academic discussions and the public debate. This happens in a time in which jurisdictions are, at the regional and often global levels, competing: For mobile capital and high-skilled labor, for instance, competition is found in taxes, but also in regulatory policies, environmental standards, and public input goods, inter alia. The facts that openness of goods and factors makes national policies strongly interrelated, and that competition for the particularly mobile factor capital guides and constrains governments in their choice of instruments are the fundamental lines of thought underlying this thesis. It is now widely agreed upon that intergovernmental competition may be harmful, which dates back to Oates (1972). He expressed the thought that jurisdictions may keep taxes suboptimally low in order to be an attractive location for businesses, which is in contrast to the so-called Tiebout hypothesis (Tiebout (1956)).[1] There is by now a plethora of papers on different issues of tax competition, including examples where it may be beneficial (for instance, Edwards and Keen (1996)). For a nice survey, refer to Wilson (1999).

My thesis has the aim of shedding some light on a few questions arising in the context of governmental action in the face of inter-jurisdictional competition. A focus will be on the implications of distortions in goods and labor markets, whereby labor market asymmetries take center stage as they are empirically relevant and allow for interesting new insights from a theoretical and a practical policy point of view. But there is more to this: It is not exaggerated if one claims that labor market phenomena like unionization, minimum wages, unemployment, and the like, are among the most (and most controversially) debated topics in economics, both at the academic level and when it comes to discussions with the more general interested public. This is true in particular for debates on globalization and its consequences. Former independent US presidential candidate and billionaire Ross Perot once famously opposed NAFTA, North America's free trade agreement, claiming that jobs would be lost for America in a 'giant sucking sound'. Will globalization, while generally proven to be beneficial due to a better international division of labor, economies of scale and a larger variety of goods, put an end to traditional Western European strong trade unions? What will happen given immediate competition from locations in Eastern Europe and especially South East Asia, where a huge workforce, increasingly trained, is able and willing to work at labor costs that are often a tiny fraction of those in Europe and the USA?[2] Against this background, it is a natural question to ask what tax policy can do in reaction. Will taxes fall to partly compensate for wages which cannot fall due to institutional constraints? Will governments try to influence unions? Under which conditions may international competition even give governments the opportunity to curtail labor market distortions? These are many and very big questions. It is the ambition of this thesis to contribute a few steps on the long way to the answers.

Although modular in nature, in this book, there is the common theme of policy competition in ever more integrating economies. Finding answers to questions that arise from the complex nexus of interrelated policies' effects and the increasingly important role of

[1] It states that jurisdictions' competition for mobile households is desirable from a welfare point of view since the provision of local public goods will be in accord with the tastes of residents. The tax competition literature, which has grown exuberantly since the 1980s, then states that similar arguments cannot be applied to mobile companies.

[2] There is, of course, a large body of work on questions related to this, e.g., in form of the literature on unionized oligopolies which examines the role of distortions in goods and labor markets. However, little work has been done relating this to tax policies.

openness on various fields requires rigorous theoretical reasoning as well as the application of modern econometric methods. In this dissertation, I concentrate more on the theory side, although empirical parts are to be found in Chapters 4 and 6.

To give a short outline of the structure and storyline, Chapter 1 has the purpose of putting into place earlier results that the outcome of competition for foreign direct investment depends on the industry structure: I argue that FDI's location depends on ownership structures of existing industry. The chapter also has the motivation of laying out a basic model which will then be used to examine further issues: Chapter 2 will display a framework in which there are two governments competing for investment by an outside firm, and the two countries are asymmetric in that the one has a unionized and the other has a competitive labor market. It will examine if and how tax policy is related to wage-setting in the sense that the union may be influenced in its behavior. Chapter 4's theoretical part uses a similar model, with one crucial modelling difference due to a very different question in mind: Endogeneity of the labor market distortion is ruled out by assumption, and the chapter examines to which degree tax policy is used to overcome a country's disadvantage that arises from a higher labor cost. Chapter 3 employs a very different model type, namely a monopolistic competition, New Trade style approach with agglomeration forces, to address the question under which conditions a unionized country finds it optimal to use tax policy to defend its existing, unionized sector industry. In this literature, it is typically found that industrialized countries will be able to defend their cores in tax competition. The chapter argues that taxes may be used to overcome an otherwise persistent inefficient lock-in.
Chapter 5 then makes a big step in a different direction and explores specific commodity taxation in view of the fact that in markets like the European car market, significant price differences (before and after taxes) can be observed. Existing literature has shown that price discrimination exploiting real trade costs should be banned; I take a look at similar regulation in the presence of goods taxes. The chapter is related to the others in that it also considers how market integration and tax policies are interrelated; this time, however, I do not consider non-cooperative policy's goals and consequences given existing structures and asymmetries, but I rather examine the optimality of the establishment of a set of rules which will then have its bearing on tax policy. In all the chapters up to this point, governments have only one instrument. Chapter 6, finally, looks at what it means when governments have two instruments. The theory part analyzes how tax and public input competition are interrelated. In the empirical section, we find that local governments adjust their business tax rate towards levels chosen in neighboring jurisdictions. Also, if neighbors increase their spending on local infrastructure, governments follow suit by increasing their

own spending, which suggests the interactions are more complex than displayed by existing literature.

Before delving into the heart of the matters, let me briefly introduce the most basic features and contributions of each of the chapters.

Chapter 1: The role of firm ownership in tax competition

Chapter 1 analyzes the role that the ownership structure of companies plays for governments in asymmetric countries' competition for a multinational's subsidiary. I argue that equilibrium tax policies as well as a foreign investor's location decision in policy competition between these countries critically depend on ownership of incumbent industry. It turns out that otherwise disadvantageous locations with high shares of their incumbent production facilities owned by foreigners may be successful in attracting multinationals. As is usual in those games, due to the auction-like character, the outcome will be efficient in that aggregate welfare will be maximized, i.e. the mobile capital will be induced to go to a country precisely if this maximizes the sum of both countries' welfare and the multinational's profits. However, regional welfare is lowered by tax competition below a certain level of trade costs. In a nutshell, I argue that the outcome of tax competition may be less determined by the industry structure than by that industry's ownership structure. The chapter is based on Mittermaier (2009).

Chapter 2: Unionization triggers tax incentives to attract foreign direct investment

Chapter 2 looks into tax competition between a unionized and a non-unionized country for the location of a mobile firm owned by third-country foreigners. Unionization offers an extra incentive for the government to attract a foreign investor, in order to affect the behavior of the domestic union. This results in the unionized country's government offering a tax discount (or a subsidy premium) to the outside firm in excess of what is needed to compensate the investor for the higher union wage. Therefore, in equilibrium, the unionized country attracts the foreign investment, even if it has no other location advantages. Still, the country with the union ends up with a lower per-capita welfare compared to the location with the competitive labor market. The model analyzes how tax policy can have an influence on other actors' behavior, who will then influence a location's attractiveness for mobile capital. So tax policy is shown to have an indirect effect via affecting the behavior of another player like a union, which can lead to surprising results: In our case, a country that can attract mobile capital although it has an inefficient labor market, an existing competitor (which the other one doesn't display) and even a smaller market. The chapter is based on joint work with Prof. Dr. Andreas Haufler, LMU Munich (Haufler and Mittermaier (2009.))

Chapter 3: The winner gives it all: Unions, tax competition and offshoring

Chapter 3 analyzes competition for capital between welfare-maximizing governments in a framework with agglomeration tendencies and asymmetric unionization. We find that a unionized country's government finds it optimal to use tax policy to induce industry to relocate towards a location with a competitive labor market instead of realizing the benefits from higher wage income while exporting part of the wage burden to foreign consumers. Via a tax regime effect, which favors the factor capital, and an efficiency effect, consumers and producers alike benefit from off-shoring industry towards a low-cost country. Our result qualifies first intuition that defending high wage industries is beneficial to a country as part of the associated cost is shifted to foreign consumers. The result is obtained in a model where capital is mobile, but its owners keep on residing in their respective home countries and repatriate income, which we consider more apt to our application than what is assumed in many other agglomeration models. Things change if governments disregard capitalists' income and focus instead on laborers: Then, the industrialized country will hold on to its industry as long as the labor market distortion is not too strong. The chapter is based on joint work with Hyun-Ju Koh, LMU Munich (Koh and Mittermaier (2009)).

Chapter 4: Do countries compensate firms for international wage differentials?

Chapter 4 shows, in a short theoretical section, that in a bidding race for FDI, it is optimal for governments to compensate firms for labor cost differentials. The model is similar in its basic structure to the one employed in Chapter 2, but a lot less complex. It illustrates that without an influence on a labor market distortion, a country will not find it optimal to attract a mobile outside firm if it doesn't have a location advantage like a larger market. However, we show there are cases where a government of a country with a labor cost disadvantage will be able and willing to attract capital, using a subsidy, where it would not be able to attract it in the absence of such a policy instrument. This finding is supported by panel data estimations for Western Europe, suggesting that corporate income tax rates are significantly lower in countries with relatively high labor costs. We exploit the exogenous integration of the former communist regimes in Eastern Europe and the ensuing surprising and immediate location competition from countries in Western Europe to show that there was a reaction in taxes on factors like wages. A direct tax competition effect is not plausible, at least not as the main driving force, as taxes in Western Europe began to fall before those in Eastern European economies. The chapter is based on joint work with Dr. Johannes Rincke, LMU Munich (Mittermaier and Rincke (2009)).

Chapter 5: Should market integration be enforced?

Chapter 5 takes up a very different issue and brings together two strands of literature, namely on specific taxation and on antidumping with imperfect competition. Taking Europe's car market as a starting point, it examines the role of market integration in the presence of non-cooperative specific taxation among welfare-maximizing governments. I show that integrated markets in the sense of a strict ban on price discrimination across markets is welfare optimal in the sense of bringing taxes closer to the cooperative solution as well as in the sense of sparing the economies wasteful reciprocal dumping. I also show that with foreign-owned firms or asymmetric countries, market integration may no longer be optimal or consensual, respectively, qualifying the earlier (and existing theory's) results. Also, integrated markets may benefit producers in contrast to what existing literature showed. The results are derived under consumption-based taxation, i.e.the destination principle, but I show that they also hold under production taxation (the so-called origin principle).

Chapter 6: Fiscal competition over taxes and public inputs: Theory and evidence

Chapter 6 characterizes the reaction functions of governments competing for capital by choosing both the business tax rate as well as a productive public input. For this purpose, we construct a simple model that enables us to analyze the strategic effects involved in competition with two instruments chosen simultaneously. We then test the model predictions regarding the nature of strategic interaction among governments. The estimations of a system of spatially interrelated equations suggest that local governments use both the business tax rate and public inputs to compete for capital. We find that if neighbors cut their tax rates, governments try to restore competitiveness by lowering their own tax and increasing public inputs. If neighbors provide more infrastructure, governments react by increasing their own spending. The chapter is based on joint work with Dr. Johannes Rincke, LMU Munich, and Dr. Sebastian Hauptmeier, ECB Frankfurt (Hauptmeier et al. (2009)).

All chapters are based on stand-alone papers and can be read separately. Hence, to facilitate reading within chapters, footnotes and equations are numbered independently in each chapter. Figures are embedded within the text, whereas appendices and tables containing empirical results can be found at the end of each chapter. A last note on pronouns: I generally prefer 'I' over the somewhat aristocrat 'we' in single-authored pieces. The parts of this thesis that are based on joint work will, of course, be written in the first person plural.

Chapter 1

The role of firm ownership in tax competition

1.1 Introduction

With increasing mobility of real capital and falling trade costs, making closeness of production to final consumers ever less important, competition for mobile capital has become one of the most widely studied and debated forms of interjurisdictional competition in the last few decades. There is a large theoretical literature on jurisdictions competing for foreign direct investment (FDI). Many examples in the European Union show that states are willing to offer considerable subsidies in order to attract potential investors' new sites. A prominent one is the aid to AMD (microelectronics) for a production site in Eastern Germany, which was approved by the EU Commission in 2004 and amounted to EUR 545m, 23% of the total investment costs. Another example is the case of a subsidy to Kia Motors for a project necessary for the production of a new model in Slovakia, where direct aid of EUR 32m, 15% of the eligible investment costs, was granted in 2007.[1] Increased local competition, reducing distortions arising from concentrated markets, and thus increased consumer surplus is one obvious advantage of the attraction of mobile firms. Creation of jobs in internationally operating industries or technological spill-overs are other widespread motives.

The present paper aims to contribute to the literature on competition for mobile firms

[1]Source: European Commission, Directorate General for Competition (Official Journal of the European Communities, C and L)). Those are examples for cases where state aid is allowed according to Articles 87(3)(a) and 87(3)(c) of the EU Treaty, cf. European Commission (2007b).

by focusing on the role of ownership structure in the domestic industry. Even though internationalization of large companies' ownership structures is a feature of globalization and economic integration in general, this topic has received little attention so far in the theoretical literature, but it is clearly of empirical relevance. International portfolio investment is at a high level in Europe (cf. Adjaouté et al. (2000)). Huizinga and Nicodème (2006), using the 'Amadeus' database (containing balance sheets and income statements for European firms), compute that the asset-weighted foreign ownership share in Europe as a whole was at about 21.5 % in 2000, and even at 32.9% in Eastern Europe, based on a sample of about 15,000 firms without an exchange listing in various sectors. Focussing on manufacturing and looking at the share of foreign-controlled affiliates in manufacturing turnover from OECD (2005) as an indicator of internationality in firm ownership, those fractions are strikingly high for some countries like Ireland (79.5%), Hungary (71.6%) or Luxembourg (52.9%); but also in larger countries like France (35.9%), Germany (24.4%) or the United States (20.3%), the numbers are significant.[2] This affects economies not only because profits will often be repatriated, but also since the dependency on strategic and employment decisions by foreign investors is high.[3] Another statistic to look at, which, inter alia, sparked the idea for this paper, is the comparison of gross domestic and gross national products. Looking at 2007 World Bank (World Development Indicators) data on GDP and GNI, the former exceeds the latter by 19% in Ireland. In contrast, the corresponding figure for the UK is only 3.3%. Although a crude measure, this can be interpreted as an indication that a comparatively larger fraction of Ireland's production facilities is not owned by nationals. The notion that countries should care about the degree to which they own 'their' industries suggests itself in policy competition among ever more integrating economies.

In this paper, I argue that differences in the national ownership share of local production facilities can be crucial in determining countries' incentives to attract international firms. In a model where a foreign multinational is choosing between two possible locations separated by real transport costs, the question is addressed whether the presence of mainly domestically owned (as opposed to more foreign-owned) industry makes a difference in

[2]When interpreting those figures, on should take into account that in order to qualify as foreign-controlled, a single foreign investor (or group of associated investors) has to hold more than 50% of the shares with voting rights.

[3]A more indirect indicator of economic globalization is employment in firms under foreign control as a percentage of total manufacturing employment. As long as foreign-controlled firms do not employ significantly more people for the same production activities, this figure also gives a hint at the lower bound of the degree of internationality in firm control. For 2006, in the Czech Republic, the figure was 39.6%. The corresponding numbers were, for example, 33.1% in Belgium, 28.4% in the United Kingdom, 26.3% in France, 15.6% in Germany, and a mere 11.2% in the United States, see OECD (2009).

bidding competition. I show that not having a national company can give an otherwise losing country the edge over a bigger rival in bidding competition.
The model is related to two different strands in the literature: One focuses on the competition for mobile firms, like the monopolist model in Haufler and Wooton (1999) and the duopoly case considered in Bjorvatn and Eckel (2006). Haufler and Wooton find that in equilibrium, the monopolist will decide to go to the bigger of the two countries which may even be able to tax it. Bjorvatn and Eckel demonstrate that the market structure plays a significant role as absence of an incumbent firm can make up for a location's disadvantage of having a smaller market.[4] A complementary piece of analysis to this paper is Ferrett and Wooton (2009) who consider the effects of ownership of the new investment (as opposed to the existing industry) and show that it does not matter for the outcome of tax competition. In terms of the basic modelling strategy, I follow this part of the literature, which, however, has not explicitly addressed the role of incumbents' ownership so far. A second strand has considered this, but in different policy settings. Fuest (2005), in a model with an endogenous export vs. FDI decision, shows that in the country considered, in the absence of tariffs, falling trade costs induce profit taxes to fall as well. The existence of foreign ownership can prevent profit taxes from falling in line with trade costs. Huizinga and Nielsen (1997) argue, inter alia, that source-based investment taxes can be used to shift income away from domestic firms that are in part owned by foreigners to domestic citizens.
For empirical evidence on the impact of taxes and market size on the FDI location decision, refer to Devereux and Griffith (1998).[5]

The paper is organized as follows. The next section presents the theoretical model. Section 1.3, the main part of the analysis, introduces policy influence and the role of both symmetric and differing ownership structures. Section 1.4 provides a brief welfare analysis. Section 5.5 concludes.[6]

[4]The case of two countries bidding for two mobile firms is examined in Ferrett and Wooton (2009); an extension to the generalized oligopoly case for both symmetric and asymmetric countries is discussed in Haufler and Wooton (2007). For an analysis of tax competition with full agglomeration in a New Economic Geography framework, see Baldwin and Krugman (2004); for a partial agglomeration case, refer to Borck and Pflüger (2006).

[5]Theory and evidence on tax competition among asymmetric jurisdictions with public consumption and public input goods can be found in Büttner (1999).

[6]A slightly abridged version of this chapter will appear as Mittermaier (2009).

1.2 FDI in an oligopolistic industry: A simple model

Consider a region with two countries, A and B, each of which already hosting one not necessarily locally owned firm of a specific industry, and a potential entrant. Let a and b denote the existing firms in countries A and B, respectively.[7] The two markets are separated by unit transport costs τ. The firms in this oligopolistic industry produce a homogeneous good, x. A is the larger economy in that there is a single household in country B and $n \geq 1$ identical households in country A. There is demand for a second, numéraire good, z, produced by perfectly competitive firms where labor is the only input so that free trade in this good equalizes wages to w. Preferences in the countries are:

$$u_I = \alpha x_I - \frac{1}{2}\beta x_I^2 + z, \qquad I \in \{A, B\}. \tag{1}$$

This quadratic, quasi-linear utility function parallels that used in Horstmann and Markusen (1992) and gives rise to linear demand. A household inelastically supplies one unit of labor, earning it an income of w. Maximizing the representative utility function subject to the implied budget constraint $w = p_I x_I + z_I$, one obtains (inverse) demand for x. This yields

$$X_A = \frac{n(\alpha - p_A)}{\beta}; \qquad X_B = \frac{\alpha - p_B}{\beta}, \tag{2}$$

(with p_I denoting the price of x in market I) as country A's and country B's aggregate demand for x, respectively. As in the z sector, wages are the only variable costs in the oligopolistic industry. In order to set up a plant, however, a fixed amount has to be spent, assumed to be sufficiently large to prevent a firm from producing in both locations.[8] Letting firms compete à la Cournot, each firm is partially protected in its domestic market by transport costs, and reciprocal dumping will occur in equilibrium, cf. Brander and Krugman (1983). The intuition for this at first glance pointless trade in homogeneous products is that eating into foreign firms' oligopoly rents makes it worthwhile to incur the real trade cost.

Now, a firm in the same industry from a third country wants to serve the regional market. I assume that trade costs between its home country and the region under consideration are too high to make exporting from there worthwhile.

[7] I assume the existing industry, but not necessarily its ownership, to be symmetrically dispersed across countries as the impact of different market concentrations across locations is not at the center of this analysis. For a discussion of the role of different industry structures within countries, refer to Bjorvatn and Eckel (2006).

[8] I do not go deeper into this point of 'exports vs. FDI' as it is has been examined extensively in the literature; see, e.g., Horstmann and Markusen (1992).

In what follows, subscripts denote the countries or firms in question and superscripts indicate the foreign investor's location decision (A or B). If f goes to A, profits will amount to

$$\pi_a^A (= \pi_f^A) = \frac{n(\alpha - w + \tau)^2}{16\beta} + \frac{(\alpha - w - 2\tau)^2}{16\beta}; \tag{3}$$

$$\pi_b^A = \frac{n(\alpha - w - 3\tau)^2}{16\beta} + \frac{(\alpha - w + 2\tau)^2}{16\beta} \tag{4}$$

for firms a, f and b, respectively. The first terms in (1) and (4) represent a firm's market A profits, the second ones market B profits. Consumer surplus will be

$$CS_A^A = \frac{n(3\alpha - 3w - \tau)^2}{32\beta}; \quad CS_B^A = \frac{(3\alpha - 3w - 2\tau)^2}{32\beta} \tag{5}$$

in countries A and B, respectively. These equations show how the two markets are 'made' by the transport costs.

Similarly, if f decides to locate in the smaller market B,

$$\pi_b^B (= \pi_f^B) = \frac{n(\alpha - w - 2\tau)^2}{16\beta} + \frac{(\alpha - w + \tau)^2}{16\beta}; \tag{6}$$

$$\pi_a^B = \frac{n(\alpha - w + 2\tau)^2}{16\beta} + \frac{(\alpha - w - 3\tau)^2}{16\beta}, \tag{7}$$

will be the firms' equilibrium profits and

$$CS_A^B = \frac{n(3\alpha - 3w - 2\tau)^2}{32\beta}; \quad CS_B^B = \frac{(3\alpha - 3w - \tau)^2}{32\beta} \tag{8}$$

will be the respective countries' equilibrium consumer surpluses. Again, CS_A^B, e.g., reads 'consumer surplus in A if f goes to B'. One further assumption will be made: Transport costs are below the prohibitive level $\tau^{proh} = (\alpha - w)/3$ so that all Cournot equilibria will be interior. This ensures that 'cross-hauling', i.e., two-way trade, will occur. If any, profits of firms a and b will be of interest to the two countries' governments, as f's profits are assumed to be fully repatriated. Without government intervention and symmetric market structures, it is immediately obvious that the foreign investor will always choose to locate in the bigger country (and will be indifferent if $n = 1$) for any positive level of trade costs. This is intuitive as when producing in the larger part, one has to bear transport costs only for a smaller fraction of the total market.[9]

[9]This phenomenon is called the 'home market effect' in the New Trade literature. The 'geographic advantage' Λ that A offers to f is simply the difference in profits (not taking into account taxes and fixed costs): $\Lambda \equiv \pi_f^A - \pi_f^B = (3/16)[\tau(n-1)(2\alpha - 2w - \tau)]$. This advantage is increasing and concave in τ.

1.3 Tax Policy

Throughout this paper, it is assumed that the two regions' governments do not cooperate. Due to increased local goods market competition, attracting the multinational has the advantage of increased consumer surplus because of lower prices.[10] Welfare in each country is determined by consumer surplus, tax receipts and, if the incumbent local industry is at least partly domestically owned, a share λ of this industry's profit.[11] Tax receipts are redistributed to the respective country's residents, or, in case a subsidy has to be paid, it is financed via a lump-sum tax. In spite of trade between countries, due to real transport costs, competition among firms within one certain location is fiercer: The marginal cost of domestic sales is lower than that of exports. However, there is the second effect that to the extent that the incumbent firm is domestically owned, that country's government will have to take into account that f as a new competitor will lower the incumbent's profits by more than if it went to the other jurisdiction.

If governments are free to tax or subsidize the foreign firm, it is not clear ex ante which country will win the 'bidding race' and whether f will have to pay taxes in equilibrium. In order to determine the outcome of tax competition, observe that the game between the two governments resembles a bidding race in which the governments charge the foreign firm the highest possible 'entry fee' (or give it the lowest possible 'welcome gift' in the case of a subsidy). The firm simply decides to locate in the region where its after-tax profits are highest. To find the equilibrium, then, one has to work out the best offer a country is willing to make to f and compare it to the minimum offer it has to make so as to outbid its competitor. The gain G_I a country I can make by attracting the firm is simply its welfare WF_I^I in that event minus its welfare if f went to the other country, WF_I^J, whereby those levels are before any tax or subsidy (i.e., gains are 'gross gains') and amount to: $WF_I^I = CS_I^I + \lambda_A \pi_i^A$,where $i = (a, b)$ and $\lambda_A \in [0, 1]$ denotes the share of firm a that is owned by A's residents (and λ_B is the corresponding expression for country B residents' share of firm b), whereby the respective rests of the firms' shares are owned by third-country foreigners, leading to an outflow of profits out of the considered region.

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[10] As mentioned above, there are many other motives that make the attraction of mobile capital beneficial to a country, like the sparking of agglomerative forces or the creation of jobs. I follow the bulk of the literature in this field (e.g., Haufler and Wooton (1999) or Bjorvatn and Eckel (2006)) in abstracting from such motives as they are much harder to model and do not yield additional insights to the research question at hand, at least not if they benefit both countries alike.

[11] This is easily observed by (using the assumption in the case of country A that profits, inasmuch as they accrue to the country's inhabitants, and taxes are equally shared among residents) plugging the expenditures for the numéraire good z, determined residually from the budget constraint, in equ. (1).

Taking the example of country A, the gain is then

$$G_A = WF_A^A - WF_A^B = (CS_A^A - CS_A^B) + \lambda_A(\pi_a^A - \pi_a^B). \quad (9)$$

A lower λ_A will make G_A larger as the second part of the sum in (3) is negative due to what one could call the 'local competition effect'. Hence, the country will, ceteris paribus, be willing to bid for f more aggressively with a lower λ_A.[12] Two baseline scenarios will be considered: On the one hand, cases with symmetric ownership structures (i.e., where A's share of a, λ_A, equals λ_B (call this scenario '(sy)' for 'symmetric'), and on the other hand, cases where ownership is asymmetric in the sense that A owns more or less than B of 'its' local incumbent (call this scenario '(as)' for 'asymmetric').
It is straightforward to determine country I's equilibrium policy choice B_I ('bid'):[13] Each country anticipates the maximum bid of the other potential host which it must outbid, i.e. it has to offer f the *other* country's entire gain. In order to win the bidding race, however, a government has to offer f on top the profit it would be making had it located in the *other* country minus what it can earn after having decided for *this* country - i.e., the profit differential. Sticking with the example of country A, the minimum bid is:[14]

$$B_A = \pi_f^B - \pi_f^A + CS_B^B - CS_B^A + \lambda_B(\pi_b^B - \pi_b^A). \quad (10)$$

From here on, the analysis can be carried out in two steps: By setting $B_I \geq 0$, one can see if a country will have to pay a subsidy or be able to raise a tax so as to attract the firm.[15] By comparing B_I, the minimum bid needed to win, and G_I, one can see if country I actually wants to attract the investment at that cost or if it is better off letting f go to jurisdiction J. It can be easily shown that one region wanting to attract f implies that the other region does not, and vice versa: The difference in f's profits $(\pi_f^I - \pi_f^J)$, by definition, exactly equals $G_J - B_I = B_J - G_I$. The results in the aforementioned cases are as follows, taking as a natural starting point the case where both countries equally own 'their' firms:
Symmetric ownership structures
If both countries equally take into account their respective incumbents' profits ($\lambda_A = \lambda_B = \lambda_{sy}$), it will always be the case that $G_A > B_A$. To see this, insert the values from eqns. (1), (4), (2), (6), (7), and (8) into B_A ((10)) and G_A ((3)), and the condition $B_A < G_A$ reduces

[12] Note that the analysis focuses on taxes or subsidies for the *initial* location decision.

[13] For a similar auction-like approach to policy competition, refer to Kessing, Konrad, and Kotsogiannis (2009).

[14] Observe in (10) that the bid consists of f's profit differential and the other country's gain.

[15] The simple lump-sum taxes are not restrictive in this game as they can be easily transformed into ad valorem profit taxes by dividing them by company profits.

to $\tau < 2(\alpha - w)$, which is always fulfilled for $\tau < \tau^{proh}$.

The equilibrium tax/subsidy threshold is determined as follows: Setting $B_A > 0$, one obtains the critical level below which[16] country A has to pay a subsidy:

$$\tau_A^{(sy)} = \frac{2(\alpha - w)\,(6n - 2(n-1)\lambda_{\text{sy}} - 9)}{6n - 2(5n+3)\lambda_{\text{sy}} - 9}. \tag{11}$$

The analogous value for country B is $\tau_B^{(sy)} = (2(\alpha - w)\,(9n - 2(n-1)\lambda_{\text{sy}} - 6))/(9n + 2(3n+5)\lambda_{\text{sy}} - 6)$, but it remains without significance since country A always attracts f.

As intuition would suggest, $\tau_A^{(sy)}$ falls in n as the market size advantage increases the taxing power.
Taking the first derivative with respect to λ_{sy},

$$\frac{\partial \tau_A^{(sy)}}{\partial \lambda_{sy}} = \frac{48(n+1)(2n-3)(\alpha - w)}{(2(5n+3)\lambda_{\text{sy}} - 6n + 9)^2}, \tag{12}$$

we see that the taxing power is increased (by lowering the critical τ boundary) for $n < 1.5$ and curbed for $n > 1.5$, reflecting a counterclockwise rotation of the $\tau_A^{(sy)}$ schedule around a point on $n = 1.5$. Intuition on this will be given below.

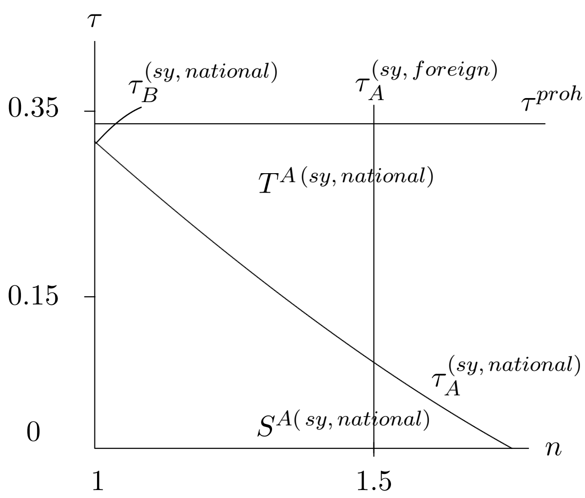
Note that the symmetric case encompasses both the scenario in which both countries fully own their firms as well as the one in which both countries do not hold any shares of a, b. I analyze those polar cases in turn for illustrative purposes. If both incumbents are fully owned by their respective countries' residents (call this regime 'national'), then $\lambda_A = \lambda_B = \lambda_{sy} = 1$ and equation (11) reduces to

$$\tau_A^{(sy,national)} = \frac{(14 - 8n)(\alpha - w)}{15 + 4n}. \tag{13}$$

Since the first derivative of this term with respect to n is negative, this critical τ level falls in A's size advantage. If both incumbent firms are owned by foreigners (call this regime 'foreign'), profits completely drop out of the welfare terms ($\lambda_A = \lambda_B = \lambda_{sy} = 0$).[17] B_B will always be positive, i.e., country B will in any event have to pay a subsidy (the precise condition is that τ be smaller than $2(\alpha - w)$). B_A (country A's minimum winning bid)

[16]To see this, observe that at $\tau = \tau_A^{(sy)}$, $\partial B_A / \partial \tau < 0$.
[17]This case mirrors the monopoly case (Haufler and Wooton (1999)): Countries are ex ante alike in all respects but size. The difference is that consumer surplus will be higher and profits will be lower here due to intensified competition.

Figure 1.1: Equilibrium outcomes with ‘symmetric ownership structures – regimes (national) and (foreign)



will be greater than 0 if $n < 1.5$, implying a subsidy in those cases and taxes for other values (in case $n = 1.5$, zero taxes will prevail). Recall that the border between A paying a subsidy and receiving a tax, $\tau_A^{(sy,national)}$, falls in n with national ownership. This means that there will be a point at which A's relative taxing power changes. The findings are summarized in

Proposition 1 *With symmetric ownership structures, in a bidding equilibrium for a multinational's affiliate f, the bigger country will always attract the investment. Its ability to tax is higher under the 'national' regime than under the 'foreign' regime for high trade costs and lower for low trade costs.*

Proof. The first result follows immediately from setting $G_A > B_A$ (or, equivalently, setting $G_B < B_B$), which yields $n > 1$. $\square$

To understand the second part of the proposition, the changed taxing power, observe that there are parameter constellations in n-τ-space where A has to pay a subsidy under regime ‘foreign’ and can already tax under ‘national’. This is above the $\tau_A^{(sy,national)}$-threshold and to the left of $n = 1.5$: Refer to Figure 1, where the case with equal full national ownership is depicted.

In this figure, as in Figure 2, the $\tau^{(\cdot)}$-lines denote, for each country, the regime borders between the minimum winning bids being subsidies or taxes. To facilitate the comparison, the frontier between A paying a subsidy and raising a tax in the equal full foreign ownership case, $\tau_A^{(sy,foreign)}$ at $n = 1.5$, is also shown[18]. The capital letters S, T indicate whether a subsidy is paid or a tax can be raised, and the superscript denotes the winning country and the regime.[19] Intuitively, above the $\tau_A^{(sy,national)}$-threshold and to the left of the $\tau_A^{(sy,foreign)}$-threshold, (always *in equilibrium* winning) country A will find it harder to outbid B under 'foreign' where the latter does not take b's profits into account. On the other hand, there is a small area to the right of $n = 1.5$ and at low trade costs where A has to pay subsidies under 'national' where it could already raise taxes under 'foreign'. There, the intuition is that it is harder for A to outbid B under 'national' as firm b's profit will be *higher* if f decides to colocate with it. This at first sight counterintuitive effect appears as at low levels of trade costs, market B is hardly shielded from competition and it is better for b if its rival does not settle in the larger A market (and, thus, has to incur the same cost disadvantage vis-à-vis firm a when serving it). The formal condition for π_b^B being greater than π_b^A, which drives this effect, reads

$$\tau < \tilde{\tau} = \frac{2(\alpha - w)(n-1)}{5n+3}. \tag{14}$$

Notice that $\tilde{\tau} = \tau_A^{(sy,national)}$ if $n = 1.5$, so this is precisely the point around which the $\tau_A^{(sy,national)}$ schedule rotates if λ_{sy} goes up.[20]

It will be argued below that tax games like the one considered here will always maximize aggregate welfare. However, an interesting implication of the results obtained so far (cf. Proposition 1) is that in terms of regional welfare, countries A and B combined lose from competition (a compared to a case where they do not have policy instruments at their disposal) in the figure's S realm, and gain from it in the T realm. For instance, in the $(sy, national)$ regime, our baseline case[21], they lose for low trade costs (and a limited size difference, see Figure 1), and they gain for high trade costs. To see this, observe that firm f would have gone to the larger country A anyway in the absence of taxes/subsidies, which then merely constitute a direct transfer from/to firm f without changing the allocation.

[18] For the comparisons of cases, as in the figures, I set the marginal cost $w = 0$ and $\alpha = 1$ in order to concentrate on trade cost and country size effects. Then, the factor $(\alpha - w)$ disappears in the numerators of the critical levels. As those parameters are identical across countries anyway, no effects are lost by this.

[19] E.g., $S_A^{(sy,\,national)}$ denotes a situation where, under equal full national ownership of firms, country A attracts the firm by paying a subsidy.

[20] The corresponding expression for firm a can never be positive as being joined in the larger market is always a disadvantage.

[21] Cases in which $0 < \lambda_{sy} < 1$ imply a τ_A-line in between the $\tau_A^{(sy,\,foreign)}$- and $\tau_A^{(sy,\,national)}$-lines, making the same reasoning applicable.

Aymmetric ownership structures
For the asymmetric case, it is assumed that $\lambda_B = 1 - \lambda_A$. To ease comparability, I call λ_A 'λ_{as}' (and λ_B '$1 - \lambda_{as}$') in this section. From Proposition 1, we already know that $\lambda_{as} = 1 - \lambda_{as} = 1/2$ leads to A's winning of f no matter the n-τ-combination. I assume from here on that $\lambda_{as} > 1/2$, i.e. that in the bigger country A, the incumbent is owned by local residents at a larger share than in B. One could think of a traditional industry in a big country, whereas in another, smaller country, one finds a firm of the same industry, but owned by people from the rest of the world at a higher fraction. This is done for the simple reason that the case where a more home-owned firm resides in the small country yields no additional insight – that the big region, having to worry less about producer surplus, will win, is confirmed in the affirmative.[22] That is, A will now consider a's profits relatively more than B will take into account b's. Proceeding as above, I set $B_A = 0$ to obtain

$$\tau_A^{(as)} = \frac{2(\alpha - w)(2n(\lambda_{as} + 2) - 2\lambda_{as} - 7)}{6\lambda_{as} + 2n(5\lambda_{as} - 2) - 15}, \tag{15}$$

below which, again, A will have to pay a subsidy to f. More importantly, B can now win the investment, namely if

$$\tau \geq \tau_d = \frac{14(n-1)(\alpha - w)}{16(n+1)\lambda_{\text{as}} - n - 15}. \tag{16}$$

Proposition 2 *If the large region's incumbent industry is more home-owned than the small one's, it is possible for the small region to win the bidding race as the large one's offer is moderated by concern for its industry's profits relatively more. This occurs above a level of trade costs τ_d, whereby this critical level is increasing in n and decreasing in λ_{as}.*

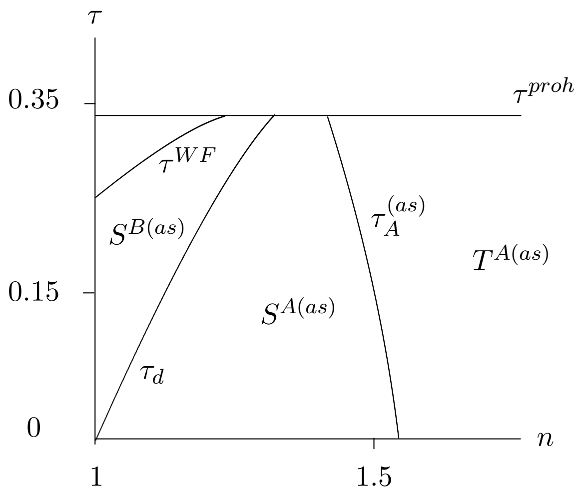
Proof. By setting $G_A > B_A \Leftrightarrow CS_A^A - CS_A^B + \lambda_{as}(\pi_a^A - \pi_a^B) > \pi_f^B - \pi_f^A + CS_B^B - CS_B^A + \lambda_{as}(\pi_b^B - \pi_b^A)$, one obtains that A will win the investment if $\tau < \tau_d$. The first derivative thereof with respect to n equals $\left(224(\alpha - w)\left(2\lambda_{\text{as}} - 1\right)\right)/(n - 16(n+1)\lambda_{\text{as}} + 15)^2$, which is strictly positive for $\lambda_{as} > 1/2$. It is seen immediately from (16) that the derivative with respect to λ_{as} is negative for $n > 1$. □

This suggests that close to the 'τ_d-line', competition for f will be most intense – i.e., subsidies will be paid in equilibrium, cf. Figure 2 (which is drawn for $\lambda_{as} = 0.8$[23]).

The $\tau_A^{(as)}$-line denotes the regime border between A's minimum winning bid being a subsidy

[22] Formally, there is no $n > 1$ for which $G_A > B_A$, $0 < \lambda_{as} < 1/2$ and $\alpha > w, \beta > 0, 0 < \tau < \tau^{proh}$.
[23] A higher λ_{as} will bend the τ_d-line to the right, which can be seen from differentiating (16) with respect to λ_{as}, which yields $-224(n-1)(n+1)(\alpha - w)/\left(n - 16(n+1)\lambda_{\text{as}} + 15\right)^2 < 0$ for $n > 1$.

Figure 1.2: Equilibrium outcomes with asymmetric ownership



or a tax. The figure shows τ^d, separating the parameter constellations under which A and B win, respectively.[24] The intuition for A having an easier game the larger is n, for any given τ, is the market size effect, as above. The dependency on τ is less clear, but it is understood by taking a closer look at the condition that $G_A > B_A \Leftrightarrow G_B < B_B \Leftrightarrow CS_B^B - CS_B^A + (1-\lambda_{as})(\pi_b^B - \pi_b^A) < \pi_f^A - \pi_f^B + CS_A^A - CS_A^B + \lambda_{as}(\pi_a^A - \pi_a^B)$: When considering whether to attract f, B weighs increasing own welfare against the costs of outbidding A, which consist of three elements: Firstly, the direct costs of attracting f, earning the latter the profit differential; secondly, A's change in consumer surplus; and thirdly, firm a's profit differential (to the extent it is taken into account by A). This last effect drives the result, as with high trade costs, a acts as a quasi-monopolist in the large market, making it unattractive for A to reduce its home firm's profits by getting f into the country – and hence, making it easy for B (caring less about b) to outbid A's low offer. For n close to 1, f's profit differential $(\pi_f^A - \pi_f^B)$ and the difference in change of consumer surplus across countries are minor, whereas it makes a big difference for a (namely, $\pi_a^A - \pi_a^B \leq 0$) whether it acts as a quasi-duopolist or a quasi-monopolist in the A market. With n increasing, the first two differences become significant, making it harder for B to profitably win the investment.

To summarize those findings: If the ownership structure gets more international in the

[24]The regime border for B being able to raise a tax does not show up for this parameter value. For $\lambda_{as} = 1$, for instance, there is a tiny realm in the northwest of the considered n-τ-space where B is even able to raise a tax.

sense that the incumbent in the small country is 'less domestic', the large country is at risk of losing FDI to the small one which is less reluctant to subsidize multinationals as it lacks a 'national champion' it could harm through local competition. Stated differently, the mere fact that B does not fully own 'its' company may induce it to attract a multinational. This result obviously hinges on the assumption that governments care about local profits. Note, however, that this is very plausible precisely in cases where industries are very concentrated: There, single firms generate high profits and are highly 'visible' at the same time.

1.4 Welfare

I now briefly turn to welfare issues. Note first that due to the auction-like character of the bidding game, the outcome will be efficient in that aggregate welfare will be maximized, i.e. the firm will be induced to go to country B precisely if this decision maximizes the sum of both countries' welfare and the firm's profits. This point has been made in the literature before (e.g., Barros and Cabral (2000), Fumagalli (2003), and Bjorvatn and Eckel (2006)) and therefore will not be repeated here.
More insightful, though, is the evaluation of regional welfare, i.e. the sum of the two regions' welfare levels without f's profits. Since positive taxes (subsidies) that do not change f's location (relative to the case without government policy) have no effect on efficiency, they trivially amount to an increase in regional welfare in case of a tax (and a reduction in case of a subsidy). This was already stressed in the discussion of the symmetric ownership case in Section 1.3. In the asymmetric case, and in cases where competition actually does change the allocation, it is not so obvious where competition helps or harms the region. If country B now wins the competition, this will of course be beneficial for it. As far as region-wide welfare is concerned, one simply has to work out if the difference in gains between countries outweighs the payment by B, i.e., if $G_B - G_A - B_B > 0$. Setting the difference equal to zero and solving for τ leads to:

$$\tau^{WF} = \frac{2(\alpha - w)\,(2(n-1)\lambda_{\text{as}} + 7 - 10n)}{15 - 2n - (22n + 26)\lambda_{\text{as}}}. \tag{17}$$

Proposition 3 *With asymmetric ownership structures, and in the case where the smaller country attracts the outside firm, regional welfare is lowered by tax competition below a level of trade costs τ^{WF}. The realm where tax competition is harmful becomes smaller as λ_{as}, the asymmetry in ownership structure, grows larger.*

Proof. Taking the first derivative of $(G_B - G_A - B_B)$ with respect to τ and evaluating at $\tau = \tau^{WF}$, one obtains $(\alpha - w)\left(-2n\left(\lambda_{\text{as}} - 5\right) + 2\lambda_{\text{as}} - 7\right)/(16\beta)$, which is positive for any $\lambda_{as} \,\epsilon\, [1/2, 1]$, $n > 1$. To see the second part of the proposition, the derivative of τ^{WF} with respect to λ_{as} is $16(19-28n)(n+1)(\alpha - w)/\left(2n + (22n+26)\lambda_{\text{as}} - 15\right)^2 < 0$, which shows that a higher λ_{as} lowers the critical τ level. □

The intuition is straightforward: The area where tax competition is beneficial is where it is not too intense and where trade costs are high, rendering the attraction of a new competitor especially beneficial. A higher λ_{as} makes $B's$ minimum winning bid smaller, enlarging the realm where competition is beneficial for the region as a whole. The corresponding line below which regional welfare is harmed by tax competition is also represented in Figure 2.

1.5 Conclusion

This paper has shown that in competition for FDI, the location pattern and equilibrium taxes are highly sensitive to ownership structures. Under the assumption that national governments as tax-setting authorities care about firm-level profits only to the extent that they will not be repatriated to some other jurisdiction, their willingness to bid for multinationals' new plants or subsidiaries will be very high if incumbents are hardly domestically owned, even though those subsidies do not apply to existing firms. This can help explain recently observed high amounts paid to companies in the European Union for settling in a particular region. As with otherwise symmetric countries, the bigger one will always have the edge over smaller jurisdictions in bidding races, evidence about FDI in the European periphery suggests that a force like the one modelled may be at work. The analysis illustrates the impact of national champions as a force that renders the attraction of foreign direct investment less desirable. What do we take from all this? From a theoretical perspective, this means that, in intergovernmental competition, it does not suffice to take into account industry structure and its influence on companies' profits, but that one rather has to take due account of the extent to which industry's interests are considered by the government. International ownership is one very intuitive reason for disregarding producer surplus, but political economic or ideological motives may as well be important (and differ across countries). For empirical research, this implies firstly that the degree to which industry is locally owned should be incorporated in estimations of policy reaction functions whenever competition in goods markets is imperfect. Secondly, and more importantly, the model developed in this paper yields the directly testable implication that a country that both hosts and – to a large extent – owns existing industry should be relatively less inclined and hence less likely to attract foreign direct investment, all other things being equal. Even though this model was built around competition for a single firm, the analyzed effects will still be present in a more general framework with a broad-based capital tax.

Chapter 2

Unionization triggers tax incentives to attract foreign direct investment

2.1 Introduction

In most OECD countries, and in many developing countries, the potential benefits from foreign direct investment (FDI) in the form of higher employment, intensified competition in product markets, and positive productivity spill-overs on other sectors of the economy are increasingly perceived by policy makers. The employment argument, in particular, has become a highly important one. In many OECD countries employment in multinational firms now accounts for more than 25% of total employment in the manufacturing sector.[1] At the same time, multinational firms are able to choose among an increasing number of potential investment locations, particularly in Eastern Europe and Southeast Asia, which offer low wages, an educated workforce, and rapidly expanding domestic markets. This has led to a number of highly publicized cases of plant relocations from rich OECD countries to lower-cost regions.

As a result of these developments the competition among potential host countries to attract internationally mobile firms has tightened visibly during the last decades. This can be seen in the corporate tax changes, in particular the reduction of statutory tax rates, that many countries have undertaken since the 1980s (see Devereux et al., 2002). A second and even more direct indicator is the increasing use of direct location subsidies that are

[1] In 2005, employment in multinational firms as a percentage of total manufacturing employment was, for example, 33.1% in Belgium, 26.4% in France, 15.2% in Germany, 48.0% in Ireland, 33.8% in Sweden, 27.6% in the United Kingdom and 11.2% in the United States. See OECD (2008).

Table 2.1: Approved investment subsidies in EU member states (2000-2007)

Investing company (sector)	headquarter country	Date of approval	Host country (city/region)	Subsidy (mill.€)	Aid intensity[a]
Investor from Rest of World					
AGC/Glaverbel (glass)	Japan	06/2000	Greece (Kavala)	41	48%
Motorola (semiconduct.)	U.S.A.	07/2000	Scotland (Edinburgh)	172	6%
Nissan	Japan	01/2001	U.K. (Sunderland)	60[b]	19%
Ford	U.S.A.	07/2003	Belgium (Genk)	45	4%
AMD (microelectronics)	U.S.A.	02/2004	Germany (Saxony)	545[c]	23%
DOW PET (synthetics)	U.S.A.	04/2004	Germany (Saxony)	28	23%
e-glass (glass)	Hong Kong	04/2004	Germany (Saxony-A.)	42	35%
AMD (microelectronics)	U.S.A.	07/2007	Germany (Saxony)	262	12%
Kia Motors	Korea	12/2007	Slovakia (Stredné Sl.)	32	15%
Investor from Europe					
ST Microelectronics	Switzerland	04/2002	Italy (Sicily)	542	26%
European Optic Media	Austria	06/2003	Germany (Thuringia)	35	35%
Volkswagen	Germany	06/2003	Spain (Navarra)	20	6%
Infineon (semiconduct.)	Germany	03/2004	Portugal (Porto)	42	29%
Peugeot Citroen	France	09/2004	U.K. (Ryton)	30[b]	10%
National investor					
Volkswagen	Germany	07/2001	Germany (Dresden)	75	12%
Infineon (semiconduct.)	Germany	04/2002	Germany (Saxony)	219	20%
Iveco (utility vehicles)	Italy	10/2002	Italy (Puglia)	109	44%
BMW	Germany	12/2002	Germany (Leipzig)	363	30%
Wacker (silicon wafers)	Germany	02/2004	Germany (Saxony)	120	28%
DHL Airways (logistics)	Germany	04/2004	Germany (Leipzig)	70	28%
De Tomaso (vehicles)	Italy	01/2005	Italy (Calabria)	81	60%

[a] present value of state aid divided by present value of investment
[b] 1 British Pound is converted to 1.5 € [c] upper limit
Source: Official Journal of the European Communities, C and L (http://eur-lex.europa.eu)

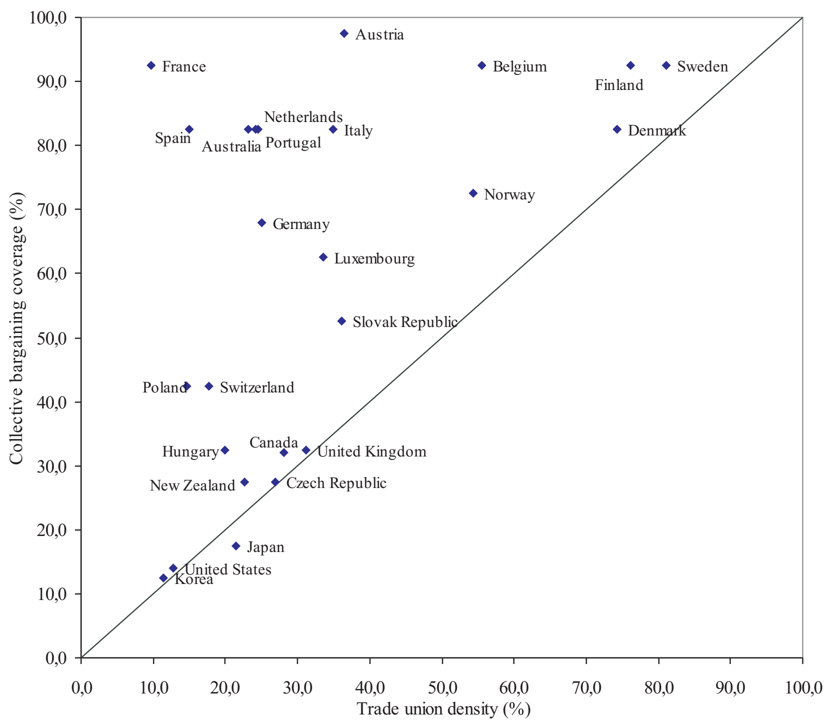
paid to foreign firms. Some examples were already given at the beginning of the last chapter. Table 2.1 provides a selective list of 21 cases for the period from 2000 to 2007 where substantial investment subsidies (above 20 million Euro) have been offered by host countries and approved by the European Commission. These subsidies often account for 25 to 30 percent of the present value of the investment, and in some cases for even more.[2]

A striking fact in Table 2.1 is that, in absolute terms, the highest subsidies are paid for firms that engage in regions characterized by weak economic activity and high unemployment, but simultaneously are part of countries with strong trade unions that succeed in keeping up wages even in low-productivity regions. This is true, in particular, for Eastern Germany and Southern Italy, where the collective bargaining coverage rate is above 80% of the

[2]Note that the subsidy payments collected in Table 2.1 cover only direct monetary transfers and thus represent merely a lower bound for the overall value of the incentive package. The latter often includes additional measures, such as the free provision of public infrastructure.

workforce.[3] To give an overview of how strongly even the most developed countries differ with respect to labor market rigidities, Figure 2.1 illustrates the degrees of unionization across OECD countries.

Figure 2.1: Union density and coverage rate in OECD member countries



Source: OECD Employment Outlook, 2004.

Whereas the density rates[4] in the year 2000 are rather low across countries (27% in the Czech Republic and 25% in Germany), the coverage rate is 68% in Germany and above 80% in France and Italy, whereas it is only around 25% in the Czech Republic and 14% in the US.

This suggests that fiscal policies are used to compensate investors for the location disadvantages of facing high wages without benefitting from positive spill-overs in an industrial core region. To some extent this reflects the European Union's regulations on state aid, which specify that location subsidies are only permitted to compensate investors for a demon-

[3]In contrast, this coverage rate (the percentage of employees for whom the wage negotiated by the union is binding) is only about 50% in the UK and 20% in the United States and Japan (Cahuc and Zylberberg, 2004, p. 372). In Eastern Europe, coverage rates have fallen dramatically in several countries and were about 35% in Hungary and 50% in Slovakia in 2001 (EIRO, 2002, Table 1).

[4]The percentage of the workforce actually being a member of a union.

strated cost disadvantage in comparison to a feasible alternative location. The question remains, however, why unionized countries are also *willing* to provide high subsidies, the cost of which have to be fully borne by them.[5]

A further motivation for our analysis comes from several empirical studies that find a surprising *positive* correlation between the degree of unionization and the likelihood of a given location to attract foreign multinationals (Coughlin et al., 1991; Friedman et al., 1992). As stressed by Friedman et al. (1992, p. 416), in their analysis "[t]he most puzzling result is on unionization." While these empirical studies control for regular business tax rates, they do not incorporate discriminatory tax concessions or investment subsidies that host government grant to individual international investors. In line with the examples in Table 2.1, one potential explanation for the positive effect of unionization on inward FDI could thus be that unionized countries (or states) have more incentives to subsidize foreign investment, as compared to their less unionized neighbors.

Against this background the present paper analyzes how the presence of a domestic union affects the incentives of governments to grant specific tax concessions, or even direct investment subsidies, in order to attract a foreign multinational enterprise (MNE). Our main result is that if a unionized and a non-unionized country compete for FDI, the unionized country will attract the investment in equilibrium, even if it has no other location advantages. This occurs because the government of the unionized country will offer a location subsidy to the outside firm which *more than* compensates the investor for the higher wages caused by union power. The fundamental argument behind this result is simple. In concentrated markets where firms set prices above marginal (wage) costs, unions exerting their market power to raise wages above their competitive levels aggravate the distortions in the economy. This gives the unionized country's government a strong incentive to reduce the existing inefficiencies, but it cannot curtail the union's wage setting power directly. Hence attracting FDI serves as a second-best instrument, giving the union an incentive to lower its wage demand, in exchange for higher employment in the multinational firm.

We develop our main result in a model where a unionized and a non-unionized country form an integrated market and compete for the location of a single, multinational firm. We

[5]A further important question is why more than 80% of the subsidies to industry in the OECD take the form of investment subsidies, rather than direct subsidies to employment, even if their purpose is to counteract labor market rigidities (see Fuest and Huber, 2000, Table 1). One answer to this question is that employment subsidies may strengthen the position of trade unions, whereas investment subsidies can induce more competition in both product and labor markets. Fuest and Huber (2000) show, in a model where firms with different productivities bargain with unions over both wages and employment, that an investment subsidy financed by a labor tax increases the number of active firms and generates welfare gains by reducing the rents of workers.

model a five-stage game where governments compete through location taxes or subsidies in the first stage, the union sets the wage in the second stage and the MNE chooses its location in the third stage. In the fourth stage the union may re-optimize its wage policy and in the fifth stage all firms choose output levels. We also show that our main result carries over to an extended setting with trade costs. In this case, the unionized country may be able to attract the outside firm, even if it has other location *disadvantages*, such as a smaller home market.

Our analysis relates to two different strands in the literature. The first set of papers analyzes the effects of unionized labor markets on foreign direct investment.[6] Mezzetti and Dinopoulos (1991) investigate the role of unionization in a firm's exporting versus FDI decision. As recently shown by Mukherjee (2008), these two modes of serving a foreign market may also be simultaneously chosen by a cost-minimizing firm when labor markets are unionized. Leahy and Montagna (2000) analyze how FDI is affected by different degrees of wage setting centralization. Most of the papers focusing directly on the link between unionization and inward FDI find a negative effect; see e.g. Naylor and Santoni (2003), or Munch (2003).[7] Our model incorporates this effect in that, *other things being equal*, unionization reduces the likelihood of a country to attract FDI. However, by also endogenizing tax policies we show that the negative effect of unionization on FDI can be more than compensated by a rationally chosen location subsidy offered by the unionized country's government.

A second and parallel strand in the literature has analyzed tax competition for FDI in models of imperfectly competitive product markets and with various country asymmetries. This 'bidding-for-firms' literature was initiated by Black and Hoyt (1989), and it has since been applied to tax/subsidy competition between countries that exogenously differ in size (Haufler and Wooton, 1999), the valuation of employment gains (Barros and Cabral, 2000), factor endowments (Davies, 2005), or the number of domestic competitors (Bjorvatn and Eckel, 2006). A general finding of this literature is that countries can tax the profits of a single internationally mobile firm to the extent that they possess a location advantage, relative to their closest competitor.[8] Related results have been derived in the 'new economic

[6]These contributions are part of a more general literature that analyzes the interaction between unionization, imperfect competition in goods markets, and economic integration. See e.g. Brander and Spencer (1988), Huizinga (1993), Driffill and van der Ploeg (1995), and Naylor (1998).

[7]An exception is Lommerud et al. (2003), who show that unionization can simultaneously induce FDI and cause job losses in the unionized country.

[8]Ferrett and Wooton (2005) show that when there are two internationally mobile firms, rather than only one, the taxing power of the competing countries is increased. Under some conditions they will even be able to extract all profits from the duopolistic firms.

geography' literature where agglomeration effects and a larger market size allow the core country to tax positive location rents (Kind et al., 2000; Baldwin and Krugman, 2004; Ottaviano and van Ypersele, 2005; Borck and Pflüger, 2006). None of these models, however, incorporates trade unions as an additional player in the competition for FDI.

We are aware of only one other paper which combines unionization and tax competition in a model with endogenous location decisions of mobile firms. This is the fair wage model of Egger and Seidel (2007).[9] In their model, however, the labor market distortion is exogenously given by the fair wage preferences of workers and can therefore not be affected by tax policies. Hence Egger and Seidel (2007) obtain the 'conventional' result that the country with stronger fair wage preferences will be at a disadvantage in attracting FDI. We show in this paper that results change fundamentally when the extent of the labor market distortion can be affected by government tax policy.

The remainder of this paper is organized as follows. Section 2 describes the general set-up of the model. Section 3 analyzes the interaction of union and firm behavior in the last four stages of our game. Section 4 turns to the tax and subsidy decisions of the two governments in the first stage. Section 5 discusses the robustness of our results with respect to alternative model assumptions. Section 6 concludes.

2.2 The model

We consider a region of two countries[10] $i \in \{A, B\}$ which compete for FDI from a multinational firm that has its home base in a third country C. The multinational firm, labelled c, produces a homogeneous output good x and competes with one incumbent firm in the region, which is located in country A and labelled a.[11] The market for good x is thus characterized by duopoly competition and the two possible scenarios are either that firms a and c both produce in country A, or that they produce in different countries. The two

[9] Skaksen (2005) analyzes the incentives for a single country to attract a foreign firm to a unionized market with a domestic incumbent. This model focuses on complementarities between the outputs produced by the incumbent and the mobile firm, however, and does not incorporate location competition between two potential host countries. There is also a small literature on tax and social policy competition when labor markets are unionized and capital is internationally mobile (see Lejour and Verbon, 1996 or Fuest and Huber, 1999). In this literature product markets are perfectly competitive and thus there are no distinct output and location decisions of individual firms.

[10] The 'countries' can also be thought of as sub-national units (such as U.S. states), as long as their labor market institutions and taxing powers are completely independent.

[11] For reasons of symmetry, one could also assume an immobile, incumbent firm in country B. This, however, would substantially complicate the algebra without adding to the substance of our analysis.

firms compete over quantities. The regional market for good x is completely integrated, with no trade costs arising between A and B in our benchmark model.[12] Hence we consider 'export-platform FDI' (e.g. Ekholm et al., 2007) where the firm from the outside country C locates in one of the countries in the region (in A or in B) and serves the entire regional market from there. Regional trade is balanced through a numéraire good z, which is produced under conditions of perfect competition.[13]

The core difference between the two countries in the region is that sector x is unionized in country A, but not in country B. To give an example in a European context, we could think of country A as being Germany (more specifically, a state in Eastern Germany), whereas country B is a less unionized country, for example Hungary.[14] The existence of an immobile, incumbent firm a in country A is central to our model because it ensures that the union has the 'outside' option to raise the wage rate in this firm, should the multinational firm decide to locate in country B.

In production, wages are the only variable costs in both sectors. In the numéraire sector, $1/\bar{w}$ units of labor are needed in both countries to produce one unit of good z. Free trade equalizes the price for good z in A and B at unity and the competitive wage rate at $\bar{w}$. In sector x one unit of capital is needed for each firm to produce any output. We assume that the multinational firm disposes of only one unit of capital and hence can set up at most one plant, either in A or in B.[15] These fixed costs are assumed to be equal for FDI in countries A and B and are ignored in the following.[16] Once the fixed factor is installed, one unit of labor produces one unit of good x. In the non-unionized country B, the wage rate is $w_B = \bar{w}$, whereas in country A the sector-specific union endogenously chooses the wage rate w_A. We assume a monopoly union model where the union sets the nominal wage so as to maximize the wage surplus in sector x, with firms consequently adjusting their output optimally.

On the demand side, the total population of countries A and B is normalized to unity.

[12] In section 5 we extend the model to allow for positive trade costs. In this section we also briefly discuss the case of price competition between firms.

[13] In a strict sense, this setting applies only to the first set of examples given in Table 2.1. However, the remaining entries in Table 2.1 are also consistent with our model because the subsidies were typically paid to prevent a European or national investor from setting up a plant for a new product line in a different EU country, and serve the European market from there.

[14] See footnote 3. Note that our analysis implicitly assumes that wage differences are caused only by unionization, whereas the competitive wage per unit of output is equal in the two countries.

[15] One example is where the fixed factor in sector x are entrepreneurial services and firm c has only one suitable manager.

[16] As we will show, the after-tax profits of firm c in the host country are always positive and we assume that they exceed the fixed costs (cf. footnote 27).

Each household in A and B exogenously supplies one unit of labor, which is mobile across sectors but immobile across countries. A share n of the total population lives in country A, whereas $1-n$ residents live in country B. While market size is thus allowed to differ between countries, we need to restrict the magnitude of these differences. In particular we assume that country B is at most 50 percent larger than country A.[17] Moreover, we must ensure that both countries have enough workers to host firm c and produce its desired output. Hence we set $0.4 \leq n \leq 0.9$ (see footnote 18 below).

The preferences of households are identical for all consumers and across countries. Per-capita utility in each country is of the quasi-linear and quadratic form[18]

$$u_i = \alpha x_i - \frac{1}{2}\,\beta x_i^2 + z_i \qquad \forall\, i \in \{A, B\},. \tag{1}$$

As only sector x in country A is unionized, an endogenous fraction s_A of country A's workforce will find employment in this sector at wage w_A. The remainder of country A's workforce is employed in the z sector and earns the competitive wage $\bar{w}$. Workers in A are homogeneous and their allocation to the two sectors is not explicitly modelled. There are simply some 'lucky' workers who earn more than the competitive wage. Since the preferences of all workers are identical, we can focus on the average income in country A for most of the analysis. In country B, all workers earn the same wage $\bar{w}$.

To derive the country-specific budget constraints, we assume that both governments use lump-sum instruments in order to finance subsidies or, in case they are able to tax the outside firm c, redistribute tax proceeds. Moreover we assume that the profit income earned by the local firm in country A is redistributed to the domestic worker-consumers in equal per-capita shares. With these assumptions, the (average) per-capita budget constraints in the two countries are:

$$\begin{aligned} w_A s_A + \bar{w}(1-s_A) + \frac{(\pi_a + t_A)}{n} &= z_A + p x_A, \\ \bar{w} + \frac{t_B}{1-n} &= z_B + p x_B. \end{aligned} \tag{2}$$

Here π_a denotes the profits of the incumbent firm a, t_i are the tax revenues in country i obtained from the outside firm c (negative, if subsidies are paid) and p is the common consumer price of good x in the integrated region.

[17] The reason for this restriction will become clear in section 4 (see footnote 24).

[18] For the above restrictions on n, the condition that the desired output of good x can be produced in both countries requires that $\beta \geq 4(\alpha - \bar{w})$. At the same time $\alpha > \beta x_i\ \forall\, i$ is required for positive marginal utility from good x.

Maximizing the representative consumer's utility function in each country, subject to the budget constraint, and aggregating over individuals gives the market demand functions for good x:

$$X_A = \frac{n(\alpha - p)}{\beta}; \qquad X_B = \frac{(1-n)(\alpha - p)}{\beta}; \qquad X_A + X_B = \frac{(\alpha - p)}{\beta}. \tag{3}$$

These market demand functions are independent of the exogenous income components in (2), due to the quasi-linearity of utility.

National welfare is obtained from the individual utility functions (1). We use the per-capita budget constraints (2) to substitute out for z_i, employ the first-order condition of the consumers' optimization problem and aggregate over households using (3). Moreover, we allow for an exogenous, positive externality σ that the location of the outside firm c exerts on the host country. This externality is the same for both countries and it is meant to capture, in a highly simplified way, the empirical finding that multinational enterprises (MNEs) often generate positive productivity spill-overs on the host country's economy.[19] In our model we assume that this technological spill-over increases the production of the numéraire good in the host country of the FDI by $\sigma > 0$ units. This gives the following national welfare measures:

$$U_A = n\,u_A = (\alpha - p)\frac{X_A}{2} + \pi_a + s_A(w_A - \bar{w}) + n\bar{w} + t_A + \sigma; \tag{4}$$

$$U_B = (1-n)u_B = (\alpha - p)\frac{X_B}{2} + (1-n)\bar{w} + t_B + \sigma; \tag{5}$$

where t_i and σ are zero for the country that does not attract the outside firm. Hence the location of firm c matters for country B through its effects on the price for good x, tax revenue collections and the productivity spill-over σ. For country A, it is furthermore relevant how domestic wage and profit income in the x sector are affected by the location choice of the multinational firm.

In order to examine the impact of union power on tax competition for the outside firm, we model a five-stage game. In the first stage, the two competing governments simultaneously and non-cooperatively choose a lump-sum tax or subsidy on the entry of the outside

[19] As is established in an extensive literature, such spill-overs originate from a superior knowledge of multinational firms, which may be transferred to the host country by means of movements of highly skilled staff, or by demonstration effects. See Görg and Strobl (2001) for an empirical meta-analysis of studies that estimate productivity spill-overs of MNEs on host countries.

firm.[20] The objective of governments is to maximize the overall utility of their respective population, as given in (4)–(5). In the second stage, the union in country A chooses the wage rate that maximizes the wage surplus in sector x. The trade-off for the union is that attracting the outside firm increases local output in the unionized sector, but at the same time the union may have to moderate its wage in order to induce firm c to come. In the third stage, the foreign firm decides to enter either market A or market B. In the fourth stage, country A's union may renegotiate the wage set in stage 2, but this is possible only when the MNE does *not* locate in country A. In the fifth stage, output levels are chosen by the firms, in response to the wage rates faced in the respective host countries.

The above sequence of moves implies that the location choice of the MNE is made only *after* the union in country A has committed to the wage rate that it would set if the MNE located in country A. Put differently, if country A attracts the mobile firm, then its union cannot renegotiate the wage after firm c has settled there. This assumption is motivated by the increasing international mobility of MNEs, which can easily relocate production, if changing cost conditions in the host country make it unattractive to stay. The location decisions of MNEs are not permanent and a firm may close a plant in one country and re-open in another, if (relative) production costs change after an initial location decision has been made. More generally, the inherently 'footloose' nature of multinationals has been stressed in the recent theoretical international trade literature[21] and this hypothesis has been supported by several empirical studies.[22] If this argument, and the evidence in favor of it, is incorporated into our static model, then it calls for a sequence of play where the outside firm chooses its location only after the wage rate has been set by country A's union. The same argument does not apply, however, when the union is confronted only with the incumbent firm a, which is internationally immobile. In this case the union can indeed re-optimize the wage, once the MNE has decided to settle in country B.

Another assumption regarding the timing of events is that the government sets its tax policy before the union in country A decides on the wage. To motivate this assumption,

[20] Assuming lump-sum instruments is analytically convenient, but it also captures the character of many existing subsidy schemes. See Table 2.1 in the introduction.

[21] Caves (1996) argues forcefully that MNEs can react promptly to adverse cost changes in the host country and shift production elsewhere. Markusen (2002, pp. 6-7) lists a high share of intangible assets, or 'knowledge capital', as a general characteristic of MNEs. The importance of intangibles like patents or brand names implies that relocation costs are low, relative to the transferred values.

[22] Görg and Strobl (2003) compare the exit probabilities of national and multinational firms in Ireland and find that multinational firms are significantly more likely to exit, other things being equal, when sectoral conditions change adversely. For the United States, Bernard and Jensen (2007) show that plants owned by either U.S. or foreign multinationals are significantly more likely to close than single-plant firms, if other relevant firm characteristics are controlled for.

we interpret the government's policy variable in a wide sense, as a general policy stance towards attracting FDI. Such a policy is arguably of a more long-term nature than the wage setting decision of trade unions and it implies that the government of country A can strategically adjust its tax policy in order to affect the wage claims of the local union. In section 5 we show that our main results are qualitatively unchanged if this sequence is reversed and the union in country A chooses the wage before governments set tax policies.

2.3 Stages 2-5: The interaction of union and firms

2.3.1 Stage 5: Output

The model is solved by backward induction, ensuring subgame perfectness. In the last stage the two firms a and c simultaneously and non-cooperatively choose their output quantities, given the marginal costs in their country of production. The (variable) cost function for firm $j \in \{a, c\}$ is $\kappa_j = w_i x_j$ where w_i is the unit labor cost in the host country i and x_j is firm j's output. Both firms observe market conditions according to (3) and maximize their profits.

In what follows we distinguish between two regimes, depending on whether firm c locates in country A (Regime A, or RA for short) or in country B (Regime B, or RB). Let superscripts denote the country in which the outside firm settles (i.e., the regime), whereas subscripts denote the countries, or firms, for which a given value is calculated. With this notation, the output of firm $j \in \{a, c\}$ in country $i \in \{A, B\}$ is

$$(RA): \qquad x_a^A = x_c^A = \frac{\left(\alpha - w_A^A\right)}{3\,\beta}\,; \tag{6}$$

$$(RB): \qquad x_a^B = \frac{\left(\alpha + \bar{w} - 2w_A^B\right)}{3\,\beta}, \qquad x_c^B = \frac{\left(\alpha - 2\bar{w} + w_A^B\right)}{3\,\beta}\,. \tag{7}$$

In Regime A duopoly competition is symmetric, as the regime-specific wage rate in the host country, w_A^A, is the same for both competitors. In Regime B, the outside firm c faces the competitive wage rate $\bar{w}$ in country B, whereas the incumbent a faces the wage rate w_A^B that country A's union sets when it cannot attract the MNE.

In conjunction with (3) this determines the equilibrium price of good x in the two regimes as a function of regime-specific wages

$$\begin{array}{ll} (RA): & p^A = (\alpha + 2w_A^A)/3; \\ (RB): & p^B = (\alpha + w_A^B + \bar{w})/3. \end{array} \quad (8)$$

These prices lead to regime-specific expressions for the consumer surplus CS_i

$$\begin{array}{llll} (RA): & CS_A^A = \dfrac{2n(\alpha - w_A^A)^2}{9\beta}\,, & CS_B^A = \dfrac{2(1-n)(\alpha - w_A^A)^2}{9\beta}\,; \\ (RB): & CS_A^B = \dfrac{n(2\alpha - w_A^B - \bar{w})^2}{18\beta}\,, & CS_B^B = \dfrac{(1-n)(2\alpha - w_A^B - \bar{w})^2}{18\beta}\,; \end{array} \quad (9)$$

and to regime-specific gross profit levels π_j^i (ignoring fixed costs of production)

$$\begin{array}{lll} (RA): & \pi_a^A = \pi_c^A = \left(\alpha - w_A^A\right)^2/(9\,\beta); & \\ (RB): & \pi_a^B = \left(\alpha - 2w_A^B + \bar{w}\right)^2/(9\,\beta), & \pi_c^B = \left(\alpha - 2\bar{w} + w_A^B\right)^2/(9\,\beta). \end{array} \quad (10)$$

2.3.2 Stage 4: The union's wage renegotiation in Regime B

There are two widely used models of trade union behavior in labor economics, the monopoly union model (as a special case of the more general right-to-manage model) and the efficient bargaining model. Both of these models are able to explain some, but not all, of the stylized facts in labor markets (Oswald, 1993). In the more narrowly related literature on the interaction between unionization and FDI, however, virtually all contributions employ the monopoly union model. This approach provides a benchmark where wages are determined unilaterally by the union, whereas firms adjust their labor demand optimally in a later stage of the game. Stated differently, the union chooses its preferred point on the firms' labor demand curve. We also adopt the monopoly union approach in this paper.

A further modelling choice is at which level the wage setting in country A takes place. In the following we assume that wages are set at the sectoral level, and hence that the same wage rate w_A applies for all firms in sector x of country A. One reason for this specification is that, at least in continental Europe, collective wage bargaining occurs predominantly at the industry level (see Cahuc and Zylberberg, p. 375, Table 1). Moreover, even if wage bargaining occurs at the firm level, these wage negotiations will typically be interdependent due to the competition for, and the intra-sectoral mobility of, workers with similar qualifications. As a result, wage differentials within the same sector are unlikely to be sustainable in equilibrium. As emphasized by Calmfors (1993, p. 170) the correlation of wage outcomes negotiated at the firm level is particularly high in tradeable sectors, such as the unionized x sector in our analysis.

Finally, we assume that the sector-specific union in country A is interested only in the nominal wage, and it neglects the effects of its wage setting behavior on the output price in sector x. This is a simplification, but one that can be motivated rather straightforwardly. Since the union cares only about the workers in the x industry, it ignores the share of the output price increase that falls on workers in country A's numéraire industry z. Moreover, since the market for good x is completely integrated within the region, the union also ignores the effects of the price increase of good x that falls on the residents of country B.

In Regime B, the sector-specific union faces only one local firm in the x sector, the internationally immobile incumbent a. Given the above assumptions, the union maximizes the sector-specific wage surplus, subject to the optimal output adjustment of firm a in (7). Denoting the sectoral wage surplus by Ω_A, the regime-specific maximization problem is

$$(RB): \quad \max_{w_A^B} \quad \Omega_A^B = n s_A (w_A^B - \bar{w}) = x_a^B (w_A^B - \bar{w}). \tag{11}$$

The wage rate that maximizes the objective function of the union is

$$w_A^B = \frac{(\alpha + 3\bar{w})}{4}\,, \tag{12}$$

resulting in a wage surplus for country A's union in Regime B of

$$\Omega_A^B = \frac{(\alpha - \bar{w})^2}{24\,\beta}\,. \tag{13}$$

2.3.3 Stage 3: The location decision of the MNE

We assume that the MNE sets up a subsidiary in either country A or country B. Firm c will be indifferent as to where to settle down when its net-of-tax profits are the same in the two countries. From (10) and the lump-sum taxes t_i this condition reads

$$\pi_c^A - t_A = \pi_c^B - t_B \iff \frac{\left(\alpha - w_A^A\right)^2 - \left(\alpha - 2\bar{w} + w_A^B\right)^2}{9\,\beta} = t_A - t_B. \tag{14}$$

In what follows we assume that the MNE will locate in country A when it is indifferent between the two locations. At the time where it takes its location decision, firm c correctly anticipates that, in Regime B, the union will renegotiate the wage with the remaining incumbent firm in its jurisdiction and set w_A^B from (12). Substituting this wage into (14) we can then solve the condition that keeps the firm indifferent between the two locations for w_A^A. The relevant solution is

$$w_A^A = \alpha - \frac{\delta}{4}\,, \qquad \delta \equiv \sqrt{25(\alpha - \bar{w})^2 + 144\,\beta\,(t_A - t_B)}. \tag{15}$$

Equation (15) gives the maximum wage that the outside firm c is willing to pay in country A, as a function of the tax differential $(t_A - t_B)$. The critical wage rate w_A^A falls when the tax rate in country A is high or that in country B is low, and it rises when the competitive wage $\bar{w}$ (which is to be paid in country B) is high.

2.3.4 Stage 2: The union's wage setting decision

We now analyze the union's wage setting decision. This wage is announced to the outside firm before the latter takes its location decision, but it will remain effective only if the union in country A wants to attract the FDI and thus induces Regime A in equilibrium. (In Regime B the union will instead renegotiate the wage in stage 4.) Hence our discussion in the following will focus on Regime A. Note also that in this regime the union must choose a sectoral wage that applies for *both* firms a and c (cf. the discussion in section 3.2). The union maximizes the regime-specific wage surplus

$$(RA): \quad \max_{w_A^A} \quad \Omega_A^A = n s_A (w_A^A - \bar{w}) = (x_a^A + x_c^A)(w_A^A - \bar{w}), \tag{16}$$

subject to the condition that the wage rate must be sufficiently low to attract the outside firm. Let us assume for the moment that the upper bound on w_A^A in eq. (15) is indeed binding so that the union chooses this wage rate. Substituting (15) and the firms' output choices (6) into (16), the union's wage surplus in Regime A is then

$$\Omega_A^A = \frac{[4(\alpha - \bar{w}) - \delta\,]\,\delta}{24\beta}\,, \tag{17}$$

where δ is given in (15).

The union in country A compares the wage surplus in the case where it is able to attract the outside firm, and in the case where it chooses instead the 'outside option' of letting the firm go to country B and extracting a high wage from the domestic incumbent. Hence the union compares Ω_A^A in (17) with Ω_A^B in (13). Since the term δ includes the tax differential $(t_A - t_B)$, the union's decision of whether to attract the outside firm will be affected by the tax rates that governments choose in the first stage. We assume that the union wants to attract the outside firm in the case where its wage surplus in Regimes A and B is just equal. Then setting $\Omega_A^A = \Omega_A^B$ yields the highest possible tax differential (superscript H) that will still induce the union to set the wage w_A^A. This is[23]

$$(t_A - t_B)^H = -\frac{(9 - 2\sqrt{3})(\alpha - \bar{w})^2}{72\beta} < 0 \, . \tag{18}$$

We can directly infer from (18) that country A's tax rate has to remain below t_B, in order for a Regime A equilibrium to be feasible. Once $(t_A - t_B)$ surpasses the critical threshold in (18), the union will not find it profitable to attract the outside firm, and the location equilibrium will thus be in Regime B.

At this stage we cannot exclude the possibility that the union finds it optimal to charge a wage *below* the maximum wage that is compatible with a location equilibrium in Regime A. In this case condition (14) is not binding and the union's unconstrained wage rate in Regime A, labelled $\tilde{w}_A^A$, is obtained by differentiating (16), using the firms' output choices (6). The resulting wage rate is

$$\frac{\partial \Omega_A^A}{\partial \tilde{w}_A^A} = \frac{2(\alpha + \bar{w} - 2\tilde{w}_A^A)}{3\beta} = 0 \quad \Leftrightarrow \quad \tilde{w}_A^A = \frac{\alpha + \bar{w}}{2} \, . \tag{19}$$

We can then derive a lower threshold (superscript L) for the tax differential $(t_A - t_B)$, which is defined by the equality of w_A^A in (15) and $\tilde{w}_A^A$ in (19). This is

$$(t_A - t_B)^L = -\frac{7(\alpha - \bar{w})^2}{48\beta} < 0, \tag{20}$$

which is unambiguously smaller than $(t_A - t_B)^H$ in (18). Since w_A^A is falling in $(t_A - t_B)$ whereas $\tilde{w}_A^A$ is independent of taxes, any tax differential below this critical value implies that $\tilde{w}_A^A < w_A^A$. In this case the tax rate in country A is so low, relative to that of country B,

[23]Equation (17) is quadratic in the tax differential so that there are two solutions for $(t_A - t_B)$ that solve $\Omega_A^A = \Omega_A^B$. In between these two solutions the union prefers Regime A to Regime B. Of the two solutions only the higher one, $(t_A - t_B)^H$, is of interest for our analysis. The second solution is irrelevant because, at that low level of t_A, the constraint to make the outside firm indifferent between Regimes A and B is not binding for the union. Hence its optimal wage will be determined from an unconstrained problem, as shown below in eq. (19).

that the union is not constrained by the condition to attract the outside firm. It optimally chooses $\tilde{w}_A^A$ according to (19) and since this wage is below w_A^A, the outside firm will surely locate in country A. We label this case Regime $A2$. In contrast, we denote by Regime $A1$ the case where the condition to attract the outside firm is binding and the union's optimal wage is given by (15). We can then characterize the wage policies of country A's union that induce a location equilibrium in each of the three regimes B, $A1$ and $A2$, as a function of the taxes decided by governments in the first stage. Starting with high values of $(t_A - t_B)$ gives:

$$\begin{array}{lll} (RB): & w_A = w_A^B = (\alpha + 3\bar{w})/4 & \text{if} \quad (t_A - t_B) > (t_A - t_B)^H; \\ (RA1): & w_A = w_A^A = \alpha - \delta/4 & \text{if} \quad (t_A - t_B)^L \leq (t_A - t_B) \leq (t_A - t_B)^H; \\ (RA2): & w_A = \tilde{w}_A^A = (\alpha + \bar{w})/2 & \text{if} \quad (t_A - t_B) < (t_A - t_B)^L; \end{array} \tag{21}$$

where δ is given in (15) and $(t_A - t_B)^H$ and $(t_A - t_B)^L$ are given in (18) and (20).

2.4 Stage 1: The governments

In the first stage, the two governments play a tax competition game with the strategic choices being lump-sum taxes or subsidies on the entry of the outside firm. The payoffs are given by the sum of utilities of the worker-consumers in (4)–(5). In a first step we substitute regime-specific output choices (6)–(7) in the union's objectives (16) and (11) and use this along with prices, consumer surplus and profits from (8)–(10) in (4)–(5). This yields regime-specific utilities in Regime A:

$$\begin{aligned} U_A^A &= \frac{2n(\alpha - w_A^A)^2}{9\beta} + \frac{(\alpha - w_A^A)^2}{9\beta} + \frac{2(w_A^A - \bar{w})(\alpha - w_A^A)}{3\beta} + n\bar{w} + t_A + \sigma; \\ U_B^A &= \frac{2(1-n)(\alpha - w_A^A)^2}{9\beta} + (1-n)\bar{w}, \end{aligned} \tag{22}$$

and analogously in Regime B:

$$\begin{aligned} U_A^B &= \frac{n(2\alpha - \bar{w} - w_A^B)^2}{18\beta} + \frac{(\alpha - 2w_A^B + \bar{w})^2}{9\beta} + \frac{(\alpha - \bar{w})^2}{24\beta} + n\bar{w}; \\ U_B^B &= \frac{(1-n)(2\alpha - \bar{w} - w_A^B)^2}{18\beta} + (1-n)\bar{w} + t_B + \sigma. \end{aligned} \tag{23}$$

In the expressions for U_A, the first term equals the consumer surplus, the second term is profit income from firm a and the third term denotes the wage surplus Ω_A. For country B, the consumer surplus in market x is given by the first terms in U_B^A and U_B^B.

To solve the tax competition game we proceed in two steps. We first derive the properties that a candidate tax equilibrium in Regime A must have and then show that there is indeed a unique equilibrium of the first-stage game in Regime A.

In the first step we show that in any candidate tax equilibrium in Regime A, the government of country A wants to raise the tax rate up to the point where neither the outside firm nor the trade union receive a rent over their next best alternatives.

Lemma 1 *In any candidate tax equilibrium in Regime A, the tax differential is given by* $(t_A - t_B)^H$ *in* (18) *and the union sets the wage according to* w_A^A *in* (15).

Proof: See Appendix.

The technical proof for the lemma is relegated to the appendix, but the reasoning behind this result is easily explained. First it is straightforward to see that, for any level of t_B, country A will never set a tax that leads to an equilibrium in Regime $A2$. In this case the wage rate would be $\tilde{w}_A^A$ in (19), which is below w_A^A in (15). Setting the wage below w_A^A implies, however, that the union leaves a location rent to the outside firm, in excess of what is needed to attract it to country A. This is anticipated by country A's government, which raises t_A and thus brings down w_A^A until $\tilde{w}_A^A = w_A^A$. This tax increase will not raise the equilibrium wage and its only effect is to increase country A's tax revenue at the expense of firm c's profits. This clearly must be beneficial for country A.

The second part of the proof shows that, for any level of t_B, optimal tax policy in country A always implies that the union is not left with a wage surplus that exceeds its surplus in Regime B [eq. (13)]. In other words, country A's optimal tax policy implies that any candidate equilibrium is at the boundary of Regimes $A1$ and B, rather than in the interior of Regime $A1$. Intuitively, w_A^A is the union's optimal wage policy in Regime $A1$, which is a decreasing function of $(t_A - t_B)$. Therefore a tax increase in country A replaces wage surplus accruing to the workers in sector x by an equal amount of tax revenue. Lowering the wage rate, however, also creates an efficiency gain because it reduces the wage-induced output distortion in sector x, whereas the lump-sum entry tax for the outside firm does not distort output decisions at the margin.[24]

Lemma 1 has two implications that greatly simplify the tax competition game below. First, since country A's optimal tax policy implies a tax differential equal to (18) for each value of t_B, we can derive the wage rate that must necessarily hold in any candidate Regime A equilibrium. Substituting (18) in (15) gives

$$(w_A^A)^* = \alpha - \frac{(2+\sqrt{3})}{4}(\alpha - \bar{w}) = \bar{w} + \frac{(2-\sqrt{3})}{4}(\alpha - \bar{w}). \tag{24}$$

Note that this wage rate is above the competitive wage rate $\bar{w}$, but it is below the wage rate that the union charges from the domestic incumbent in Regime B [see eq. (12)].

Second, Lemma 1 also implies that the union's wage surplus is identical in the two regimes. Substituting (24) in (6) and in the union's objective function in Regime A [eq. (16)] gives country A's wage surplus in any (potential) Regime A equilibrium, which equals that in Regime B:

$$(\Omega_A^A)^* = \frac{(\alpha - \bar{w})^2}{24\beta} = \Omega_A^B. \tag{25}$$

These results allow us to express regime-specific national welfare in each country as a function of exogenous parameters and tax rates only. We substitute $(w_A^A)^*$ from (24) and w_A^B from (12) into (22) and (23), respectively. This gives for Regime A:

$$U_A^A = \frac{[13 + 4\sqrt{3} + n(14 + 8\sqrt{3})](\alpha - \bar{w})^2}{144\beta} + n\bar{w} + t_A + \sigma$$

$$U_B^A = \frac{(7 + 4\sqrt{3})(1-n)(\alpha - \bar{w})^2}{72\beta} + (1-n)\bar{w}\ ; \tag{26}$$

and analogously for Regime B:

$$U_A^B = \frac{20 + 49n(\alpha - \bar{w})^2}{288\beta} + n\bar{w}\ , \qquad U_B^B = \frac{49(1-n)(\alpha - \bar{w})^2}{288\beta} + (1-n)\bar{w} + t_B + \sigma\ . \tag{27}$$

To derive the tax equilibrium, we set up the best response functions of the two governments.

[24] Lemma 1 does not hold for $n < 0.4$ and this is why we have constrained n from the outset (see footnote 17). The reason is that if country A becomes too small, it internalizes few of the efficiency gains from attracting firm c, which accrue to all consumers in the region through a lower price for good x. Instead country A then wants to raise the wage rate in order to increase the union's wage surplus at the expense of foreign consumers. This leads to country A choosing a tax rate *below* the one compatible with $(t_A - t_B)^H$, in order to accommodate a higher wage demand of its union. The analysis of this case is complex and unrewarding, however, and generally a tax equilibrium in pure strategies cannot be shown to exist.

Starting with country A, its government will never make a tax offer that leaves the country worse off in Regime A, as compared to the allocation that results in Regime B. Hence, setting $U_A^A = U_A^B$ in (26) and (27) gives the *best offer* (denoted by a superscript o) that country A's government is willing to make to the outside firm c. This is the minimum tax that country A is willing to accept, or the maximum subsidy that it is willing to pay, in order to host the firm:

$$t_A^o = \frac{-[6 + 8\sqrt{3} + n(16\sqrt{3} - 21)](\alpha - \bar{w})^2}{288\beta} - \sigma \,. \tag{28}$$

Note that country A's best offer is negative, even if no technological externality arises from FDI (i.e, $\sigma = 0$). Hence country A is willing to subsidize the outside firm, if it is forced to do so by a sufficiently low tax rate of country B. The willingness to subsidize the firm results from the additional employment in the x sector generated by the foreign investment. Moreover, any positive spillover effect $\sigma > 0$ is fully reflected in a still higher subsidy offer of country A.

Moreover, we know from Lemma 1 that in any candidate equilibrium in Regime A, country A's best response to the tax rate of country B is implied by the critical tax differential $(t_A - t_B)^H$ in (18).[25] Hence country A's best response function is[26]

$$t_A = \begin{cases} t_B - \dfrac{(9 - 2\sqrt{3})(\alpha - \bar{w})^2}{72\beta} & \text{if } t_B \geq \tilde{t}_B \quad (RA), \\ \dfrac{-[6 + 8\sqrt{3} + n(16\sqrt{3} - 21)](\alpha - \bar{w})^2}{288\beta} - \sigma & \text{if } t_B < \tilde{t}_B \quad (RB). \end{cases} \tag{29}$$

The threshold value $\tilde{t}_B$, below which country A stops matching successively lower taxes offered by country B is given from substituting t_A^o in (18)

$$\tilde{t}_B = \frac{[30 - 16\sqrt{3} + n(21 - 16\sqrt{3})](\alpha - \bar{w})^2}{288\beta} - \sigma \,. \tag{30}$$

In a similar way, we can set up the best response function of country B. The best offer that this country will make to the outside firm, t_B^o, is obtained from equating $U_B^A = U_B^B$

[25] Recall our assumptions that the union in country A wants to attract the firm when its wage surplus in Regime A is at least as high as in Regime B, and the outside firm settles in country A when its net-of-tax profits are equal in A and in B.

[26] Strictly speaking, the lower branch of country A's best response function is a correspondence, as any value of t_A that does not attract the outside firm yields the same welfare level for country A.

in (26) and (27):

$$t_B^o = \frac{(16\sqrt{3}-21)(1-n)(\alpha-\bar{w})^2}{288\beta} - \sigma. \tag{31}$$

In the absence of spill-overs ($\sigma = 0$), country B's best offer is positive. The reason is that in Regime B the union in country A will push through the high wage w_A^B in (12), harming consumers in B. Country B wants to be compensated for this loss in consumer surplus by positive tax revenues, in order to be willing to attract the FDI.

In Regime B, country B's best response to any given level of t_A is to offer a tax rate that is marginally below the one implied by (18). If instead t_A is so low that country B no longer wants to attract the firm, then it will still want to ensure by its tax offer that the union in country A does not receive a wage above $(w_A^A)^*$ in (24). The reason is that country B's consumers are unambiguously hurt by high wages in country A. Hence in this case country B will just bid the tax implied by (18), as this ensures that country A receives the firm (see footnote 25). Hence the best response function of country B is

$$t_B = \begin{cases} t_A + \dfrac{(9-2\sqrt{3})(\alpha-\bar{w})^2}{72\beta} - \varepsilon & \text{if } t_A \geq \tilde{t}_A \qquad (RB), \\ t_A + \dfrac{(9-2\sqrt{3})(\alpha-\bar{w})^2}{72\beta} & \text{if } t_A < \tilde{t}_A \qquad (RA); \end{cases} \tag{32}$$

where ε is a small positive number and $\tilde{t}_A$ is the tax offer of country A below which country B no longer wants to attract the outside firm. Substituting t_B^o in (18) gives

$$\tilde{t}_A = \frac{[24\sqrt{3} - 57 - n(16\sqrt{3}-21)](\alpha-\bar{w})^2}{288\beta} - \sigma < 0\,. \tag{33}$$

Note that the structural difference between the best response functions lies in the lower branches of (29) and (32), respectively. Country A is indifferent between all allocations in Regime B, due to the fixed wage rate in country B. In contrast, country B prefers the allocation in Regime A that minimizes the endogenous wage rate w_A^A, and uses its tax policy accordingly.

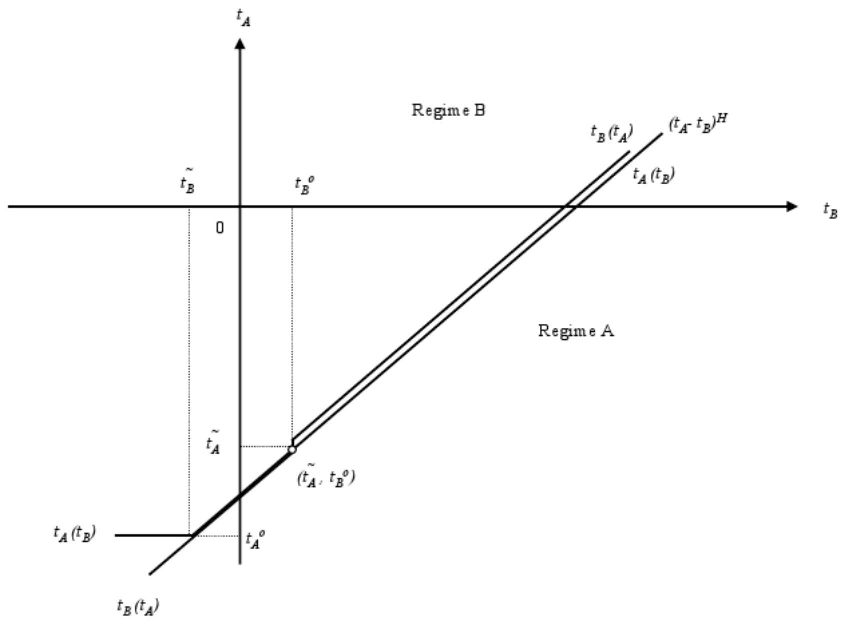
To find the equilibria of the tax game we must look for mutually consistent pairs of tax offers. From (29) and (32) the equilibrium will be in Regime A if $\tilde{t}_A > t_A^o$ holds. Intuitively, this implies that starting from high tax rates which are successively lowered, country B drops out of the bidding game before country A does. Conversely, a Regime B equilibrium is characterized by $\tilde{t}_A < t_A^o$ (or, alternatively, by $\tilde{t}_B > t_B^o$). It is easily checked from (28) and (33) that $\tilde{t}_A > t_A^o$ is indeed fulfilled for all levels of n in our specified range. Hence the tax pair

$$\{\tilde{t}_A, t_B^o\} = \left\{ \frac{[24\sqrt{3} - 57 - n(16\sqrt{3} - 21)](\alpha - \bar{w})^2}{288\beta} - \sigma,\ \frac{(16\sqrt{3} - 21)(1 - n)(\alpha - \bar{w})^2}{288\beta} - \sigma \right\} \tag{34}$$

is an equilibrium of the tax competition game in the first stage, where the outside firm locates in country A.[27]

Eq. (34) also shows that the positive spill-over effect $\sigma > 0$, which is identical for the two countries, is fully reflected in a lower tax rate of the country attracting the outside firm in equilibrium (country A). Hence all benefits from the spill-over accrue to the outside firm, as a result of tax competition between the two potential hosts.

Figure 2.2: The tax competition game



The tax competition equilibrium is shown graphically in Figure 2.2. The figure shows that the equilibrium tax pair (34) is not the only one in our first-stage game. In fact, all tax rates $\tilde{t}_A \geq t_A \geq t_A^o$ are matched by mutually consistent tax rates of country B [see the

[27]Since the outside firm receives a subsidy in this equilibrium, its after-tax profits exceed before-tax profits. Hence, a sufficient condition for firm c to locate in country A is that the fixed costs F of setting up a subsidiary do not exceed firm c's before-tax profits. From (10) and (24) the latter are $(7 + 4\sqrt{3})(\alpha - \bar{w})^2/(144\beta)$.

lower branch of (32)]. Hence all these tax combinations lead to equilibria in Regime A and have the property that the tax differential equals $(t_A - t_B)^H$ in (18). The reason for this multiplicity of equilibria is that, whenever country A lowers its tax below $\tilde{t}_A$, country B will fully match this tax reduction in order to minimize the unionized wage in country A, while at the same time ensuring that it does not attract the outside firm. Hence it is possible in our setting that country B offers a tax rate *below* its best offer in (31).[28]

The particular Nash equilibrium given in (34) may, however, be regarded as the dominant equilibrium in our analysis (cf. Fudenberg and Tirole, 1991, pp. 20-21). This is because it is the Pareto optimal equilibrium from the perspective of the two governments taken together. Any other of the Nash equilibria involves lower tax revenues for country A (to the benefit of the outside firm c) and no welfare change in country B. For this reason we will focus on the tax vector (34) in the following. At the same time, it is worth emphasizing again that *all* possible Nash equilibria lie in Regime A. We can thus summarize:

Proposition 1 *In the tax/subsidy game between two countries that differ with respect to union power, the unionized country (country A) offers a location subsidy and attracts the outside firm in equilibrium.*

The result in Proposition 1 is surprising at first glance, as the unionized country seems to be at a disadvantage in the location competition for the outside firm. What is crucial, however, is that this country has an incentive to subsidize the firm, which exceeds the cost disadvantage that the MNE faces when it locates in country A. By subsidizing the MNE, the government of country A can induce the union to moderate its wage in exchange for higher employment in sector x [recall from (12) and (24) that $w_A^B > (w_A^A)^*$], thus reducing the inefficiencies in country A's labor and product markets.

Note, moreover, that it is also *globally efficient* in the present setting that the outside firm locates in country A. Substituting (24) and (12) in (8) shows that the price for good x in the integrated market is lower when both firms produce in country A at unit labor costs w_A^A in (24) than in Regime B, where the outside firm produces in country B at costs $\bar{w}$, but the incumbent firm in country A has unit labor costs w_A^B. This is an intuitive result in the present setting, where tax policy can reduce the wage surplus to its reservation value

[28] In the existing literature on tax competition for FDI, the country that loses the competition for FDI is typically indifferent between all bids that do not attract the outside firm(s). Hence a refinement of Nash equilibrium can be invoked to exclude multiple equilibria by arguing that countries will never play weakly dominated strategies. See, for example Barros and Cabral (2000, Figure 1), or Ferrett and Wooton (2005, p. 17). The same argument cannot be used in the present analysis, however, because country B is *not* indifferent between its bids in Regime A.

Ω_A^B. The union in country A will then accept a wage below the average of $\bar{w}$ and w_A^B in Regime A, because it will benefit not only from the location of the outside firm but also from the output expansion of both firms following a wage decrease. This output expansion constitutes the efficiency gain that can be reaped when the FDI takes place in country A.

The result that the unionized country attracts the outside firm in equilibrium does *not* imply, however, that workers in country A are also 'better off', on average, than those in country B. For a meaningful comparison of per capita welfare in the two countries we need to disregard the additional profit income from firm a. We thus assume that all profit income in country A accrues to a group of capitalists with mass zero, whereas the n workers do not receive any profit income. From (22) workers' income in country A is then $(U_A^A)^w = U_A^A - (\alpha - w_A^A)^2/(9\beta)$. Dividing $(U_A^A)^w$ and U_B^A in (22) by n and $(1-n)$, respectively, and forming the difference yields

$$\frac{(U_A^A)^w}{n} - \frac{U_B^A}{(1-n)} = \frac{1}{n}\left[(\Omega_A^A)^* + \tilde{t}_A + \sigma\right] = \frac{[24\sqrt{3} - 45 + n(21 - 16\sqrt{3})](\alpha - \bar{w})^2}{288\beta n} < 0, \tag{35}$$

where (25) and (33) have been used in the second step. Hence, for any (permitted) level of n, non-profit income per capita is lower in country A than in country B. In other words, the equilibrium subsidy paid by country A exceeds the sum of the wage surplus for workers in sector x and the technological externality σ. Moreover, this result must hold for all Nash equilibria of the tax game, because welfare in country A is never higher than in the equilibrium given by (34), whereas welfare in country B is the same in all Nash equilibria. Hence we get:

Proposition 2 *In all Nash equilibria, per-capita non-profit income in the unionized country (country A) is less than per-capita income in the non-unionized country.*

A simple way to explain this result is to compare the different ways in which countries A and B can (partly) extract the profits from the outside firm, if it locates in their jurisdiction. In country B only the tax instrument is available for this purpose, but this instrument causes no allocative distortions. In country A, in contrast, profit extraction occurs through a mix of higher wages and lump-sum taxes. Since the wage instrument is distortive but must nevertheless be used in order to ensure the compliance of the union, country A's set of instruments to capture the outside firm's profits is less efficient, on average. Since the overall level of profit extraction is fixed for both countries by the arbitrage condition that governs firm c's location choice, these efficiency losses translate into a lower average non-profit income in country A.

Proposition 2 immediately leads to the question of why a union exists in country A, given that its presence is welfare-reducing, on average. One answer to this question is the presence of redistributive effects. It is easily shown that even though unionization reduces the average non-profit income in country A, the *unionized* workers in A are better off than they would be in the absence of the union. This result holds under the condition that the share of workers in the x sector does not exceed a critical threshold. Put differently, there must be a sufficiently large z sector whose workers bear both the efficiency losses and the redistributive gains of their unionized counterparts:

Proposition 3 *If the share of workers in the unionized sector is below a critical value* $s_A^c \approx 0.41$*, the per-capita welfare of unionized workers in country A is higher than in the absence of the union.*

Proof: See Appendix.

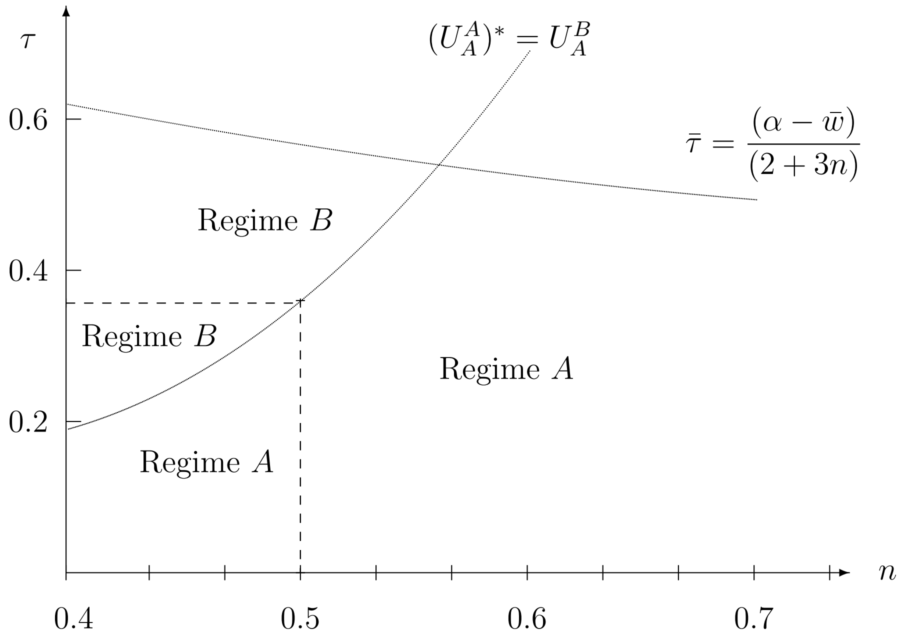
2.5 Extensions and discussion

In this section we examine the robustness of our results when some of the model's assumptions are changed. One relevant extension is when positive trade costs are incurred for shipping goods between countries A and B. In this setting with imperfect market integration, the relative size of national markets becomes directly relevant for the question of who attracts the firm in equilibrium. This case is analyzed in the appendix. While the calculations are considerably more tedious, the basic mechanisms at work in this extended model are completely analogous to those in our benchmark case.

The results of the extended model are presented graphically in Figure 2.3. On the horizontal axis is country A's market share in the region (n), whereas the vertical axis graphs per-unit transport costs τ between countries A and B. The upward sloping curve gives the locus of all (n, τ) combinations where optimized welfare in the two regimes is just equal for country A. As shown in the appendix, all equilibria in Regime A are then to the right of this curve, whereas equilibria in Regime B are to the left.

The graph combines two asymmetries that have been analyzed in the previous literature. In the presence of transport costs, the larger country wins the competition for an outside firm, other things being equal (Haufler and Wooton, 1999). If instead two countries of equal size compete for an outside firm and trade costs partially separate markets, then

Figure 2.3: Location of firm c as a function of trade costs and market size



Note: The figure is drawn for $\alpha = 10$, $\bar{w} = 8$, $\beta = 9$.

the MNE will choose the less competitive environment and locate in the country without an incumbent firm (Bjorvatn and Eckel, 2006). These findings are also incorporated in Figure 2.3, as a larger domestic market size n makes it more likely for country A to attract the outside firm, whereas high transport costs strengthen the competitive advantage of country B, which does not have an incumbent firm.

If a sector-specific union in country A is added to this picture, first intuition would suggest that the unionized country A needs to have other, compensating advantages in order to attract the FDI. Figure 2.3 shows, however, that exactly the opposite is true and country A can win the competition for the outside firm, even though it has the smaller home market *and* it already hosts an incumbent firm. This occurs in the area underneath the regime frontier, but to the left of $n = 0.5$. Hence, the fact that country A has a domestic union is able to simultaneously offset two other (albeit limited) location disadvantages. In this sense Proposition 1 carries over to the more general setting analyzed here.

When the trade costs in Figure 2.3 exceed a critical threshold $\bar{\tau}$, trade will cease in at least one of the two regimes (see Appendix for details). When trade costs become so high as to make exports from A to B unprofitable in Regime A, it is obvious that a Regime B equilibrium must result in order for B's residents to be able to consume good x. Hence the case of prohibitively high trade costs requires a symmetric set-up with one internationally immobile, incumbent firm in each of countries A and B. In this case it is again true that the unionized country will attract the outside firm, even if it has a (limited) market size disadvantage vis-à-vis country B. Thus Proposition 1 also generalizes to a setting with prohibitively high trade costs, if the model is adjusted to incorporate symmetric market conditions in the two countries.[29]

In the following we revert again to the case of zero trade costs. A second issue is whether, and how, the results of our model are affected when the sequence of play is altered.[30] One alternative scenario is that the union's decisions are of a longer-term nature than tax policies and hence the union in country A chooses the wage rate before the two governments set taxes. This setting changes the distribution of rents, in comparison to our benchmark case. If the union in country A has a first-mover advantage it will choose the sector-specific wage w_A so as to just make country A's government willing to set a sufficiently low tax rate in order to attract the outside firm. In other words, the government of country A will then always have to bid its best offer. In comparison to our benchmark case, this scenario leads to higher wages and a lower average per-capita utility in country A. However, it will still be true that the unionized country attracts the FDI in equilibrium and hence Proposition 1 carries over to this alternative sequence of moves.

In contrast, the assumption that the outside firm makes its location choice only *after* the wage is set by country A's union is crucial for the results of our model. To see this let us consider a scenario where governments set taxes in the first stage, firm c makes its location in the second stage, the union in country A sets the wage in the third stage and both firms choose output levels in the fourth stage.[31] In this case the union in country A will set the monopoly wage also in Regime A, as the investment is locked in at the time of the union's wage decision. Hence tax policy is unable to induce wage moderation and, as a result, country A's government is unwilling to make a sufficiently generous tax offer to attract the FDI. Such a scenario would imply, however, that the international mobility of the multinational firm is permanently lost, once this firm has settled in one country. Instead, as we have discussed in section 2, it is a characteristic feature of MNEs that they retain their 'footloose' nature even after a (temporary) location decision has been made and hence can relocate easily, should the union in country A increase the sector-specific wage rate.

[29] See our working paper version, Haufler and Mittermaier (2008), for a full analysis of this case.

[30] The complete set of results for these cases is available from the authors upon request.

[31] This setting is equivalent to allowing the union in the fourth stage of our analysis (section 3.2) to renegotiate the wage also in Regime A.

Another possible sequence of events is that the union can commit to the wage rate set in stage 2, even if the MNE locates in country B (i.e., it does not renegotiate the wage in stage 4). In this setting Proposition 1 is maintained and a Regime A equilibrium becomes even more likely than in our benchmark case. The reason is that the incumbent firm a faces a lower wage rate and hence produces more output in Regime B when the wage is not renegotiated. This in turn makes it less attractive for the MNE to locate in country B. However, this scenario would imply that the union can commit to a wage rate in Regime B that is below the ex-post optimal wage w_A^B in eq. (12). Given the immobility of the incumbent firm a, this announcement will not be credible.

Thirdly, we briefly consider the case of price competition between the two active firms. In the benchmark setting with homogeneous goods and no trade costs, Bertrand competition effectively eliminates all union power. The reason is that if the MNE locates in country B and faces the marginal wage cost $\bar{w}$, the incumbent firm in country A will not have positive sales in the integrated market, unless the wage in this country also drops to $\bar{w}$. But this implies that the union loses its outside option and hence its wage surplus in equilibrium can be driven to zero by an optimizing strategy of country A's government.

Finally, we have chosen the most straightforward way to model asymmetric union power by assuming that a union is present in country A, whereas the labor market in country B is competitive. We expect our results to carry over qualitatively to the case where a union is also present in country B, but it is less powerful than that of country A. If union power is fully symmetric in countries A and B, then the equilibrium location of the outside firm will be indeterminate, unless other relevant asymmetries are introduced into the model.

2.6 Conclusion

In this paper we have analyzed a model of tax competition between two countries of different size, of which one has a sector-specific union in an imperfectly competitive market, whereas the other country's labor market is perfectly competitive. This model leads to the seemingly counterintuitive result that it is the unionized country which attracts an internationally mobile firm in equilibrium. In a model extension with positive trade costs, the unionized country can win the FDI even if it has two simultaneous location disadvantages, such as a smaller home market and an incumbent firm in the relevant market. The core reason underlying our results is that the government of the unionized country will provide a generous tax environment to the firm as a means to induce wage moderation from its domestic union. Foreign direct investment plays a crucial role in this process because it offers a discrete increase in employment opportunities when the union 'cooperates' in attracting the mobile firm.

Our analysis may help to explain why high investment subsidies are commonplace in locations with high wages and union power. At the same time it may also provide a possible explanation for the puzzling result in several empirical studies that a high degree of unionization is *positively* correlated with the likelihood of a given location to attract multinationals (Coughlin et al., 1991; Friedman et al., 1992). While these studies typically incorporate the regular rates of business taxes, they do not include specific location subsidies, on which the present analysis has focused. Incorporating such (direct or indirect) subsidies as an explanatory variable would thus allow a direct test of our theoretical hypotheses.

Our model can be extended in several directions. One possible route is to widen the set of policy instruments in the hands of governments and to include distortionary taxes. We would expect that the overall policy package in the (more) unionized country is still more generous towards international investors, and hence that the unionized country will attract more FDI, other things being equal. A second possible extension is to relax the assumption of a monopoly union and replace it by a bargaining game between the union and the firm(s). Finally, and perhaps most ambitiously, an extended model could allow for repeated interactions between the union and the multinational firm, when the latter can relocate in response to changing wage demands by the union, but incurs some costs of doing so. We leave the analysis of these extensions to future research.

2.7 Appendix

Proof of Lemma 1

We start from country A's welfare in Regime A, U_A^A, as given in (22). In Regime $A2$, where the union's wage is not constrained by the condition to attract the outside firm, we substitute $\tilde{w}_A$ from (19) into (22). This gives

$$U_A^{A2} = \frac{(2n+7)(\alpha - \bar{w})^2}{36\beta} + n\bar{w} + t_A + \sigma.$$

Hence $\partial U_A^{A2}/\partial t_A = 1$ holds throughout Regime $A2$, implying that it is optimal for country A's government to raise taxes until Regime $A1$ is reached.

In Regime $A1$, we substitute w_A^A from (21) into (22). This gives

$$U_A^{A1} = \frac{\delta^2(2n-5) + 24\delta(\alpha - \bar{w})}{144\beta} + n\bar{w} + t_A + \sigma,$$

where $\delta(t_A, t_B)$ is given in (15). Maximizing with respect to t_A, for any given level of t_B, yields[32]

$$t_A^m = \frac{(16-5n)(5n-4)(\alpha - \bar{w})^2}{144(2-n)^2\beta} + t_B. \tag{A.1}$$

Hence country A either sets t_A^m in (A.1), or it raises its tax until it reaches the border to Regime B, where $(t_A - t_B)^H$ holds as given in (18). For any given t_B, country A thus wants to raise its tax throughout Regime $A1$ iff $t_A^m > t_A^H$. This condition is fulfilled if

$$\frac{(16-5n)(5n-4)(\alpha - \bar{w})^2}{144(n-2)^2\beta} - \frac{\left(2\sqrt{3}-9\right)(\alpha - \bar{w})^2}{72\beta} > 0 \quad \Leftrightarrow \quad n > 2\left(3\sqrt{3}-5\right) \approx 0.39. \tag{A.2}$$

Hence, for any $n \geq 0.4$ the tax differential in any candidate equilibrium in Regime A is given by $(t_A - t_B)^H$ in (18). □

[32] The second order condition for a maximum is fulfilled.

Proof of Proposition 3

From (22) country A's aggregate welfare, but excluding profit income, in Regime A is

$$(U_A^A)^w = \frac{2n\left(\alpha - w_A^A\right)^2}{9\beta} + \frac{2(w_A^A - \bar{w})(\alpha - w_A^A)}{3\beta} + n\bar{w} + t_A + \sigma. \tag{A.3}$$

We substitute $(w_A^A)^*$ from (24) and $\tilde{t}_A$ from (34). To obtain the per capita welfare of a *unionized* worker, we divide tax revenues and consumer surplus by n but the wage surplus by $s_A n$, since only the share of workers in sector x enjoys the wage surplus. This gives

$$u_A^{union} = \left[\frac{7+4\sqrt{3}}{72} + \frac{1}{24ns_A} + \frac{(21-16\sqrt{3})n + 24\sqrt{3} - 57}{288n}\right]\frac{(\alpha-\bar{w})^2}{\beta} + \bar{w}. \tag{A.4}$$

In the absence of a trade union, both countries are indifferent about attracting the firm, except for the technological externality σ. This leads to $t_i = -\sigma$ in equilibrium and both countries are indifferent about being in Regime A or B. Hence (non-profit) per capita welfare of all workers in country A amounts to

$$u_A^{nounion} = \frac{2(\alpha-\bar{w})^2}{9\beta} + \bar{w}. \tag{A.5}$$

Equating per capita welfare in (A.4) and (A.5) and solving for s_A yields the critical share s_A^c where unionized workers are indifferent between having the union or not:

$$s_A^c = \frac{4}{19 - 8\sqrt{3} + 5n}. \tag{A.6}$$

This share is falling in n and thus reaches its minimum at the maximum value of n in the permitted range, which is $n = 0.9$. In this case $s_A^c(n = 0.9) \approx 0.415$. Hence $s_A < 0.41$ is a sufficient condition for each unionized worker to gain from having the union, for all values of n permitted in our analysis. □

The model with positive trade costs

We now assume that there is a per unit trade cost of τ on each unit of good x shipped between countries A and B, whereas trade in the z industry remains free. Firms' profits in the final stage of the game are then

$$\pi_a^A = \pi_c^A = \frac{n\left(\alpha - w_A^A\right)^2}{9\beta} + \frac{(1-n)\left(\alpha - \tau - w_A^A\right)^2}{9\beta} \tag{A.7}$$

if the outside firm c goes to A. If it goes to B then

$$\begin{aligned} \pi_a^B &= \frac{n\left(\alpha + \bar{w} + \tau - 2w_A^B\right)^2}{9\beta} + \frac{(1-n)\left(\alpha + \bar{w} - 2\tau - 2w_A^B\right)^2}{9\beta}, \\ \pi_c^B &= \frac{n\left(\alpha - 2\bar{w} - 2\tau + w_A^B\right)^2}{9\beta} + \frac{(1-n)\left(\alpha - 2\bar{w} + \tau + w_A^B\right)^2}{9\beta}. \end{aligned} \tag{A.8}$$

The quantities produced in the two regimes are

$$x_a^A = x_c^A = \frac{n\left(\alpha - w_A^A\right)}{3\beta} + \frac{(1-n)\left(\alpha - \tau - w_A^A\right)}{3\beta} \tag{A.9}$$

and

$$\begin{aligned} x_a^B &= \frac{n\left(\alpha + \bar{w} + \tau - 2w_A^B\right)}{3\beta} + \frac{(1-n)\left(\alpha + \bar{w} - 2\tau - 2w_A^B\right)}{3\beta}, \\ x_c^B &= \frac{n\left(\alpha - 2\bar{w} - 2\tau + w_A^B\right)}{3\beta} + \frac{(1-n)\left(\alpha - 2\bar{w} + \tau + w_A^B\right)}{3\beta}, \end{aligned} \tag{A.10}$$

respectively. In stage 4, using these quantities in (11) and maximizing with respect to w_A in Regime B gives

$$w_A^B = \frac{1}{4}[\alpha + 3\bar{w} + (3n-2)\tau], \qquad \Omega_A^B = \frac{[\alpha - \bar{w} + (3n-2)\tau]^2}{24\beta} \tag{A.11}$$

as the union's wage and the wage surplus in Regime B. In stage 3, equating the multinational's gross profit differential in the two countries to $(t_A - t_B)$, as in (14), solving this term for w_A^A and substituting w_A^B from (A.11) gives

$$\begin{aligned} & w_A^A = \alpha - (1-n)\tau - \\ & \frac{1}{4}\sqrt{25(\alpha-\bar{w})^2 - 10(9n-2)\tau(\alpha-\bar{w}) + (2-n)(47n+2)\tau^2 + 144\beta(t_A - t_B)}, \end{aligned} \tag{A.12}$$

which collapses to (15) for $\tau = 0$. In stage 2, we use (4) and (A.9) to calculate the wage surplus Ω_A^A. Equating this to Ω_A^B in (A.11) yields

$$\begin{aligned} (t_A - t_B)^H = \frac{1}{72\beta} & \left[-9(\alpha-\bar{w})^2 + 2(25n-8)\tau(\alpha-\bar{w}) + n(23n-48)\tau^2\right. \\ & \left. +2\sqrt{[3\alpha - 3\bar{w} - (4-5n)\tau](\alpha - \bar{w} - n\tau)(\alpha - \bar{w} + n\tau - \tau)^2}\right], \end{aligned} \tag{A.13}$$

which reduces to (18) for $\tau = 0$.

In the first stage of the game, the governments maximize welfare in a way analogous to (22) and (23). The firms' profits are given in (A.7)-(A.8) and the wage surplus of country A's union is obtained by inserting (A.9) and (A.10) into (11) and (16). Consumer surplus in the different regimes amounts to

$$CS_A^A = \frac{2n\left(\alpha - w_A^A\right)^2}{9\beta}, \qquad CS_B^A = \frac{2(1-n)\left(\alpha - w_A^A - \tau\right)^2}{9\beta},$$
$$CS_A^B = \frac{n\left(2\alpha - \bar{w} - \tau - w_A^B\right)^2}{18\beta}, \qquad CS_B^B = \frac{(1-n)\left(2\alpha - \bar{w} - \tau - w_A^B\right)^2}{18\beta}. \tag{A.14}$$

Substituting (A.11), (4) and (A.13) into the welfare terms and equalizing country B's welfare in the two regimes, we derive country B's best offer tax rate as

$$t_B^o = -\sigma + \frac{1}{288\beta}\left\{-[7\alpha - 7\bar{w} - (3n+2)\tau]^2 + 4\left[\sqrt{7(\alpha-\bar{w})^2 + 2(5n-6)\tau(\alpha-\bar{w}) - (n^2+4n-4)\tau^2 + 4\gamma(\alpha - \bar{w} + n\tau - \tau)} - 4n\tau\right]^2\right\} \tag{A.15}$$

where

$$\gamma \equiv \sqrt{3(\alpha-\bar{w})^2 - 2(2-n)\tau(\alpha-\bar{w}) + (4-5n)n\tau^2}\,. \tag{A.16}$$

It is straightforward to show that Lemma 1 also holds for $n \geq 0.4$ when $\tau > 0$. Intuitively this is because the presence of trade costs makes it less attractive for country A to pursue a beggar-thy-neighbor policy by means of high unionized wages (cf. footnote 24). Hence we can add the tax differential $(t_A - t_B)^H$ from (A.13) to (A.15) to get the tax rate that country A will optimally offer in a candidate Regime A equilibrium. Substituting this tax rate to get maximized Regime A welfare, $(U_A^A)^*$, and subtracting U_A^B determines under which conditions country A wants to host the firm. This difference is

$$\begin{aligned}(U_A^A)^* - U_A^B &= \frac{1}{288\beta}\left\{-51(\alpha-\bar{w})^2 + 2(127n-38)(\alpha-\bar{w})\tau\right. \\ &+ \left.[n(197n-324)-12]\tau^2 + 32\gamma[\alpha - \bar{w} + (n-1)\tau]\right\}\,,\end{aligned} \tag{A.17}$$

where γ is defined in (A.16). Setting this welfare difference equal to zero yields the locus of all (n, τ) combinations where country A is indifferent about attracting the firm or not. This is the upward sloping curve labelled $(U_A^A)^* = U_A^B$ in Figure 2.3. Below this line (A.17) is positive and a Regime A equilibrium results, whereas above the line (A.17) is negative and the equilibrium is in Regime B.

To obtain the lowest prohibitive level of trade costs where firm a stops exporting to country B, we substitute the equilibrium wages (A.11) and (4) into the profit terms (A.7) and (A.8) and set these two zero. This yields a lowest prohibitive trade cost level of $\bar{\tau} = (\alpha - \bar{w})/(3n + 2)$, which arises in Regime B. This upper limit on τ is represented by the downward sloping curve in Figure 2.3.

Chapter 3

The winner gives it all: Unions, tax competition and offshoring

3.1 Introduction

In January 2008, Nokia's Executive Vice president Veli Sundbäck announced the closure of its handset factory in Bochum in North Rhine-Westphalia (NRW) and the relocation of Nokia's manufacturing activity to Cluj (Romania) as a response to changes in market conditions and an increased requirement for cost effectiveness. However, as Nokia had received investment subsidies from the state of NRW for its production site in Bochum and will be exempt from the real estate tax in Romania, the decision to relocate its production facility to a low-labour-cost country reignited an old debate on the distribution of state subsidies. As a matter of fact, the latest case of production delocation is just another example of what has been common practice long before the enlargement of the European Union: Governments exploiting firms' responsiveness to subsidies and engaging in subsidy races.[1] Accordingly, Germany may have lost the latest race for a large manufacturer, but has come off as the winner in the past at the cost of subsidy payments when bidding for a BMW plant in 2001 against Kolin (Czech Republic) or averting Volkswagen's threats to relocate towards Hungary in 1996.

[1] As more than three quarters of subsidies to industry in the OECD are investment subsidies (see Fuest and Huber, 2000, Table 1) there is hardly any doubt that local governments use subsidies as an instrument to influence the location decision of capital. Van Biesenbroeck (2008) gives an overview of bidding wars between the Canadian and the US government for the automotive industry. See also Greenstone and Moretti (2004).

Against this background, the present paper assesses the outcome and welfare implications of a subsidy race between countries with different degrees of labor market distortions. Our analysis builds on a model in which industrial activity is inefficiently locked-in in a unionized core country. What we have in mind is that a certain region historically emerged as an industrial center which sparked the emergence of trade unions, capturing some of the location rents earned in such an agglomeration. Our most important result is that tax competition among a leading unionized industry core and a challenging emerging country is efficiency enhancing as it leads to relocation of industry towards the country with a non-distorted labor market. A government of an industrial core whose objective it is to maximize residents' welfare will find it optimal to let its competitor attract mobile capital so as to benefit from increased efficiency and the competing location's tax regime.

Local labor markets are typically thought of as important determinants of subsidy policies, disregarding alternative employment opportunities of local workers and the fact that consumers across the country as well as shareholders of locally owned companies may benefit hugely from real capital moving to low-wage or low-tax regions. Our at first sight somewhat surprising result suggests that what we observe in everyday political discussions and decisions may, in some respects, be in contrast to what would be optimal policy once general equilibrium effects are taken into account.

Moreover, disentangling the welfare effects of industry relocation to factor groups reveals that capitalists are the clear winners of the subsidy race as they benefit from lower consumer prices and the repatriation of subsidy income. Workers of the non-unionized competitive industry in the winning country benefit from their government's action only if union wages have been way above the competitive wage rate such that the benefit from lower consumer prices compensates the financing costs of attracting an industry cluster. The opposite holds for non-unionized workers in the former industrial core country. Surprisingly, they suffer, together with former unionized workers, from a delocation of industry and in particular when union wages were high. Since union wages depend on the same parameter as consumers' love for variety a loss of industry will be more severe if the valuation for the industry good is high as this will have a strong impact on the country's consumer price index.

Our modelling approach has various advantages. Firstly, the monopolistic competition framework allows us to be consistent with empirical findings by Stewart (1990), Abowd and Lemieux (1993) and Nickell et al. (1994) who give evidence for unions' wage setting behaviour to depend on firms' market power next to their own bargaining power. Secondly, the model which follows recent work by Borck et al. (2009) is able to reflect the stylized fact that economic activity is not evenly distributed across space but tends to cluster according to certain agglomeration mechanisms as outlined by Marshall (1890), creating location rents for each individual firm. These location rents can to a certain extent be extracted, e.g. by governments or unions without changing the spatial allocation of firms instantaneously.

Our work draws on different strands of the literature. Recent years have seen an increasing interest in the interaction of agglomeration economies and local government tax setting behaviour (Kind et al. (2000), Ludema and Wooton (2000), Baldwin and Krugman (2004), Borck and Pflüger (2006)) with one major insight being that the presence of agglomeration economies reduces the mobility of capital and creates taxable location rents. These models, however, do not incorporate labor market frictions as an additional factor in the competition for mobile capital. Picard and Toulemonde (2006) examine the role of trade unions on the allocation of firms across two regions. They describe how the existence of union wages reinforce the home market effect supporting the concentration of firms in one location. A parallel strand in the literature has focused on the deterring effects of unionization on foreign direct investment (Leahy and Montagna (2000); Naylor and Santoni (2003); Lommerud et al. (2003)).[2] These papers, however, consider only trade unions and firms while ignoring government tax policies. A notable exception is recent work by Haufler and Mittermaier (2008) who show that a unionized country with additional location disadvantages (such as a smaller market) may end up attracting mobile foreign capital, whereby taxes have a strategic effect on the union's behavior. Our model however differs conceptually as it explicitly accounts for agglomeration tendencies which are empirically well established[3] and explain the co-existence of industrialized core and lagging regions as empirically outlined in Redding and Venables (2004). Moreover, our paper, by contrast, examines the role unions plays for tax competition without their behavior being controllable (directly or indirectly so) by governments.

The remainder of this paper is organized as follows. Section 2 describes the general setup of the model. Section 3 illustrates the impact of tax competition on the allocation of industrial firms. Section 4 demonstrates the welfare effects on each single factor group. Section 5 discusses the outcomes of the game for an alternative government objective. Section 6

[2]These contributions are part of a more general literature that analyzes the interaction between unionization, imperfect competition in goods markets, and economic integration. See e.g. Brander and Spencer (1988), Huizinga (1993), Driffill and van der Ploeg (1995), and Naylor (1998).

[3]For an overview of the empirical literature on agglomeration economies see Rosenthal and Strange (2004).

concludes.

3.2 The basic model

The theoretical model follows the model proposed by Borck et al. (2009). We consider two countries $i \in \{h, f\}$ (h and f being mnemonic for 'home' and 'foreign') where one of the two production factors, labor (L), is immobile, whereas the other, capital (K), is mobile across countries such that it can be employed in one region while its owners (who do not move) spend its return in the other region.

Countries are symmetric in technology, preferences and size, but are allowed to differ in labor market rigidity as measured by a parameter of union power. There are two sectors, an 'A' sector with perfect competition, and an industrial 'M' sector displaying differentiated goods, increasing returns to scale and monopolistic competition. Trade in the competitive good is costless, whereas the increasing returns sector faces per unit 'iceberg' transport costs τ à la Samuelson (1954) which means that for each unit to arrive at location j, $1+\tau$ units have to be shipped from location i. The A sector produces a homogeneous traditional good which we choose to be the numéraire using labor only. Units are scaled such that one unit of labor produces one unit of output, so that the competitive wage also equals one.

3.2.1 Preferences

There are two types of households in each country, inelastically supplying their factor endowment, labor and capital, respectively. In country i, there is a total of $K_i + L_i$ households, whose utility stems from consumption of the traditional as well as the differentiated, industrial varieties. Those preferences are reflected by a two-tier utility function, whereby the upper tier is quasi-linear and the lower tier is of the C.E.S. type. The upper tier utility function of a household is

$$U_i(M_i, A_i) = \alpha \ln M_i + A_i - \alpha[\ln \alpha - 1], \quad (1)$$

where the last term is a constant that disappears when indirect utility is derived, A_i denotes consumption of the traditional good and M_i stands for differentiated industrial varieties v

according to the lower-tier function

$$M_i = \left(\int_0^{n_i} m_{ii}(v)^{\frac{\sigma-1}{\sigma}} dv + \int_{n_i}^{N} m_{ji}(v)^{\frac{\sigma-1}{\sigma}} dv \right)^{\frac{\sigma}{\sigma-1}}, \quad \sigma > 1, \quad N = n_i + n_j. \tag{2}$$

Here σ denotes the constant elasticity of substitution between any two varieties and n_i the mass of varieties produced in i. m_{ii} and m_{ji} denote the quantity consumed by a household in country i of a variety produced in i and j, respectively. Assuming $0 < \alpha < y_{is}$, ($i = h, f$; $s = K, L$) it is ensured that both goods will be consumed. Utility maximization yields the following demand functions:

$$\begin{array}{l} M_i = \frac{\alpha}{P_i}, \quad A_{is} = y_{is} - \alpha, \quad s = K, L \\ m_{ii} = \alpha p_i(v)^{-\sigma} P_i^{\sigma-1}, \quad m_{ji} = \alpha(\tau p_j(v))^{-\sigma} P_i^{\sigma-1}, \end{array} \tag{3}$$

where

$$P_i \equiv \left(n_i p_i^{1-\sigma} + n_j(\tau p_j(v))^{-\sigma} \right)^{\frac{1}{1-\sigma}} \tag{4}$$

denotes the perfect C.E.S. price index[4] where we take into account that firms within one country are identical and charge identical producer prices.[5] Indirect utility is

$$V_{is} = y_{is} - \alpha \ln P_i, \qquad s = K, L \tag{5}$$

where income is either labor ('L') income or capital ('K') income.

3.2.2 Industrial production

The perfectly competitive A sector has already been described above. Every firm in the industrial sector produces one variety[6] with a fixed input, namely one unit of capital, and labor. Moreover, a higher concentration of industry in the country lowers the labor input requirement, according to the following specification: For each unit of output, $\gamma_i \equiv 1/(1+\theta n_i)$ units of labor are needed as a variable input, where $\theta > 1$ measures the local knowledge spill-over occurring between workers of the M sector. This way of modelling spill-overs is obviously a short-cut for considering the various channels through which industry concentration may benefit each and every single firm. It can be rationalized in the present setting

[4]This is the expenditure needed to purchase a unit-level of welfare.

[5]However, producer prices across regions are no longer equal once we allow for labor market frictions.

[6]Note that this is not an assumption, but a result. For details, refer to Baldwin et al. (2003).

by knowledge exchange or thick labor markets.[7] Using this specification, the firms' profit function in i reads

$$\pi_i = (p_i - w_i\gamma_i)q_i - r_i, \tag{6}$$

where p_i denotes the consumer price, w_i is the wage rate, and r_i is the capital reward rate. Equilibrium in the goods market requires total (world) demand for a domestic industrial good to equal supply of this variety. The market clearing condition reads

$$q_i = m_{ii}(L_i + K_i) + \tau m_{ij}(L_j + K_j) \tag{7}$$

This latter term shows that part of demand is indirect due to iceberg trade costs which are fully borne by consumers. Straightforward profit maximization gives us the firm's mill price

$$p_i = \frac{\sigma}{\sigma - 1} w_i\gamma_i, \tag{8}$$

whereby the same price, multiplied by τ, is charged to customers abroad. Now, since capital supply is fixed, so is the number of firms which will bid for capital; hence, its compensation adjusts so as to ensure zero profits in equilibrium. Using this zero-profit condition and (8), we obtain the output level which allows a firm to break even

$$q_i = \frac{r_i(\sigma - 1)}{w_i\gamma_i}. \tag{9}$$

Labor demand of an industrial firm reads

$$l_i^M = \gamma_i q_i. \tag{10}$$

3.2.3 Mobile factor's reward

In the short run the allocation of capital and hence the location of M firms is exogenous. To derive capital's reward note that, due to the fact that one unit of capital is needed to run a firm, its reward is bid up to the point where it equals operating profit. To ease notation, we will henceforth use the share notation where $s_n \equiv n_h/N$ denotes region h's share of the world's industry, $\lambda \equiv L_h/L$ is region h's share of world labor and $\kappa \equiv K_h/K$ denotes the share of world capital region h owns. With (8) and (9), it follows immediately that the capital reward rate r_i reflects operating profit, i.e. $r_i = (1/\sigma)p_i q_i$. Using this, the

[7]For a thorough analysis on the micro-foundations of agglomeration economies, see Duranton and Puga (2004).

demand functions (3) and market clearing (7) and normalizing $N = L = K = 1$, yields

$$\begin{aligned} r_h &= \frac{\alpha}{\sigma}\left(\frac{\kappa+\lambda}{s_n+\phi\chi\,(1-s_n)}+\frac{((1-\kappa)+(1-\lambda))\phi}{\phi s_n+\chi\,(1-s_n)}\right), \\ r_f &= \frac{\alpha}{\sigma}\left(\frac{\phi\chi(\kappa+\lambda)}{s_n+\phi\chi\,(1-s_n)}+\frac{((1-\kappa)+(1-\lambda))\chi}{\phi s_n+\chi\,(1-s_n)}\right); \end{aligned} \tag{11}$$

where $0 < \phi \equiv \tau^{1-\sigma} \leq 1$ stands for the level of trade freeness and $\chi \equiv (\frac{p_f}{p_h})^{1-\sigma} = (\frac{w_f \gamma_f}{w_h \gamma_h})^{1-\sigma}$.

In the long run capital is mobile and seeks for the highest nominal return. Local technological spillovers on the sectoral level support a locational equilibrium where all industrial activity is clustered in one region since, all else equal an increase in the number of firms in h increases operating profit in h and hence the capital reward gap $(r_h - r_f)$ which induces a further capital inflow into h. On the other hand, firms in h will face intense local competition as s_n increases which deters other firms to enter the market. However, for ongoing trade integration ϕ firms compete with other firms irrespective of their location which entails that the opportunity cost of agglomerating in one country and serving the foreign market from abroad become low. Consequently, for a sufficiently high level of trade freeness firms will be agglomerated in one region as they benefit from the spatial proximity to other firms through local industry spill-over effects. The critical level of trade freeness at which the benefit of agglomeration begins to exceed the cost of serving from one location is typically denoted as the break point level of trade freeness, ϕ^B and derived solving $\frac{\partial r_h - r_f}{\partial s_n}\Big|_{s_n=1/2} = 0$ for ϕ.[8]

For the purpose of our later analysis which assesses the outcome of a tax competition game between an industrialized country hosting an industry cluster ('core') and a lagging region ('periphery'), we describe a locational equilibrium where the level of trade freeness is sufficiently high ($\phi > \phi^B$) such that all industry is agglomerated in one region, say h.[9] This could be due to historical reasons, just as the story goes in Krugman's seminal 1991 paper. For instance, one could think of a highly industrialized country in Western Europe versus an emerging market in Eastern Europe. As said in the introduction, we think that historically determined agglomeration patterns then may have sparked labor's organization, giving rise to asymmetric unionization. Firms in the industrial core earn an

[8] A formal expression of the break point is available upon request. For a more detailed model exposition see Borck et al. (2009).

[9] Tax competition within agglomeration models where trade costs are so high that no agglomeration occurs yield results that are closer in nature to the 'basic tax competition model' (see Baldwin et al. (2003)). For an analysis of such interior cases in a New Trade Theory model, refer to Egger and Seidel (2007) who show that a country with a stronger labor market distortion will find it optimal to choose a lower Nash tax rate in competition for mobile capital.

agglomeration rent (Ω) which is defined as the loss a single firm would incur if it relocated to the periphery, given that all other firms stay in the core. In other words, capital is tied to the core and capital owners will have no incentive to relocate their capital unit as long as they earn positive location rents which can be expressed as

$$\Omega \equiv r_h - r_f\big|_{s_n=1} = \frac{\alpha}{\sigma}\left(2 - \frac{1}{\phi}\left(\frac{w_f(1+\theta)}{w_h}\right)^{1-\sigma}(1+\phi^2)\right). \tag{12}$$

Obviously, the agglomeration rent is increasing in θ the intensity of local industry spill-overs, the level of trade integration ϕ and foreign's wage rate w_f, whereas it is decreasing in core's wage, w_h.

3.2.4 Union wage setting

As noted earlier the emergence of an industrial cluster may have sparked labor's organization, giving rise to asymmetric unionization. We find it therefore natural to choose the industrialized core to be the unionized country whereas periphery's labor market is perfectly competitive. Hence, whereas the immobile factor's reward in the periphery is equal to the competitive wage rate, we allow firm-specific unions (which are conceptually identical to sector-specific unions in this model) in the core to set the nominal[10] reward for unionized workers using a decentralized wage setting approach for two reasons: Nation-wide unions are hardly observed in reality and, more importantly, the feature of our model that unions, much like competing firms, try each to get the highest rent possible without internalizing consequences for the overall price level, tax policies and industry location, is one that makes it plausible as a stylized description of many OECD countries' union behavior. Workers employed in unionized firms will enjoy higher nominal wages than those working in the non-unionized sector of the economy. Consequently, as firms set their prices according to a fixed mark-up rule (8), consumer prices will, of course, be higher under unionization, which implies that A sector employees and capital owners will lose from it, as will foreign country's residents who buy imported differentiated goods from core's industry. The non-unionized traditional A industry serves as a 'buffer' sector for those who do not find employment in the industrial M sector, so there will be no unemployment.

[10]Obviously, we do not use a monetary model here. We use the term 'nominal' as opposed to 'real' in the sense that the latter means taking the price index into account.

We employ a monopoly union approach,[11] where the union maximizes the nominal wage bill of its members over and above the competitive one, $(w_h - 1)l_i^M$. The firm then exerts its 'right to manage', i.e. it chooses optimal output given the wage rate. From here on, w_h denotes the union-sector wage in h (whereas the competitive wages in core and periphery are equal to 1, see above). Using (7), (10) and the demand functions from (3), we rewrite union's objective function,

$$(w_h - 1)\,\gamma\, q_h = (w_h - 1)\gamma_h \left(\frac{\sigma}{\sigma - 1}\,\gamma_h\, w_h\right)^{-\sigma} \alpha\psi, \tag{13}$$

where $\psi \equiv [P_h^{\sigma-1}(\kappa+\lambda)+P_f^{\sigma-1}((1-\kappa)+(1-\lambda)]$.[12] The left hand side of (13) reveals how each union equally weighs the factors 'wage rate above competitive wage rate' and 'employment' so as to maximize the excess wage bill. The iso-elasticity of both labor demand (that stems from the iso-elasticity of product demand and constant per unit labor input requirement) and the firm's part of the Nash bargaining lead to the wage that maximizes (13)

$$w_h = 1 + \frac{1}{\sigma - 1} \tag{14}$$

which is simply a fixed mark-up on the competitive wage. Intuitively, the union wage rate falls in the elasticity of substitution which measures a firm's mark-up in the monopolistically competitive industry.[13]

A natural question that arises within a core-periphery equilibrium and unions' mark-up wages in the core is whether, in the absence of government intervention, this allocation of capital remains stable. This is a straightforward problem to tackle, which leads us to

Proposition 1 *Agglomeration rents earned in the core can partially be reaped by trade unions, up to a wage level of* $w_b = (1+\theta)\left(\frac{2\phi}{1+\phi^2}\right)^{\frac{1}{\sigma-1}}$. *Beyond this point, the core-periphery*

[11] This is a special case of Nash bargaining between the representative union and the firm where all the bargaining power is with the union. We are aware that this is only one out of many ways to model industrial relations; however, it seems to be the most widely used one due to its tractability. For an exhaustive overview of collective bargaining and some empirical evidence, we refer to Cahuc and Zylberberg (2004).

[12] Note that each union neglects the effects on the economy's consumer price index.

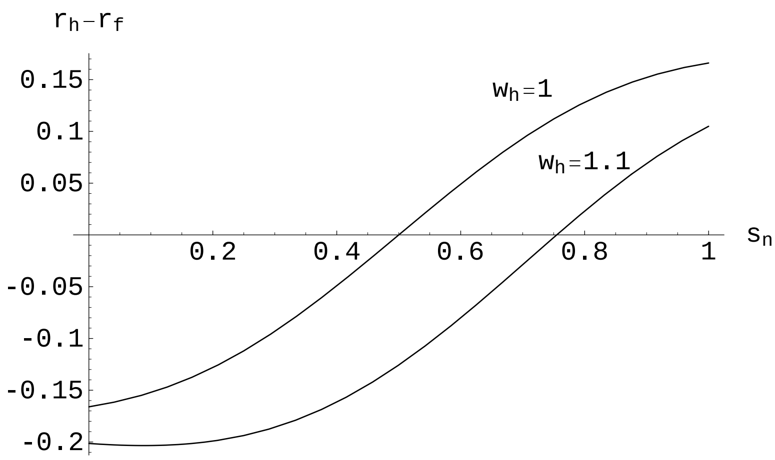
[13] It is worth noting that we get an only quantitatively different result with the more general Nash bargaining approach. The union's outside option is zero, and the firm's outside option is to produce nothing, having already sunk the fixed cost which is the same whether an agreement is reached or not and hence cancels from the Nash maximand (This point is parallel to Picard and Toulemonde (2006). They emphasize that this assumption is implicitly made in many models where fixed costs are set to zero). Adding weights of β and $1-\beta$ to the union's and firm's objectives in the Nash product, respectively, and maximizing yields $w_h = 1 + \beta/(\sigma - 1)$. Since this does not provide us with additional insights, we do not pursue this further.

equilibrium becomes unstable as the rents in f are higher.

For the proof, we simply set r_h equal to r_f and solve the equation for w_h, evaluating the expression at $s_n = 1$. This is the 'break wage rate' above which each and every unit of capital is better off in country f than in the core h.

The first derivatives are straightforward: w_b rises in local technological spill-over (θ) and falls with market integration (ϕ). Figure 3.1 illustrates the stability of the core-periphery equilibrium under asymmetric unionization.

Figure 3.1: Stability of core-periphery equilibria under asymmetric unionization



$\sigma = 4$; $\alpha = 0.5$; $\theta = 0.3$; $\phi = 0.6$.

Figure 3.1 reveals that as long as the union wage rate set in the core does not exceed the break wage rate w_b, capital will be tied to the region where it earns an agglomeration rent. Of course, with the presence of unions in the agglomerated core part of the location rent which, in the absence of labor market distortion fully accrued to capital owners are now redirected to unionized workers.

3.3 Tax competition

Governments maximize residents' welfare and deploy lump-sum taxes on factor endowment, using the revenues for a direct subsidy to capital employed within their borders.[14] In accordance with the models in this literature (see Baldwin and Krugman (2004), Borck and Pflüger (2006)), we assume that the core is a Stackelberg leader in that it gets to set its tax rate first. In our framework, this assumption can be rationalized in the following way: The country that disposes of the unionized industries knows that it may face competition from a challenger and will essentially play an 'entry-deterrence' game.
Letting z_i denote a subsidy to capital employed in i and $r_i + z_i$ the return to capital including subsidies, we end up with the government budget constraints

$$s_n z_h = T_h(\kappa + \lambda); \quad (1 - s_n)z_f = T_f((1-\kappa) + (1-\lambda)), \tag{15}$$

with T_i denoting the tax rate. To best disentangle the effects of asymmetric unionization on the location of capital we assume that countries are of equal size ($\kappa = \lambda = 0.5$).[15] Governments are utilitarian and maximize the sum of residents' indirect utility, where welfare of unionized M and non-unionized A workers as well as capitalists, in h reads

$$V_h^M = L_h^M(w_h - \alpha \ln P_h - T_h), \tag{16}$$

$$V_h^A = (L - L_h^M)(1 - \alpha \ln P_h - T_h), \tag{17}$$

$$V_h^K = K_h(y_K - \alpha \ln P_h - T_h), \tag{18}$$

where y_K denotes capitalist's income and $L_h^M = l_h^M n_h$ is the core's industrial sector's labor demand. Observe that since the world is a lumpy place in this model, both parties will effectively compare two situations: being the core (henceforth indicated by the superscript 'c') or the periphery (indicated by 'p'). At this point, the simple structure of the model helps us greatly when it comes to optimal policy analysis as we get a closed-form welfare function. Taking the example of country h being the core,[16] welfare is derived adding up (16)-(18) evaluated at $s_n = 1$

$$WF_h^c = \frac{1}{2}\left(1 - z_h + \frac{2\alpha}{\sigma}\right) + L_h^{Mc}(w_h - 1) - \alpha \ln P_h^c, \tag{19}$$

[14] Tax competition here is modelled in a very simple way: Given that the *owners* of both factors are immobile, they are simply taxed on their endowment, i.e. residence-based taxes are employed.

[15] The interested reader is referred to Borck et al. (2009) who consider inefficiencies arising through asymmetrically sized countries.

[16] Note that $r_h|_{s_n=1} = r_f|_{s_n=0} = 2\alpha/\sigma$.

where $L_h^{Mc} \equiv \frac{2\alpha}{\sigma}\frac{(\sigma-1)}{w_h}$. Country f's welfare in this case is

$$WF_f^p = \frac{1}{2}\big(\frac{2\alpha}{\sigma} + z_h + 1\big) - \alpha \ln P_f^p. \tag{20}$$

If, by contrast, all industry locates in f, the welfare terms are

$$WF_h^p = \frac{1}{2}\big(\frac{2\alpha}{\sigma} + z_f + 1\big) - \alpha \ln P_h^p \tag{21}$$

$$WF_f^c = \frac{1}{2}\big(\frac{2\alpha}{\sigma} - z_f + 1\big) - \alpha \ln P_f^c \tag{22}$$

The simplified price indices are obtained using (8) and (14) in (see (4))

$$\begin{aligned} P_h^c &= \tfrac{\sigma}{\sigma-1} w_h \gamma, \qquad P_h^p = \tfrac{\sigma}{\sigma-1}\phi^{1/(1-\sigma)}\gamma, \\ P_f^c &= \tfrac{\sigma}{\sigma-1}\gamma, \qquad P_f^p = \tfrac{\sigma}{\sigma-1}\phi^{1/(1-\sigma)} w_h \gamma. \end{aligned} \tag{23}$$

where $\gamma \equiv 1/(1+\theta)$. Note that part of core's union wage rate is borne by consumers abroad ('wage cost exporting').

Moreover, given our assumption that the labor market distortion occurs only in h, we can show that global welfare $WF^{glob} = WF_h + WF_f$ could be enhanced if the industry core shifted towards the non-unionized periphery:

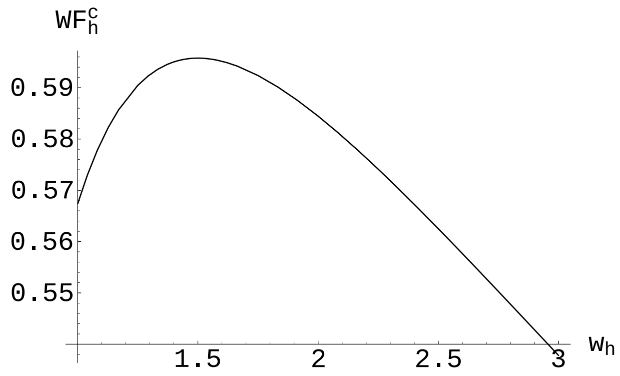
Proposition 2 *For high levels of trade freeness and $w_f < w_h < w_b$ the core-periphery equilibrium $s_n = 1$ is stable but globally inefficient,*

$$WF^{glob}|_{s_n=1} < WF^{glob}|_{s_n=0}.$$

Proof: See Appendix.

The obvious question then is whether core will defend its industry cluster and prevent the shift of industry towards an efficient allocation, using a generous tax regime to compensate capital for high union wages and at the same time ensuring higher nominal wages for its industrial workers. Hosting the industry core is attractive since local production avoids consumer-borne trade costs for one's residents ('cost-of-living effect'). Moreover, whereas the benefit of higher nominal wages accrues to unionized workers in the core only, part of the resulting higher consumer prices is borne by consumers abroad ('wage cost exporting'). However, the latter effect enhances welfare in the core only up to a certain union wage level after which consumer prices become so high that less workers will be employed in the unionized sector as less of the industrial good is demanded. This is illustrated in Figure 3.2 which depicts core's welfare as a function of union wages in the absence of subsidies

Figure 3.2: Core's welfare function for different union wages



$\sigma = 4$; $\alpha = 0.3$; $\theta = 0.3$; $\phi = 0.6$.

3.3.1 Second Stage: Periphery's government

Solving the game via backward induction, we start with the government of the periphery at stage two of the tax game. As all firms are alike, this is a straightforward exercise: The government of the periphery, government f, has a maximum subsidy/minimum tax it is willing to offer. This can be found at the point where its overall welfare level is the same no matter if it hosts the industry or not, $WF^c_f = WF^p_f$. Solving this for the subsidy, we obtain 'z^{max}_f':

$$z^{max}_f = -z_h + 2\alpha \left(\ln w_h - \frac{\ln \phi}{\sigma - 1} \right) \tag{24}$$

The first term denotes the foregone repatriation of subsidy income from c for periphery's capitalists once p attracts the industry. The second term captures the benefits of industry relocation towards the non-unionized country. Residents in the periphery benefit from lower consumer prices since wages are competitive and transport costs are absent for them once industry locates in the periphery. On the other hand, the government of the periphery knows that it has to offer each firm at least what core's government offers, in addition to the agglomeration rent Ω. We call this subsidy level 'z^{min}_f' which is obtained solving

$\Omega + (z_h - z_f) = 0$ for z_h using (12):

$$z_f^{min} = z_h + \frac{\alpha}{\sigma}\left(2 - \frac{1}{\phi}\left(\frac{1+\theta}{w_h}\right)^{1-\sigma}(1+\phi^2)\right). \tag{25}$$

Now, as long as z_f^{max} is greater than z_f^{min}, periphery can profitably attract the capital from the core. Note that these terms depend only on core's tax policy (z_h) and exogenous parameters (as the monopoly unions' wage, w_h, only depends on the parameter σ). The next step is to examine government h's behavior.

3.3.2 First Stage: Core's government

The core's government is aware of the influence its policy exerts on the ability and willingness of the periphery to attract capital. To determine core's optimal behavior, we first determine the policy at which periphery's government will not be able to profitably attract the mobile capital. In a next step we check whether core's government will actually want to hold on to the industrial core.

From inspection of (24) and (25), it can easily be seen how we can work out the 'knife-edge' level of subsidy, say z_h^d, at which the core can make it unprofitable for the periphery to attract the industry which will be the case whenever z_f^{min} is at least as large as z_f^{max}. We set (24) equal to (25) and solve for z_h:

$$z_h^d = \frac{\alpha}{2\sigma}\left(\frac{1}{\phi}w_h^{\sigma-1}(1+\theta)^{1-\sigma}(1+\phi^2) + 2\sigma\ln w_h - \frac{2\sigma\ln\phi}{\sigma-1} - 2\right). \tag{26}$$

This means that core's offer has to be at least z_h^d to make sure that the periphery's government will not be a threat to the pre-existing allocation.[17]

It is however not immediately obvious what core's government opts for: Production in its part of the world leads to a lower price index for all of its consumers ('cost-of-living effect'). Moreover, industrial workers in the core earn higher wages than they otherwise would - whereby part of this excess wage bill is paid, via higher prices, by foreigners ('wage cost exporting effect'). On the other hand, allowing the industry to delocate to f means h's capitalists would benefit from the repatriation of subsidy income and also that its consumers would be able to buy goods produced in a low-wage region. So, in the case

[17] Obviously, every better offer will do the trick, but will never be optimal since the subsidies do not alleviate any distortion. Rather, they amount to a transfer to the other country which will be kept as tiny as possible.

where core holds on to its industry, it will set $z_h = z_h^d$. In the case where it does not, it will set the subsidy level marginally smaller, $z_h = z_h^d - \epsilon$, where ϵ is some small but positive number. To see this latter point, note that this guarantees the highest possible subsidy transfer from the periphery (remember, $z_f^{min} = z_h + \Omega$). Core's optimal policy can therefore be summarized by

$$z_h^* = \begin{cases} z_h^d & \text{if} \quad WF_h^c(z_h^d) \geq WF_h^p(z_f^{min}(z_h)), \\ z_h^d - \epsilon & \text{otherwise.} \end{cases}$$

This gives us also f's optimal policy when it attracts all industry: As the second mover, it takes the given z_h^*. So we plug z_h^d for z_h into (25), which is optimal by a similar argument to the one above: It is the cheapest way to attract the industry. On the contrary, in case of no industry delocation it is simple to conclude that the subsidy to capital and hence the tax on L and K will be zero as being the periphery implies not hosting any industry.

Now that we derived each country's optimal policies in the two cases, we proceed to the equilibrium outcome of the game. The reduced-form equations can be obtained by plugging the optimal policies for each case into the region's respective welfare functions (19)-(22) using (25) and (26). It is then a straightforward exercise to compare welfare levels. Core's government will simply compare the difference between $WF_h^c(z_h^*)$ and $WF_h^p(z_f^*)$. If it is positive, then the country as a whole is better off holding on to its industry; if it is negative, the opposite holds true. Using (19) and (21) the welfare differential can be written as

$$WF_h^c - WF_h^p = L_h^{Mc}(w_h - 1) - \frac{z_h^*}{2} - \frac{z_f^*}{2} - \alpha \ln\left(\frac{P_h^c}{P_h^p}\right). \tag{27}$$

The excess wage bill in the first term reflects the benefits of keeping all industry whereas the second and third term reflect the financing cost and the foregone subsidy payment of doing so, respectively. The last term's sign is ambiguous as both P_h^c and P_h^p will exceed one. Hence, depending on the level of trade freeness and the union wage the last term will be positive or negative. Note that both governments take into account all general equilibrium effects. Specifically, all tax and wage effects as well as trade cost and price effects are taken into account. We can now state

Proposition 3 *A welfare-maximizing government in the unionized core will find it in its best interest to let the industrial core move to the periphery i.e.,*

$$WF_h^c(z_h^d) - WF_h^p(z_f^{min}) < 0.$$

Proof: See Appendix.

This result is striking at first sight. After all, the core acts as a Stackelberg leader and maximizes welfare within its border. So one might have expected it to hold on to its industry via a generous tax regime since the costs of higher union wages are partly borne by consumers abroad while the benefits of higher wage income accrue solely to workers within the country. Upon closer inspection, however, our result is quite intuitive: By letting its capital relocate to f, while still owning it, country h gets rid of the labor market distortion[18] and, at the same time, makes sure capital owners get a favorable tax regime abroad, leading to repatriated subsidies. This makes a nice case why governments may, in bidding for mobile factors, make favorable offers: They may have in mind the preferential regimes their countrymens' businesses will get abroad. Furthermore, the presence of a challenging emerging market, i.e. tax competition leads to increased global welfare via restoring an efficient allocation of industry.

3.4 Winners and losers of the subsidy race

The above analysis showed that unionized core benefits from inducing a relocation of firms towards the periphery country f. It chooses a subsidy level at which the periphery can profitably attract all industry. Hence, both countries are clearly winners of the game and benefit from delocating industry towards a country with a non-distorted labor market. This section identifies the winners and the losers of the subsidy race within the different income groups. We begin with country h's and f's capital owners.

Proposition 4 *Capitalists in both locations are the clear winners of the subsidy race. Capitalists in h win due to the repatriation of capital income whereas capitalists in f benefit from a lower cost-of-living index.*

Proof: See Appendix.
For core's capital owners, the benefits from repatriating subsidies exceed the cost of incurring transport costs for imported varieties. Capitalists in f benefit from a lower cost-of-living index while the financing cost for subsidies are shared between capitalists and workers.
The impact on workers in the new core country is however ambiguous. To begin with workers of the new core the indirect utility ($V_{f,w}$) differential of workers in f before and

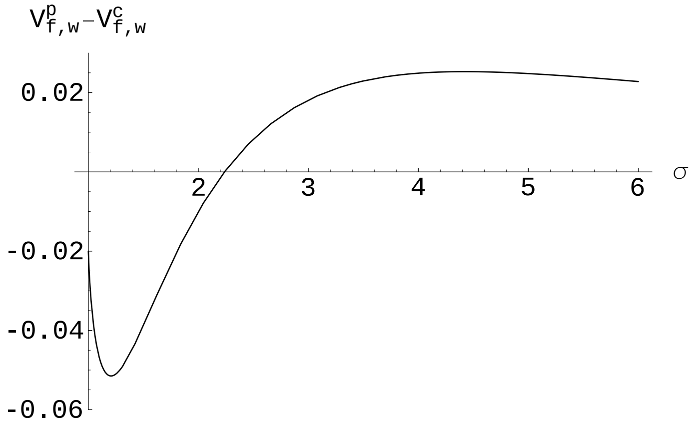
[18] Trade costs will, at a certain point, counteract the 'lower-wage' effect on prices. However, high trade costs undermine stability of the core-periphery equilibrium in the first place, which is why we concentrated on lower levels of τ from the outset.

after reads

$$V_{f,w}^p - V_{f,w}^c = L_f\left(\alpha(\ln P_f^c - \ln P_f^p) + z_f^{min}\right). \tag{28}$$

The difference in price indices is negative since $P_f^c < P_f^p$, indicating that workers are better off with firms producing in their country. The last term, however, indicates that workers might be better off in a periphery when financing costs are high. Figure 3.3 illustrates the welfare differential in (28).

Figure 3.3: Foreign workers' welfare differential



$\phi = 0.6$; $\alpha = 0.3$; $\theta = 1$.

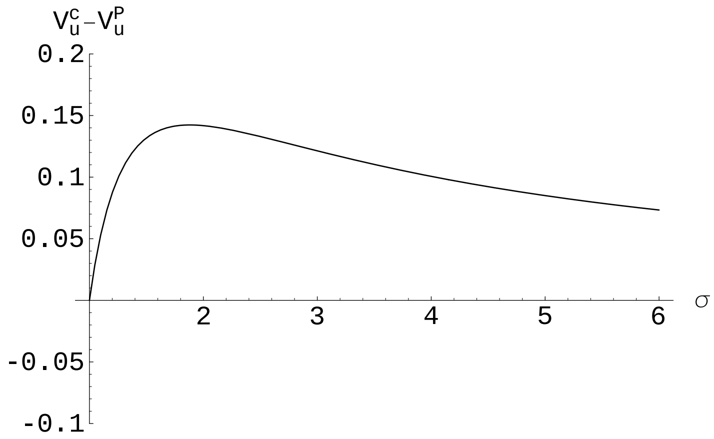
Figure 3.3 reveals that workers in f will only benefit from an industry relocation for low σ. Put differently, workers in f win only if they have severely suffered from wage cost exporting, i.e. for high union wages (low σ) such that it becomes worthwhile to incur the financing costs of attracting firms.

Intuitively, union members as a whole lose as industry shifts towards f. Their real income unambiguously falls on two counts, the decline of the nominal wage and the increase of the price index. The difference of before and after welfare of union workers denoted as V_u^c and V_u^p, respectively is derived using (16) and (23) for the core and periphery case

$$V_u^c - V_u^p = \frac{2\alpha}{\sigma}\left(\frac{\sigma-1}{\sigma}\right)\left(1 + \alpha[(\sigma-1)\ln(\frac{\sigma-1}{\sigma}) - \ln\phi]\right). \tag{29}$$

Figure 3.4 depicts union workers' welfare differential in (29) for different σ which confirms that union workers particularly suffer from subsidy competition for low σ, i.e. high union wages.

Figure 3.4: Welfare of h's union workers before and after industry relocation



$\phi = 0.6$ and $\alpha = 0.3$.

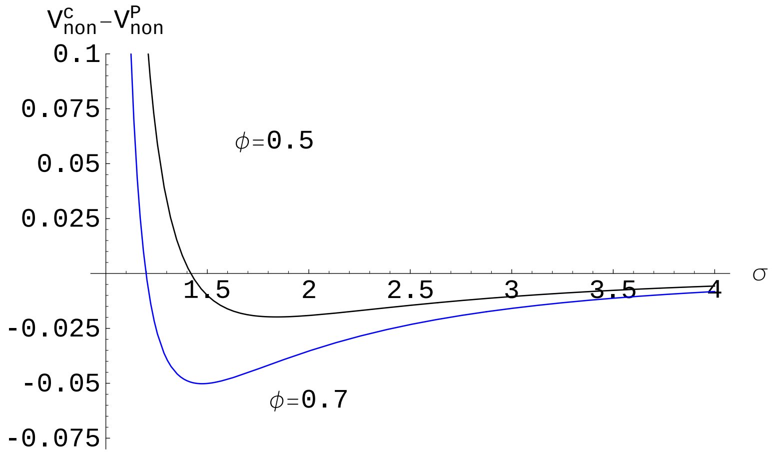
Turning to non-union workers in h, their welfare differential is obtained after inserting the respective price indices into h's non-union workers' indirect utilities using (17) for both cases

$$V_{non}^{c} - V_{non}^{p} = -\alpha(\lambda - L_h^{Mc})(\ln w_h - \frac{1}{1-\sigma}\ln\phi) \qquad (30)$$

From inspection of (30) it is not ex ante clear whether non-union workers unambiguously benefit from industry relocation towards a country with no labor market distortion. More precisely, non-union workers benefit from industry delocation as they no longer bear high consumer prices resulting from asymmetric unionization (this effect is captured in '$\ln w_h$') whereas they suffer from losing all industry as they have to bear transport costs for imported varieties which is reflected through '$\ln\phi$'. To learn whether the overall effect is positive or negative Figure 3.5 displays non-union workers' before and after welfare differential at different levels of σ evaluated at different degrees of trade freeness.

Surprisingly, non-union workers were *better off* for low σ, i.e. under (high) union wages and experience higher welfare from industry relocation only for higher σ (low union wages). This seems to be counterintuitive at first sight as we would expect non-union workers to gain (like workers in f) especially for low σ, i.e. for high union wages. To understand the result, first note that non-union workers face a trade off between higher consumer prices due to union wages and higher consumer prices because of shipping costs. However, recall that a low elasticity of substitution σ implies high union wages but at the same time indicates a high love for variety. Consequently, consumers in h suffer from industry delocation especially if their valuation for the industrial good is high as this leads to a strong

Figure 3.5: Welfare of h's non-union workers (before and after industry relocation



$\alpha = 0.3$.

increase in the cost-of-living index P_h which depresses households' purchasing power in h. Formally, this effect reads

$$\frac{\partial P_h^p}{\partial \sigma} = \frac{\phi^{\frac{1}{1-\sigma}}(\sigma \ln \phi + 1 - \sigma)}{(1+\theta)(\sigma-1)^3} < 0, \qquad \frac{\partial^2 P_h^p}{\partial \sigma \partial \phi} = \frac{\phi^{\frac{\sigma}{1-\sigma}}(\sigma^2 - 1 - \sigma \ln \phi)}{(1+\theta)(\sigma-1)^4} > 0. \qquad (31)$$

which reflects that an increasing elasticity of substitution (a declining 'love for variety' and lower union wages) attenuates the loss arising from a high peripheral cost-of-living index. This effect is amplified by decreasing levels of trade freeness.

3.5 Discussion

Obviously, our strong main result arises out of two specific assumptions: Firstly, governments are true welfare-maximizers and weigh workers' and capital owners' utility equally. Then, the most efficient solution prevails, which is offshoring production to a location where the labor market is not distorted.[19] A straightforward extension here is to assume a government that only cares about workers, which could be due to its preferences or the fact that capital ownership is concentrated in very few hands, whereas the by far biggest share of households are labor households. In this case, the core will not find it optimal

[19]The tax game here has, as is true of many of the models in this literature, an auction-like character - hence the globally efficient outcome.

to get rid of its industry up to a certain union wage, but will rather accept the distortion which is partially borne by periphery's residents. We briefly illustrate the case of a government that does not care about capital owners: Such a government's objective function has as its arguments only A- and M-sector workers' utility. Apart from that, we proceed in perfect analogy to the analysis above, i.e., we compare price indices and welfare levels with all industrial activity in h and f, respectively, and work out the critical tax/subsidy levels $\hat{z}_h^{max}$, $\hat{z}_h^d$ under this alternative scenario. Finally, inserting the optimal policies under the revised scenario into the government objective function and conducting government h's welfare comparison, like before leads to the welfare differential

$$\tilde{WF_h}^c - \tilde{WF_h}^p = L_h^{Mc}(w_h - 1) - \frac{z_h}{2} - \alpha \ln\left(\frac{P_h^c}{P_h^p}\right). \tag{32}$$

Inserting the new subsidy levels $\hat{z}_h^d$ and the corresponding price indices finally yields

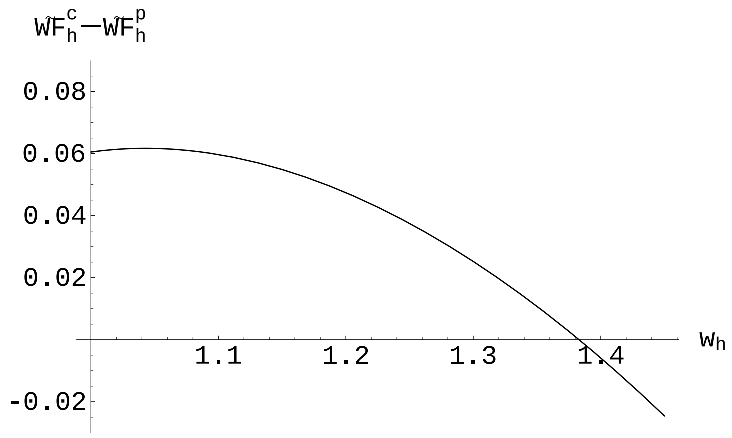
$$\tilde{WF_h}^c - \tilde{WF_h}^p = 2\alpha - \frac{1}{w_h}\frac{2\alpha(\sigma-1)}{\sigma} - \frac{\alpha}{\sigma}\left(1 + \frac{(1+\phi^2)}{2\phi}\left(\frac{1+\theta}{w_h}\right)^{1-\sigma}\right) - \alpha \ln w_h. \tag{33}$$

As one would expect, it is rising in the agglomeration force (θ) and in trade freeness (ϕ). Since technological spillovers as well as the level of trade integration increase the agglomeration rent, it also decreases the cost of financing a subsidy level necessary to defend the core. These familiar effects notwithstanding, core's optimal decision in this alternative 'leftist' scenario is no longer as clear cut as it was in Section 3. To see this Figure 3.6 illustrates the welfare difference as a function of the union wage rate w_h.

For moderate union wages a 'leftist' government that represents workers' interests will set a subsidy level low enough to prevent a relocation of industry towards an efficient outcome. This may not seem too surprising as unionized workers benefit from the distortion, but remember that non-union workers and home capitalists equally enter the government's welfare calculus.

Even though the model is highly stylized, we think the model and its predictions have intuitive appeal: Due to the quasi-linearity of the utility function, the M-sector can be thought of as one specific industry producing differentiated goods, whereas the competitive sector represents the ('big') rest of the economy. If such a sector suffers from a labor market distortion, it may not be ex ante clear that a government will find it in its best interest to compensate mobile factors for high wages. Rather, it may well be welfare-enhancing to use tax instruments or other government action to get industries offshored to low-wage

Figure 3.6: h's welfare difference between being core and periphery for different union wages



$\sigma = 4$; $\alpha = 0.5$; $\theta = 0.3$; $\phi = 0.6$.

countries, which benefits consumers with low consumer prices and shareholders with higher dividends. Thinking of particular industries such as consumer electronics, it may well be that industrialized countries' governments have understood that it can be in their best interest to allow production and assembling to be shifted to places with lower labor costs. Then, downward pressure on taxes benefits them as national shareholders gain from them. Thinking of the car industry, on the contrary, one typically has in mind that jurisdictions do a lot to hold on to it, which may show the importance of local interest groups as decisions on industry- or even firm-specific tax breaks or subsidies will not only, in general, be based on national welfare-maximizing behavior, but also on the interests of local politicians.

3.6 Conclusion

In a simple model of tax competition between countries with asymmetric union power and agglomeration tendencies, we have shown that the government of the agglomerated and unionized country may not have an incentive to try to hold on to its industry. Instead of realizing the benefits from higher wage income while exporting part of the wage burden to foreign consumers via higher prices, it rather allows the competing country to attract industry and benefit from the other country's generous tax regime as well as low production costs, leading to low consumer prices. Tax competition is welfare enhancing as it leads to a relocation of industry towards a country with a non-distorted labor market. In contrast to the previous literature which focused on the agglomeration-holding country's ability to hold on to the core, we show why its willingness to do so may be curtailed. The finding has intuitive appeal when one thinks of the fact that welfare is, after all, driven by consumption, which in this case is increased by two facts: Lower prices because of the circumvented labor market distortion, and higher income because of capitalists' repatriated income.

We highlight the way in which winners and losers are generated in tax competition and leave it for future work to look into this in more depth empirically. In terms of theory, it seems promising to examine the role of special interest groups and their organization when it comes to influencing governments in their choice of policy variables in the presence of international tax competition.

3.7 Appendix

Proof of Proposition 2

Global welfare is derived adding up the indirect utility functions of A sector workers, unionized and non-unionized M workers as well as capital owners across countries. Taking the difference of global welfare evaluated at $s_n = 1$ and global welfare at $s_n = 0$ gives, after inserting $w_h = \frac{\sigma}{\sigma-1}$,

$$WF^{glob}\Big|_{s_n=0} - WF^{glob}\Big|_{s_n=1} = -1 - \frac{\sigma^2}{\sigma-1}\ln\left(\frac{\sigma-1}{\sigma}\right). \tag{A.1}$$

one can easily see that the expression above is non-negative for $\sigma > 1$. □

Proof of Proposition 3

Setting $z_h = z_h^d$ and $z_f = z_f^{min}(z_h)$ in equation (27), as well as inserting the respective price indices from (23) reduces to

$$WF_h^c(z_h) - WF_h^p(z_f) = \frac{2\alpha(\sigma-1)}{w_h\sigma}(w_h - 1) - 2\alpha \ln w_h. \tag{A.2}$$

Note that the first term is simply union's objective which is the excess wage bill of its members whereas the second term denotes the potential benefit of a relocation, namely getting rid of the distortion. This equals, after substituting $w_h = \frac{\sigma}{\sigma-1}$,

$$WF_h^c(z_h) - WF_h^p(z_f) = \frac{2\alpha(\sigma-1)}{\sigma^2} - 2\alpha \ln\left(\frac{\sigma}{\sigma-1}\right). \tag{A.3}$$

This term is smaller than zero for any $\alpha > 0, \sigma > 1$, indicating that the government in h will always be better off when the core is in f. The equilibrium subsidy levels are given by $z_h^* = z_h^d - \epsilon$ and $z_f^* = z_f^{min}(z_h^*)$, for some small ϵ. □

Proof of Proposition 4

The indirect utility differential of capitalists in h reads

$$V^c_{h,\,cap} - V^p_{h,\,cap} = K_h\big(\alpha(\ln P^p_h - \ln P^c_h) - z_f^{min}\big) \tag{A.4}$$

Inserting the respective price indices, (23), and the union wage yields

$$V^c_{h,\,cap} - V^p_{h,\,cap} = \frac{\alpha}{4\sigma^2}\frac{(1+\theta)^{1-\sigma}(\sigma-1)^{1-\sigma}\sigma^{\sigma}(1+\phi^2)}{\phi} + \frac{\alpha[2\sigma(\ln(\sigma-1)-\ln\sigma)-1]}{2\sigma}. \tag{A.5}$$

This expression will be infinitely negative for $\sigma \to 1$ and approaches zero for $\sigma \to \infty$. Hence, capitalists in h gain from firms' relocation towards the union-unionized country. The welfare differential of capital owners in f reads simply

$$V^c_{f,\,cap} - V^p_{f,\,cap} = K_f\big(\alpha(\ln P^p_f - \ln P^c_f)\big). \tag{A.6}$$

After inserting the respective price indices and w_h simplifies to

$$V^c_{f,\,cap} - V^p_{f,\,cap} = \frac{\alpha}{2}\big(\ln\sigma - \ln(\sigma-1) - \frac{1}{\sigma-1}\ln\phi\big), \tag{A.7}$$

which is unambiguously positive for any $\alpha > 0$, $\sigma > 1$ and $0 < \phi < 1$. □

Chapter 4

Do countries compensate firms for international wage differentials?

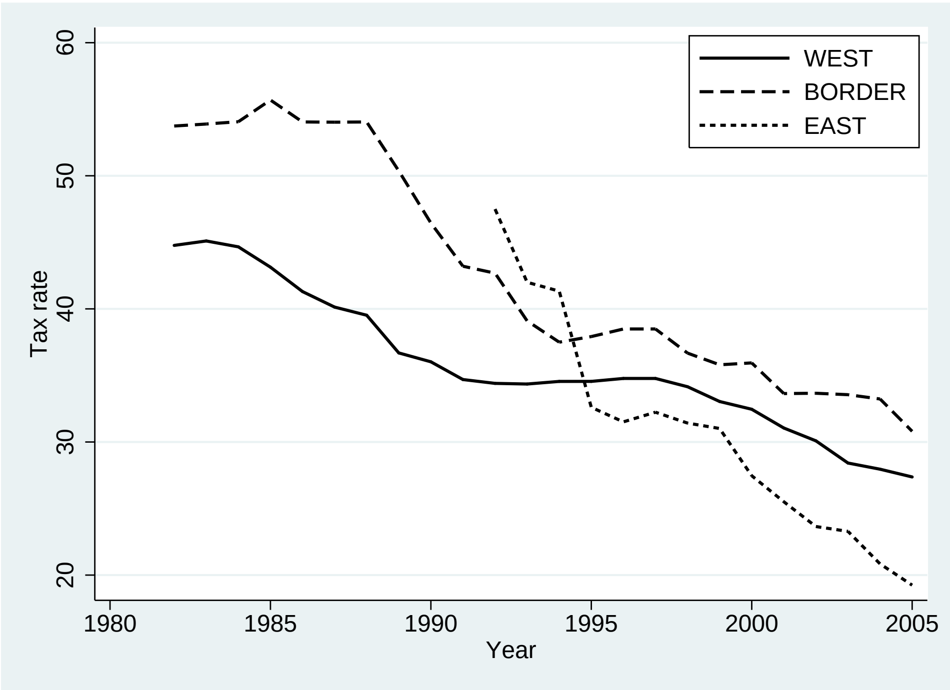
4.1 Introduction

There has been a remarkable downward trend in corporate tax rates in Europe over the last decades, bearing witness to the fact that in an ever more integrating Europe, there is intensive competition for mobile capital. Figure 4.1 shows the average statutory tax rate over time for three groups of European countries (for a definition of 'border' countries, refer to Footnote 12). It is remarkable that taxes were relatively stable until the late 1980s. The graph also shows that countries in the center ('at the border', along the former iron curtain), like Germany and Austria, had higher rates on average than more peripheral 'western' locations (such as the United Kingdom or Portugal). 'Eastern' countries, for which meaningful data only date back to the early 1990s (since they had communist regimes before), lowered taxes significantly to their present very low levels.[1] But the astounding thing is that the border countries lowered their rates to almost the levels of western European countries - which cannot have been driven by a tax competition effect as the eastern countries at that time had tax levels that even exceeded the ones in the western countries. As Overesch and Rincke (2009) put it, '[...]the main part of the downward adjustment of corporate tax levels in the border countries was achieved between 1990 and 1994'. So it looks like the integration shock with close, but very starkly differing competitors drove tax rates down, and we want to exploit precisely this quasi-natural experiment to show some evidence for this hypothesis: It seems pretty natural to see the unexpected competition

[1]For more details on those countries and taxes, we refer you to Overesch and Rincke (2009).

from those low-wage countries, hitting countries at the border harder than those further away, as one of the driving forces behind the ensuing fall in tax rates. Determinants of corporate tax rates have been analyzed in a host of different papers, such as Devereux et al. (2008) (on strategic tax competition), Slemrod (2004) and Winner (2005) (on openness), and(Bénassy-Quéré et al.) (on infrastructure). The literature on foreign direct investment (FDI) and corporate taxation so far, however, has largely ignored the role of labor cost differentials. This is surprising since in a world with integrated capital markets, labor costs are among the most important determinants of firms' location decisions, and governments competing for FDI should take this into account. We contribute to filling this gap by introducing labor cost differentials into a model of competition for FDI as in Haufler and Wooton (1999) and Bjorvatn and Eckel (2006). We show that if two governments compete for a mobile firm, the high-wage country is willing to offer a more favorable tax regime. Obviously, such a specified model designed precisely to illustrate a government's incentive

Figure 4.1: Average statutory tax rates for different European regions over time



to attract a single firm has to be interpreted with discretion, but we think this incentive will be found in very different and much more complicated settings, and we are convinced it bears empirical relevance. Our empirical test, then, exploits precisely the exogenous variation in labor cost differentials in Western Europe induced by the sudden integration with Eastern Europe after 1989/90. The evidence in fact suggests that countries with relatively high labor costs set significantly lower corporate income tax rates. To come up with this evidence, we recur to both pure labor compensation cost data and unit labor cost data, whereby the latter take productivity differences into account and can hence be considered a more accurate measure of a location's competitiveness.

4.2 Bidding for FDI: The role of wage differentials

Consider a mobile foreign entrant firm, f, and two countries, A and B, whose markets are separated by unit transport costs τ. The entrant produces a homogeneous good, x, in what is to become a monopolistic market.[2] There are n identical households in country A and $1-n$ households in country B. A numéraire good, z, is produced by perfectly competitive firms with labor being the only input. Free trade in z equalizes wages to w. One unit of labor generates one unit of output, fixing the competitive wage at unity. Household preferences are $u_i = \alpha x_i - (1/2)\beta x_i^2 + z_i$, $i \in \{A, B\}$, and each household inelastically supplies one unit of labor. Maximizing u_i subject to $w = p_i x_i + z_i$ (with p_i denoting the price of x in i), one obtains $X_A = n(\alpha - p_A)/\beta$ and $X_B = (\alpha - p_B)/\beta$ as A's and B's aggregate demand for x. Wages are the only variable costs, but for plant set-up the firm incurs a fixed cost sufficiently large to prevent production at both locations.

Let subscripts denote a country's terms and superscripts f's location decision. If f goes to A, profits are

$$\pi^A = \frac{n\left(\alpha - w_A\right)^2}{4\beta} + \frac{(1-n)\left(\alpha - \tau - w_A\right)^2}{4\beta}, \tag{1}$$

with the first term representing market A and the second market B profits. Consumer surplus is

$$CS_A^A = \frac{n\left(\alpha - w_A\right)^2}{8\beta}; CS_B^A = \frac{(1-n)\left(\alpha - \tau - w_A\right)^2}{8\beta}. \tag{2}$$

Analogous expressions for profits and surplus hold if f goes to B. Suppose now that, for some exogenous reason like union power, only A has an x industry ('manufacturing') wage w_A above the competitive one (which prevails in its z industry), $w_A > w_B = 1$.[3] Apart from increasing consumer surplus because of lower prices, for A attracting f has the advantage of a higher manufacturing wage income which is partially borne by foreign consumers. Assuming that f's after-tax profits are fully repatriated and that tax receipts

[2] The model in this section is similar in structure to the one in Chapter 1.

[3] Alternatively, we could have used a higher labor input requirement in A (i.e., lower manufacturing productivity) to model a unit labor cost differential.

are redistributed to residents, welfare W_A is composed of consumer surplus, tax receipts and the 'extra wage' earned in the x industry. [4] With f choosing the location where after-tax profits are highest, welfare-maximizing governments will engage in a bidding race, offering the lowest possible subsidy (or charging the highest possible 'admission' in the case of a tax). A's gross gain (before taxes/subsidies) of attracting f is

$$\Delta_A = W_A^A - W_A^B = CS_A^A - CS_A^B + (w_A - w_B)\frac{\alpha - w_A - (1-n)\tau}{2\beta}. \tag{3}$$

Observe that a country's gain is its willingness to pay for the investment: If $W_i^i > W_i^j$, the country will be prepared to offer a subsidy. Comparing Δ_A and Δ_B at size symmetry yields $\Delta_A - \Delta_B = (2\alpha - 3w_A - \tau + 1)(w_A - 1)/(8\beta)$, which is positive at $1 < w_A < (2\alpha - \tau + 1)/3$. This reveals that, as long as w_A is 'not too large', A will have the stronger incentive to attract f, translating into a lower minimum tax (higher maximum subsidy) it will be prepared to offer.[5] So the high-wage country is willing to offer a lower tax rate as long as the resulting distortion is not too pronounced.

It is straightforward to determine the minimum winning bids. Each country anticipates the maximum offer of the other country which it must outbid, i.e. it has to offer the rival's gross gain. On top of that, so as to (just) win the race, i has to offer f the whole profit differential (what it would earn locating in j net of what it can earn in i). The minimum winning bid for A is thus $O_A = \pi^B - \pi^A + W_B^B - W_B^A = (2\alpha - \tau - w_A - 1)((3-n)w_A + n - (5n-3)\tau - 3)/(8\beta)$. O_A is increasing in w_A, implying a higher subsidy if the wage differential gets larger. It also has the intuitive property of falling in n. Note that only if $\Delta_A > O_A$, country A actually wants to attract the investment. Setting Δ_A equal to O_A and solving for τ, we get a critical level of trade costs above which country A will win the investment,[6]

$$\tau^{cr} = \frac{1}{6}(6\alpha - w_A - 5) + \frac{w_A - 1}{6(2n-1)} - \frac{\sqrt{(3\alpha - n(6\alpha - 5) - (1-n)w_A - 2)^2 - 3(2n-1)(w_A - 1)(2\alpha + w_A - 3)}}{3(2n-1)}. \tag{4}$$

The analogous critical value in the absence of tax policy (obtained from solving $\pi^A = \pi^B$

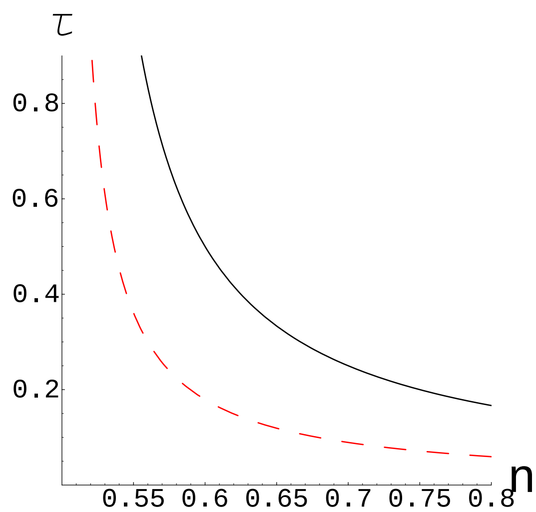
[4]The latter could alternatively be interpreted as the employment gain in a country with unemployment where the shadow price of labor is lower than the nominal wage.

[5]Haaparanta (1996) makes a similar point using a model without trade and governments maximizing labor income.

[6]This suffices to show that B does not want to attract it: The difference in f's profits, $\pi^i - \pi^j$, equals $\Delta_j - O_i = O_j - \Delta_i$.

for τ) equals $\tau^0 = (w_A - 1)/(2n - 1)$. Confirming the insight from Bjorvatn and Eckel (2006), we find that due to its cost disadvantage, A cannot attract the investment if its market is smaller, no matter if there is tax competition or not: for $0 < n \leq 0.5$, there is no non-prohibitive $\tau > 0$ permitting A to win f.[7] Note how this differs from the outcome in Chapter 2 (where precisely the case was examined that when the labor cost differential is not exogenous from the viewpoint of governments, a smaller country may be able to attract the firm). For $0.5 < n < 1$, however, the critical level of trade costs is strictly smaller than the one that would prevail without subsidies. Hence, a labor cost differential gives a country both the opportunity and the incentive to attract investment via tax policy where it otherwise would not. Figure 4.2 illustrates this effect in $n-\tau$-space: The dashed line displays the regime border between A (above) and B (below) winning, respectively, with subsidies. The solid line is the regime border that would prevail if the use of policy instruments was ruled out.

Figure 4.2: The effect of the presence of tax policy on the equilibrium allocation



$\alpha = 2$; $\beta = 4$; $w_B = 1$; $w_A = w_B + \frac{1}{10}(\alpha - w_B)$.

[7]This is different in another paper in this literature: Barros and Cabral (2000). In their work, however, there is no difference in the cost to the firm, but merely in the shadow price of labor. Apart from that, in that paper, production (rather than entry) is subsidized.

4.3 Evidence

We test the model implication using an unbalanced panel of 16 Western European countries, 1982-2005.[8] Even though the cross-section in Europe is necessarily small, this approach has many advantages as tax competition is prevalent in Europe, labor costs differ widely across regions that are geographically close, and the 1990 integration shock provides us with an exogenous break in the number of competitors. Assuming a linear relation between taxes and labor costs, our estimation equation reads

$$TAX_{it} = \alpha \Delta LC_{it} + X_{it}\beta + c_i + \gamma_t + \epsilon_{it}, \quad i = 1 \ldots, N, \quad t = 1982, \ldots, 2005, \qquad (5)$$

where TAX_{it} is the corporate income tax rate, X_{it} is a vector of controls[9], c_i denotes country-specific and γ_t period-specific effects. The key explanatory variable is the labor cost differential, $\Delta LC_{it} = LC_{it} - \sum_j w_{ij} LC_{jt}$, with the weights of competitors w_{ij} being based on geographical distance, d_{ij}, and population, pop_i, taking the form $w_{ij} = \frac{\ln(pop_j+1)/d_{ij}^2}{\sum_{k \neq i} \ln(pop_k+1)/d_{ik}^2}$ if $j \neq i$ and $w_{ij} = 0$ if $j = i$. The theoretical model predicts a negative α, indicating that countries with less competitive labor costs choose lower tax rates.

Since labor market conditions depend on a country's attractiveness for private investment and, therefore, tax policies, we treat ΔLC_{it} as an endogenous regressor and devise an instrumental variable (IV) approach to estimate equation (5). Our IV exploits the breakdown of the communist regimes in Eastern Europe around 1989/90 as a source of exogenous variation in competitors' labor costs (and, hence, labor cost differentials). Specifically, we use as an IV the weighted average of a country's competitors' exposure to the 1989/90 integration shock. Based on the count of the number of countries one has to drive through (or to fly over in case of no land connection) starting from j's capital and heading at the closest Eastern European capital, $DIST\,EAST_j$,[10] we construct the IV as $\sum_j w_{ij}(5 - DIST\,EAST_j) \times (2006 - t) \times D_{1990}$, where D_{1990} is a dummy for post-1989 years.[11] Note that the IV captures variation in ΔLC_{it} driven by differences between coun-

[8] The countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, UK.

[9] We include the log of GDP to control for country or market size. Also, the age structure of the population may influence tax policies: A large share of young and elderly people may drive up tax rates because of a higher need public spending. Finally, it has been argued that high capital mobility itself causes downward pressure on corporate tax rates. Hence, we also include the annual inflow of FDI (divided by GDP) as one of the common measures for openness.

[10] Counting both i and the country of the closest Eastern European capital, this gives, for instance, a value of one for Poland, two for Germany, three for France, and four for the UK.

[11] Using $(5 - DIST\,EAST_i) \times (2006 - t) \times D_{1990}$ as IV gives similar, but statistically less significant results.

tries in terms of their exposure to countries in Eastern Europe with initially low (and then slowly increasing) relative labor costs.

To ensure the validity of our IV we need to account for the direct effect of the 1989/90 break on taxes. We do this by including as an ordinary regressor an indicator equal to $(5 - DIST\,EAST_i) \times (1989 - t) \times D_{1990}$. Note that, in contrast to our IV, $(5 - DIST\,EAST_i) \times (1989 - t) \times D_{1990}$ does not show a discrete jump in 1990, reflecting the fact that the economic integration between East and West was a gradual process rather than an immediate result of the 1989/90 revolution. As an alternative, we use the indicator $BORDER_i \times (1989 - t) \times D_{1990}$, where $BORDER_i$ is a dummy for Western European countries with immediate Eastern European neighbors.[12] This is obviously a rather crude approach, but one, as we think, that captures the effect in a practicable way. Note also that using the integration shock to identify the impact of labor cost differentials implies that only Western European countries can be used for estimation. However, data on Eastern Europe is used to compute ΔLC_{it}.

To estimate Equation (5), we use the statutory corporate income tax rate[13] together with a compensation cost index (USA=100) provided by the US Bureau of Labor Statistics, comprising hourly compensation costs in manufacturing. These are prepared by the Bureau of Labor Statistics specifically in order to assess international differences in employer labor costs. The measure includes hourly direct pay and employer social insurance expenditures and other labor taxes. The exchange rates used are prevailing commercial market exchange rates. In addition, we use unit labor costs in manufacturing, representing the current cost of labor per 'real quantity unit' of output produced, taken from the ILO's 'Key Indicators of the Labor Market' database. This indicator represents a direct link between productivity and the cost of labor used in generating output, and is designed as an indicator of cost competitiveness. Apart from country size (GDP) and openness (share of exports and imports in GDP), we control for preferences for public expenditures (percentage of population below 15 and above 65 years). For more details on statutory tax rates and controls (including sources), see Overesch and Rincke (2009).

Table 4.1 presents descriptive statistics. Note that due to missing data for labor costs in Eastern Europe prior to 1993, we do not make use of the cross-sections 1990-1992.

Table 4.2 displays results of two-stage least squares (2SLS) regressions accounting for the

[12] The group comprises Austria, Denmark, Finland, Germany, Greece, Italy, and Sweden.

[13] We would like to thank Michael Overesch (ZEW Mannheim) for generously sharing his tax data with us.

endogeneity of labor cost differentials.[14] Columns (1) to (3) use compensation costs as the key explanatory variable. Irrespective of whether and how we control for the direct effect of the 1989/90 shock on tax policies, the estimates point to a statistically significant impact of labor cost differentials on tax rates. But the estimated effects are also economically significant: If the compensation cost differential increases by one percent of the current compensation cost in the US, firms are, on average, compensated by a 0.19 percentage point cut in the tax rate. A one-standard deviation increase in the compensation cost differential thus triggers a 5.1 percentage point cut in taxes. If we take into account differences in labor productivity we find similar effects. As shown in columns (4) to (6), a one-standard deviation increase in the unit labor cost differential is estimated to decrease the statutory tax rate by 7.3 to 7.5 percentage points.

4.4 Conclusion

We develop a simple model highlighting the behavior of governments in a bidding race for FDI when countries exogenously differ in labor costs. It is shown that tax policy opens up room for a country with a disadvantage in labor cost terms to optimally attract mobile capital where it would not be able to become the location of choice in the absence of government intervention. Using data on Western Europe, we estimate a substantial effect of labor cost differentials on corporate tax rates, confirming the model prediction. One policy conclusion is that if labor unions are successful in setting wages above the competitive level, this may not only cause unemployment, but also force the government to compensate multinational firms by reducing corporate income taxes.

[14] We report standard errors which are robust to clustering by country within four-year windows.

Table 4.1: Descriptive Statistics

Variable	Mean	Std.Dev.	Min	Max
Statutory tax rate	0.393	0.102	0.125	0.659
Compensation cost differential	5.79	27.1	-56.8	96.9
Unit labor cost differential	0.031	0.165	-0.527	0.541
Log(GDP)	12.2	1.34	8.22	14.5
Openness	0.870	0.510	0.366	2.89
% young	0.183	0.026	0.139	0.303
% old	0.149	0.018	0.105	0.197
(5-DIST EAST)$\times(1989-t)\times D_{1990}$	-14.1	14.6	-48.0	0
BORDER$\times(1989-t)\times D_{1990}$	-2.09	3.80	-13.0	0
$\sum_j w_{ij}(5-DIST\,EAST_j)\times(2006-t)\times D_{1990}$	11.4	11.4	0	46.1

Unbalanced panel (16 countries, years 1982-1989 and 1993-2005, 304 observations).

Table 4.2:

Labor cost differentials and tax policies, 2SLS estimations

Dependent variable: Statutory tax rate	(1)	(2)	(3)	(4)	(5)	(6)
Compensation cost differential	-0.0019***	-0.0019***	-0.0019***	-	-	-
	(0.0007)	(0.0006)	(0.0007)			
Unit labor cost differential	-	-	-	-0.443**	-0.442**	-0.454**
				(0.186)	(0.183)	(0.192)
Log(GDP)	0.156**	0.209***	0.139**	0.184**	0.202**	0.131
	(0.062)	(0.064)	(0.060)	(0.088)	(0.092)	(0.085)
Openness	-0.199***	-0.220***	-0.194***	-0.299***	-0.306***	-0.288***
	(0.053)	(0.055)	(0.052)	(0.103)	(0.104)	(0.099)
% young	0.832	0.346	0.836	2.04**	1.87*	2.08**
	(0.591)	(0.629)	(0.591)	(1.00)	(1.03)	(1.013)
% old	2.976***	2.61***	2.96***	4.18***	4.06***	4.17***
	(0.883)	(0.894)	(0.876)	(1.27)	(1.28)	(1.263)
(5-DIST EAST)$\times(1989-t)\times D_{1990}$	-	-0.002	-	-	-0.0007	-
		(0.001)			(0.001)	
BORDER$\times(1989-t)\times D_{1990}$	-	-	0.001	-	-	0.004*
			(0.002)			(0.002)
R^2	0.764	0.769	0.764	0.631	0.632	0.631
First stage: Partial R^2	0.305	0.362	0.370	0.115	0.117	0.118
First stage: F-statistic	19.77	30.59	29.10	10.69	11.42	11.19

Years 1982-1989 and 1993-2005, 304 observations. Standard errors are robust to heteroscedasticity and clustering by state using four-year windows. Country and year effects included.

Chapter 5

Should market integration be enforced?

5.1 Introduction

With the completion of the single market in a unified Europe and a common currency, we are closer than ever to a truly integrated market in the European Union. In terms of policies that directly affect consumption, there is a striking contrast between the fields of competition and trade policy, which are now in significant parts at the supranational level, and tax policy where countries are still a lot more independent. I am interested in the interplay of these two policy fields. A sector on which the media frequently report that there are substantial price differences in Europe is the car industry. This is, at the same time, a sector with great factual and perceived importance, as the evidence presented in Chapter 2 at least anecdotically suggests. Car producers are among the biggest employers and largest companies in terms of their balance sheet totals and profits. Also, it is a sector where specific taxation is in place and differs substantially across countries. It is the repeatedly expressed will of the European Commission to see car prices converge in Europe as large differentials are clearly not in the spirit of the common market. It wants tax harmonization within the Union and has suggested to at least reduce registration taxes or to abolish them altogether (see European Commission (2002)). Progress has been made compared to a situation a few years ago, when car manufacturers had exemptions from usual cartel rules and could choose at their discretion which dealers to provide with how many vehicles, and these dealers had fully exclusive territories. As of today, auto dealers are also allowed to open up stores in other European Union countries. Car price reports by the European Commission (2007a, 2009), however, show that there are still very significant price differences across Europe. Car prices are among the lowest in Denmark where a registration tax above 100% applies. For instance, the price difference for the compact-sized Renault Mégane (expressed as percentage of the price in Euros before tax, comparing the most expensive with the cheapest Euro zone market) was an astounding 51.6% on January 1, 2009 (European Commission (2009)). The Volkswagen Polo had a tax inclusive (in brackets: tax exclusive) price of EUR 12050 (10126) in Germany, EUR 13226 (9128) in the Netherlands, EUR 12191 (9773) in Austria, EUR 14146 (9072) in Finland and EUR 20746 (8750) in Denmark. Seeing those figures, it is hardly surprising that Lutz (2004) identifies a significant effect of registration taxes on registration on tax-exclusive auto prices. Those numbers raise an interesting research question and spark the idea to examine a very direct approach to tackle the issue: If car prices in Europe differ before *and* after taxes, a natural question to ask is if a mandatory equalized producer price across markets would be beneficial, and for whom. Thus, in this article, I look into how market integration and tax policies are interrelated. A supranational entity determines whether markets will be segmented or integrated/tied, very much as in Anderson et al. (1995) who view enforced market integration as a strict antidumping policy. Given this information, national welfare-maximizing governments then non-cooperatively set commerce taxes. Since the destination principle, i.e. the taxation of consumption, is more apt to the car market example, and is commonplace in Europe anyway, I expose the basic model around this case. The main result is that antidumping policy is welfare superior, and that this needs to be qualified if firms are not domestically owned. I also examine whether my main results change when countries differ in productivity or when there is instead taxation of production (i.e., the origin principle in place).

Given the focus of my analysis, the paper builds on two strands of the literature. Firstly, it is related to papers on competition/trade policy in the form of antidumping rules. There is a huge literature on this topic; I mainly recur to Anderson et al. (1995) who show that a move from segmented to integrated markets will benefit consumers and harm producers while increasing overall welfare. Older contributions include Davidson et al. (1989) who tailor their model to the EU (then EC) car market and show that antidumping may actually lower welfare. Venables (1990) models the process of market integration as a reduction in a firm's perceived ability to price differentially in different national markets and finds that market integration in that sense is unambiguously welfare improving. Antidumping is an active area of research in international economics, in particular since multilateral trade negotiations have made the analysis of tariffs, quotas and the like obsolete in many cases. Blonigen (2000), in an empirical study, demonstrates that European firms react with FDI to American antidumping measures. A theoretical contribution on antidumping and FDI is Belderbos et al. (2004). They discuss antidumping measures against a producer from outside the EU, however. Feuerstein (2007) shows, in a two-country model with a single producer, that the optimal importing country's tax rate depends positively on the car manufacturers' scope to price discriminate, reducing tax rates when arbitrage costs fall. I will give a short overview over segmented and integrated markets, with some additional literature, in the next section. The link to antidumping policy will then become more obvious.

The second strand I draw upon is on commodity taxation under imperfect competition such as Hashimzade et al. (2005) who find that with linear demand, the origin principle dominates the destination principle. Similar in nature is the more general contribution of Haufler et al. (2005) who show that the case for origin-based taxation becomes stronger when barriers to trade fall. Keen and Lahiri (1998) show in an integrated market (in the sense that there are no transport costs) that, for both coordinated and noncoordinated taxation, the origin principle tends to be globally optimal. These papers put into perspective an older series of articles that examined destination-vs. origin based taxes under perfect competition (see, e.g., the seminal contribution of Mintz and Tulkens (1986), or Kanbur and Keen (1993)). Lockwood (2001) gives a survey of this literature. One of the general messages from the literature is that the result that destination taxes tend to be preferable under perfect competition can easily be turned into a dominance of origin taxation when product markets are imperfectly competitive. To the best of my knowledge, the paper closest to the present one (at least in terms of modelling) is Haufler and Pflüger (2007) who examine the incentives for strategic commodity tax-setting under various regimes (Cournot vs. Bertrand competition, segmented vs. integrated markets, origin vs. destination taxation). They show, inter alia, that origin taxes lead to downward competition of tax rates in all cases. However, the focus of my analysis is different: I focus on the general efficiency of market integration under varying assumptions.

A short comment on the modelling side: The literature on commodity taxation under imperfect competition has developed a two-country, two-firm workhorse model which I will build to here. It is also employed by the antidumping model in Anderson et al. (1995), for good reasons: It nicely displays all relevant strategic effects while being simple enough to yield closed-form solutions. The taxes considered in this model are specific unit commodity taxes.

The paper is organized as follows. The next section presents the theoretical model. Section 5.3, the main part of the analysis, introduces a role for competing governments via tax/subsidy policies and determines which regime is preferable in the benchmark symmetric case, and also looks at market integration with a different government objective function due to absentee ownership of firms and with asymmetric countries. Section 5.4 illuminates the role of government revenue needs and production taxation to check the robustness of my main findings. Section 5.5 concludes.

5.2 Taxation and antidumping: A simple model

Before going into the details of the model, it makes sense to briefly illustrate the concepts of segmented and integrated markets. With segmented or separated markets, used in most trade models, there is the assumption that imperfectly competitive firms optimize for their different markets separately. This is the reciprocal dumping model from Brander and Krugman (1983), used in many following influential contributions such as Brander and Spencer (1985). It is somewhat less clear what integrated/tied markets means: It may simply mean the existence of independent arbitrageurs or cross-border shopping, so firms may not charge a price differential in excess of the transport cost. This is generally non-binding with 'segmented markets' due to what is called freight absorption, i.e. the firms' optimally bearing some of the transport cost.[1] Alternatively, it means that there is a single factory-gate price, so the firm must sell all output at one producer price no matter where one particular unit is going. This is what is used by most papers, inter alia by Anderson et al. (1995) and Haaland and Wooton (1998), and what I will be using here. It means, in particular, that firms are not *allowed* (rather than not *able*) to earn less on a unit sold abroad than on a unit sold in their home country, where they produce. In that sense, there is a formal equivalence between price discrimination and dumping. Haufler and Pflüger (2007) use the term integrated markets to express that for any single firm, there is no difference between producer prices across markets. In the Anderson et al. (1995) article, this simply means that a firm will be bound to pass on the full cost differential, i.e. it must, when producing in i, charge consumers in j the real trade cost and must not 'underinvoive' strategically. With production/origin taxes, I have exactly the same concept here. With consumption/destination taxes, matters are slightly more

[1] This definition is used by Wright (2003), who shows that policymakers may use tariffs to segment markets. It is also the basis of an article by Ishikawa (2004) where it is argued that an antidumping rule can be beneficial to consumers while hurting producers.

intricate. Tied markets, i.e. equal producer prices, then mean that firms have to take tax differentials into account when setting prices for the two markets. This is exactly what happens in the Haufler and Pflüger (2007) integrated markets case, and I will analyze this case in what follows.[2] So, in essence, the question I am trying to answer is if it is welfare optimal to introduce a supranational law which binds firms to set a single producer price (and then let non-cooperative governments and firms set consumption taxes and prices non-cooperatively.)

The model is kept as simple as possible: There are two countries, 1 and 2, and three consumption goods, denoted x, y and z, with x being produced by a firm in country 1 (say, firm 1) and good y by a firm in 2 (firm 2). These goods are variants of a differentiated product. The z good is produced under conditions of perfect competition with costless trade. It is used as the numéraire, and labor is the only input throughout the model such that a unit input requirement renders the wage rate in both countries equal to one as well. Following Hashimzade et al. (2005, 2006), without loss of generality, I set the marginal cost in differentiated goods production to zero. Doing so is a mere normalization[3], and a convenient one since when modelling asymmetries across countries later on, the marginal cost will be $\delta > 1$ in one of the countries, sparing me one parameter. The constraint that prices are positive remains slack throughout the analysis due to firms' market power. Transporting a unit of goods x or y involves a real trade cost of τ. A fixed quantity of labor, L, which I normalize to 1, is inelastically supplied by each consumer. Tax revenue raised from the taxation of the differentiated good is returned lump-sum to consumers by each government.

The utility function is characterized by

$$u = (x + y) - \frac{1}{2}\left(x^2 + 2y\gamma x + y^2\right) + z, \tag{1}$$

which is adapted from Vives (1984). The mass of consumers in each country is normalized

[2]Note that producer prices, i.e. prices before trade costs and taxes having to be equalized is the only meaningful definition: For instance, referring only to the trade cost in the cost pass-on rule would be an empty concept since it is impossible to disentangle 'which' costs have or have not been passed on. It is also this sense under which the ban on price discrimination is being understood in the European political discussion.

[3]In a previous version, I had a positive marginal cost parameter, which did not affect any of my results. The only thing that changes is one then has to make sure the labor endowment is large enough for both countries to produce the diversified as well as the perfectly competitive good.

to one. The per-capita budget constraint is

$$q_x x + q_y y + z = 1 + \Lambda, \tag{2}$$

where Λ denotes lump-sum income consisting of tax revenues and profits.[4] Note that due to the quasilinearity of the utility function, this has no bearing on the equilibrium quantities of x, y. $\gamma \,\epsilon\, [\,0, 1\,[$[5] measures products' substitutability, with a larger γ implying closer substitutes. Throughout this paper, q stands for consumer prices and p will denote producer prices. By utility maximization, I get the inverse demand functions

$$q_x = 1 - x - \gamma y, \tag{3}$$

$$q_y = 1 - y - \gamma x, \tag{4}$$

illustrating γ's role as substitutability parameter. Denoting country 2 parameters and variables with an asterisk, I get inverse demand there as

$$q_{x^*} = 1 - x^* - \gamma y^*, \tag{5}$$

$$q_{y^*} = 1 - y^* - \gamma x^*. \tag{6}$$

Note that x^* is the quantity sold by firm 1 in country 2 and y^* is the quantity sold by firm 2 in its home market. Using the example of country 1, direct demand functions are:

$$x = \frac{1}{1+\gamma} - \frac{1}{1-\gamma^2} q_x + \frac{\gamma}{1-\gamma^2} q_y, \tag{7}$$

$$y = \frac{1}{1+\gamma} - \frac{1}{1-\gamma^2} q_y + \frac{\gamma}{1-\gamma^2} q_x. \tag{8}$$

Expressions for quantities in market 2, x^* and y^*, are analogous. Firms compete in prices with differentiated products. The motivating example of the car industry seems to be a case where traditionally a lot of competition was done via capacity choice and one could thus argue that Cournot competition might be more appropriate. However, the last years have seen dramatic overcapacities and quite substantial rebate waves in car markets like Europe

[4]The latter may be unevenly distributed if firm ownership is not symmetric within countries, which will be of relevance later.

[5]Demand functions in this model do not allow for $\gamma = 1$, see Singh and Vives (1984). There is nothing conceptually wrong with perfect substitutes, of course, but the outcome cannot be determined using calculus any more.

and North America, rendering price competition more convincing.[6] Governments deploy unit taxes in the x and y industries, leaving the numéraire untaxed. Specific taxes, such as on cars, are the underlying policy motivation, although a link can be made to existing literature, which focuses on taxes like the VAT and also leaves the numéraire untaxed as without selective taxation, there tends to be no difference between the destination and origin principles (Lockwood et al. (1994)). The structure of the game is as follows: At the beginning (say, stage zero), a supranational institution (e.g., the EU) determines whether markets are segmented or integrated. What then follows is a two-stage game: At the first stage, governments determine tax rates. At the second stage, firms set prices. With taxes and prices given, production and consumption take place. The model is solved, of course, by backward induction.

5.3 Destination Principle

With output being taxed where it is consumed, firms' profit functions are:

$$\begin{aligned} \pi^d &= (q_x - t)x + (q_{x^*} - t^* - \tau)x^*, \\ \pi^{*\,d} &= (q_{y^*} - t^*)y^* + (q_y - t - \tau)y, \end{aligned} \tag{9}$$

where t and t^* stand for 1's and 2's taxes, respectively, and the first summands stand for the respective firms' home market profits. Note that producer prices are then $p_x = q_x - t$, $p_{x^*} = q_{x^*} - t^* - \tau$, and analogously for firm 2.

5.3.1 Segmented markets

Maximizing (9) (using the demand functions from the previous section, namely (7), (8), and their foreign counterparts) with respect to producer prices separately for each market,

[6] Since antidumping rules/integrated markets affect pricing behavior directly, I consider Bertrand competition as a natural choice. My guess on Cournot competition would be that it would not make a qualitative difference: It does tend to lead to higher profits in those models, but the basic strategic effects governments' subsidies have are qualitatively similar. Furthermore, Anderson et al. (1995) show that their result goes through under Cournot competition as well, and the results in Haufler and Pflüger (2007) are pretty similar for price and quantity competition, whereas segmented vs. integrated markets makes a big difference.

and solving these equations, I get the Nash equilibrium in prices:

$$\begin{aligned} p_x &= \frac{2-\gamma^2+\tau\gamma-\gamma+t\left(\gamma^2+\gamma-2\right)}{4-\gamma^2}, \\ p_x^* &= \frac{(1-t^*)(1-\gamma)(\gamma+2)-\tau\left(2-\gamma^2\right)}{4-\gamma^2}, \\ p_y^* &= \frac{2-\gamma^2+\tau\gamma-\gamma+t^*\left(\gamma^2+\gamma-2\right)}{4-\gamma^2}, \\ p_y &= \frac{(1-t)(1-\gamma)(\gamma+2)-\tau\left(2-\gamma^2\right)}{4-\gamma^2}. \end{aligned} \tag{10}$$

Accordingly, consumer prices will amount to:

$$\begin{aligned} q_x &= \frac{2(1+t)-(1-\tau-t)\gamma-\gamma^2}{4-\gamma^2}, \\ q_x^* &= \frac{2(1+\tau+t^*)-\gamma+t^*\gamma-\gamma^2}{4-\gamma^2}, \\ q_y^* &= \frac{2(1+t^*)-(1-\tau-t^*)\gamma-\gamma^2}{4-\gamma^2}, \\ q_y &= \frac{2(1+\tau+t)-\gamma+t\gamma+\gamma^2}{4-\gamma^2}. \end{aligned} \tag{11}$$

Note that these prices depend, of course, on taxes. Substituting them back into the demand functions, I get quantities depending on only taxes and exogenous parameters. These can then be used in welfare expressions. Welfare consists of consumer surplus, labor income, tax revenues and profit income:

$$W = CS + 1 + t(x+y) + \pi; \quad W^* = CS^* + 1 + t^*(x^*+y^*) + \pi^*. \tag{12}$$

Hence, welfare in country 1 is

$$W^{d,s} = (x+y) - \frac{1}{2}\left(x^2 + 2\gamma yx + y^2\right) - q_x x - q_y y + 1 + t(x+y) + \pi^{d,s}, \tag{13}$$

with 'd, s' standing for the 'destination, segmented' regime and welfare in country 2 is

$$W^{*\,d,s} = (x^*+y^*) - \frac{1}{2}\left(x^{*2} + 2\gamma y^* x^* + y^{*2}\right) - q_{x^*}x^* - q_{y^*}y^* + 1 + t^*(x^*+y^*) + \pi^{*\,d,s}. \tag{14}$$

Maximizing (13) and (14) with respect to t and t^* yields[7]

$$t^{d,\,s} = t^{*\,d,\,s} = -\frac{\tau(\gamma+1)}{2(\gamma+2)}. \tag{15}$$

[7] Second order conditions for maximization are checked and fulfilled throughout this chapter.

These taxes are zero when trade is free. There are two basic motives, pulling the tax in different directions. On the one hand, they will be used as a corrective subsidy due to the under-consumption caused by market power. On the other hand, to the extent that they hit imports, they can be used to shift rents away from the foreign firm. It turns out that in the present specification with linear demand, these two effects exactly cancel each other under free trade. This makes intuitive sense as without trade frictions, the foreign industry is just as important to a country (and a subsidy to it just as effective) as the home industry. The taxes turn into subsidies when trade is costly, so there are never positive taxes in this basic version of the model without an exogenous revenue need or foreign ownership. This stems from the effect that the best thing to do in a closed economy would be granting the monopolist the optimal subsidy, which is counteracted by a tax-the-foreigner effect under trade. Observe that an increase in τ makes markets more and more separated, driving up the firms' market power in their home markets and calling more strongly for corrective subsidies. These results are well-known (see, e.g., Hashimzade et al. (2005)). With those taxes substituted back into (13) and (14), I get the equilibrium welfare levels under destination taxes and segmented markets. Taking country 1, this is

$$W^{d,s} = \frac{1}{4\left(4-\gamma^2\right)^2\left(\gamma^2-1\right)}\left\{\tau^2\left(-2\gamma^4+\gamma^3+11\gamma^2-\gamma-19\right)+\right.$$
$$\left.4\left(\gamma^4-4\gamma^3+\gamma^2+9\gamma-7\right)(\gamma+2)^2+4\tau\left(\gamma^4+2\gamma^3-6\gamma^2-7\gamma+10\right)\right\}. \quad (16)$$

For future reference, welfare without profit income (i.e. $W_{noprofit} = CS + 1 + t(x+y)$) is

$$W^{d,s}_{noprofit} = \frac{1}{4\left(4-\gamma^2\right)^2\left(\gamma^2-1\right)}\left\{\tau^2\left(-3\gamma^3+7\gamma^2+3\gamma-9\right)+\right.$$
$$\left.4\tau\left(\gamma^4-6\gamma^2-\gamma+6\right)+4\left(\gamma^6-9\gamma^4+\gamma^3+27\gamma^2-20\right)\right\}. \quad (17)$$

These terms are somewhat messy. I restate them for $\gamma = 1/2$ as a natural benchmark case of intermediate substitutability across goods, and will make use of this simplification several times in what follows for purely expositional purposes (the role of different values of γ will be become clearer below):

$$W^{d,s}|_{\gamma=\frac{1}{2}} = \frac{1}{675}(4\tau(67\tau-85)+1075), \quad W^{d,s}_{noprofit}|_{\gamma=\frac{1}{2}} = \frac{1}{675}\left(98\tau^2-260\tau+875\right). \quad (18)$$

The above expressions characterize the non-cooperative solution. As a benchmark for ensuing welfare analyses, I now turn to the taxes that would prevail under a cooperative solution, i.e. the (common) consumption tax that would maximize the sum of the two countries' welfare levels:

$$t^s_{coop.} = -\frac{1}{2}(2-\tau)(1-\gamma). \tag{19}$$

This will be discussed further below. One thing to note right away is that $t^{d,s}$ is generally larger (less of a subsidy) than $t^s_{coop.}$. This reflects that when setting taxes non-cooperatively, governments do not take into account the negative effects on the other country's industry's profits (which are negatively affected by a tax increase) and thus end up setting taxes too high (from a global point of view).

Before proceeding to the next section, it is worthwhile to spend a moment considering the outcome of the game. Since with symmetric countries, taxes will be the same in 1 and 2, and since firms absorb some of the freight cost (at least with the linear demand assumed here, and which is suggested to be the case in the bulk of the corresponding empirical literature), there is no way arbitrage alone can prevent firms from earning different producer prices across markets. The next section will now examine how a rule precluding them from doing exactly the latter will influence taxes, and, above all, whether such a rule is desirable.

5.3.2 Integrated markets and comparison

With integrated markets, or, expressed differently, with an antidumping law prohibiting both firms to earn less on their respective foreign markets than their home markets, firms can no longer freely set their prices across markets. In fact, producers effectively lose one instrument since for given taxes and exogenous trade costs, they must not strategically earn less in one market.[8] This is the intuition why firms lose from tied markets, at least in the absence of taxes.

Maximizing (9) (again using (7), (8), and their foreign counterparts) with respect to producer prices under the conditions that $p_x = p_{x^*}$ and $p_y = p_{y^*}$, and solving the first order conditions, I get the following Bertrand-Nash equilibrium in prices:

[8] If the taxes considered are registration fees rather than 'standard' commodity taxes one has to pay in the moment of acquisition, arbitrage ensures that consumer prices can differ at most by real trade costs, leaving producers the scope to price discriminate. Then, an 'equalize producer prices rule' effectively forces producers to pass on the trade cost to consumers.

$$
\begin{aligned}
p_x = p_{x^*} &= \frac{(1-\gamma)\,(2-t-t^*-\tau)}{2(2-\gamma)}, \\
p_y = p_y^* &= \frac{(1-\gamma)\,(2-t-t^*-\tau)}{2(2-\gamma)}.
\end{aligned} \tag{20}
$$

Consumer prices will then be:[9]

$$
\begin{aligned}
q_x &= \frac{2+3t-t^*-\tau-\gamma\,(2+t-t^*-\tau)}{2(2-\gamma)}, \\
q_x^* &= \frac{2+3t^*-t+3\tau-\gamma\,(2-t+\tau+t^*)}{2(2-\gamma)}, \\
q_y^* &= \frac{2+3t^*-t-\tau-\gamma\,(2-t+t^*-\tau)}{2(2-\gamma)}, \\
q_y &= \frac{2+3t-t^*+3\tau-\gamma\,(2+t+\tau-t^*)}{2(2-\gamma)}.
\end{aligned} \tag{21}
$$

As above, substituting prices back into the demand functions, I get quantities depending only on taxes and exogenous parameters. Welfare in country 1 is:

$$
W^{d,i} = (x+y) - \frac{1}{2}\left(x^2 + 2\gamma yx + y^2\right) - q_x x - q_y y + 1 + t(x+y) + \pi^{d,i}, \tag{22}
$$

and welfare in country 2 is

$$
W^{*\,d,i} = (x^*+y^*) - \frac{1}{2}\left(x^{*2} + 2\gamma y^* x^* + y^{*2}\right) - q_{x^*} x^* - q_{y^*} y^* + 1 + t^*(x^*+y^*) + \pi^{*\,d,i}. \tag{23}
$$

Maximizing (22) and (23) with respect to t and t^*, and solving the corresponding system of first-order conditions, yields

$$
t^{d,\,i} = t^{*\,d,\,i} = -\frac{(1-\gamma)(2-\tau)}{2(5-(4-\gamma)\gamma)}. \tag{24}
$$

It is obvious that these tax rates are *not* equal to zero when trade is costless. In fact, they even rise in $\tau : \partial t^{d,\,i}/\partial\tau = (1-\gamma)/(2(5-(4-\gamma)\gamma)) > 0$ for $\gamma \,\epsilon\, [\,0,1\,[$. This illustrates how tying markets feeds back on optimal tax policy depending on the level of trade costs.[10] So, the presumption is that the subsidies are higher than subsidies under segmented markets

[9] As a consistency check, setting taxes to zero and appropriately relabelling parameters and variables, I get the term in equ. (9) from Anderson et al. (1995). To see this, observe that they merely expose their model in different terms: Setting their a equal to $1/(1+\gamma)$, b to $1/(1-\gamma^2)$ and c to $\gamma/(1-\gamma^2)$, and setting taxes to zero (as they are absent in their model), I get the same demand system and the same firms' optimal prices.

[10] More on this will follow below, in a discussion on the deviation of the non-cooperative from the cooperative tax rate.

at least for a range of parameter values. In fact, $t^{d,s} - t^{d,i}$ equals:

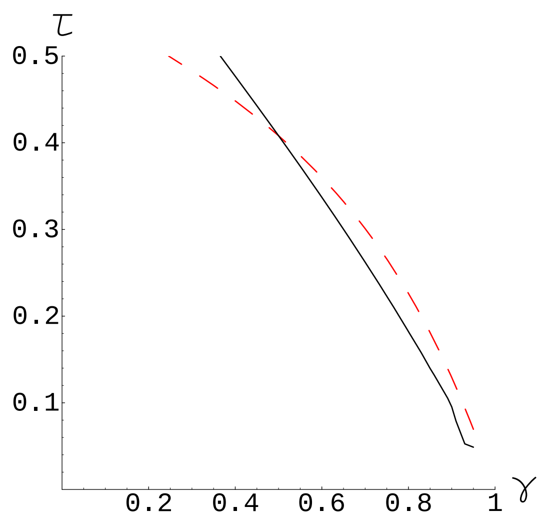
$$\frac{1}{2}\left(\frac{(\gamma-1)(\tau-2)}{(\gamma-4)\gamma+5} - \frac{(\gamma+1)\tau}{\gamma+2}\right). \tag{25}$$

As this difference depends only on two parameters, it is easy to plot a line where it is zero in $\gamma-\tau$-space, see Figure 5.1. The dashed line displays loci where the tax under segmented markets and the one under integrated markets are equal. Below, $t^{d,i}$ is smaller than $t^{d,s}$[11], which leads to

Proposition 1 *Under the destination principle, subsidies are higher under integrated markets than under segmented markets for a large range of trade costs.*

Proof. For $\tau = 0$, $t^{d,s} - t^{d,i}$ from (25) equals $\frac{\gamma+1}{5-(4-\gamma)\gamma} > 0$. For a general τ, $\partial(t^{d,s} - t^{d,i})/\partial\tau$ equals $\frac{-\gamma^3+4\gamma^2-7}{2(\gamma^3-2\gamma^2-3\gamma+10)}$, which is negative for any $\gamma \,\epsilon\, [\,0,1\,[$. In the benchmark case of $\gamma = \frac{1}{2}$, $t^{d,s} - t^{d,i} = 0$ at $\tau = \frac{20}{49}$. □

Figure 5.1: Line of equality in consumption taxes under segmented vs. integrated markets



To understand why taxes differ under integrated markets, note that they play a very different role. A look at prices under segmented (10) and integrated (20) markets reveals that in the latter case, firm i's taxes have a direct effect on firm j's producer prices. This

[11]To see this, note that the first derivative of (25) with respect to τ is negative for any γ in the admissible parameter range.

is because of the binding constraint that a firm must not earn less per unit on its foreign market than on its home market (and, obviously, firms' optimal reactions). With tied markets, e.g., a tax on consumption in country 1 not only makes firm 1 lower its home producer price, it also makes it lower its export market producer price (p_{x^*}). Since the same rule applies to firm 2, the same happens there (see (20)). Via the effect on consumer prices, this makes firms sell more in 2, driving up consumption there. So, in addition to the obvious negative spill-over on the foreign firm's profits that is present in both regimes, there is now a positive spill-over as a country will see its consumption (and, uno acto, its tax base) increase if the other raises its tax.

Looking a bit closer at those spill-overs, firstly those on profits, it turns out that both rise in trade costs (i.e., become less negative) as markets get more apart. With segmented markets, this is the well-known standard result from a falling market share; under integrated markets, note that the cost pass-on rule also drives firms' market shares on foreign markets down. Algebraically, those externalities are:[12]

$$\frac{\partial \pi^{d,s}}{t^{*s}} = \frac{(2-\tau)\gamma^2 + 2\gamma + 3\tau - 4}{(\gamma-2)^2(\gamma+1)(\gamma+2)}, \quad \frac{\partial \pi^{d,i}}{t^{*i}} = \frac{(\gamma-3)(\gamma-1)(\tau-2)}{(\gamma-2)(\gamma+1)((\gamma-4)\gamma+5)}, \tag{26}$$

where both are negative and rising (that is, becoming smaller in absolute terms) in τ. Intuitively, all spill-overs become smaller as trade gets costlier simply because the volume of trade goes down. Subtracting the latter from the former term in (26) shows that the profit spill-over is more negative (i.e., more pronounced) under integrated markets. So, the fact that $t^{d,i}$ is generally lower must be driven by overcompensating spill-overs on consumption (consumer surplus, to be precise) and tax base. There will then be a point depending on τ where spill-overs as well as taxes are the same. Overall spill-over effects are:

$$\frac{\partial W^{d,s}}{t^{*s}} = \frac{(2-\tau)\gamma^2 + 2\gamma + 3\tau - 4}{(\gamma-2)^2(\gamma+1)(\gamma+2)}, \quad \frac{\partial W^{d,i}}{t^{*i}} = -\frac{(\gamma-1)(\tau-2)}{\gamma^3 - 3\gamma^2 + \gamma + 5}, \tag{27}$$

where the former is identical to the one in (26) as there are no other effects under segmented markets. Again, both are falling in absolute value in τ. As a consistency check, taxes should be the same where spill-overs are the same. In fact, the locus of $\gamma - \tau$-combinations where the two terms in (27) are the same is identical to the one in Figure 5.1 where taxes are the same. Another view on the whole matter is that a subsidy has a strategic effect on the other country's firm's behavior with integrated markets, and turns out to be a more powerful policy tool in competition that way, pushing it closer to the cooperative level than under

[12] All spill-over effects are evaluated at the non-cooperative equilibrium.

segmented markets.[13] In the figure (and the following ones), I also plot a solid line which denotes the prohibitive level of trade costs under integrated markets (which is the lower prohibitive level as compared to segmented markets as the forbidden price discrimination makes each firm sell more on the home and less on the foreign market).[14] So, it is only for $\gamma < 1/2$[15] and almost prohibitively high trade costs that taxes are higher under integrated markets. Since taxes are almost the same in this realm and all ensuing results are mainly driven by standard wasteful-trade-saving effects if trade is very costly (as will be discussed below), I will be concentrating on lower trade cost ranges. The intuition that prohibitive trade costs fall in γ is that a rising γ makes the products closer substitutes, rendering competition fiercer.

For the cooperative solution, one essentially chooses the optimal tax for a closed economy, which is why one expects the same rate under segmented and integrated markets.[16] In fact, I obtain a cooperative tax rate of:

$$t^i_{coop.} = -\frac{1}{2}(2-\tau)(1-\gamma), \tag{28}$$

which is the same as the one in (19). Now, the cooperative tax, not surprisingly, turns out to be a subsidy. Assume for a moment that goods are maximally differentiated and trade is completely free ($\gamma, \tau = 0$). Then, it is equal to -1, which is a standard result given we normalized the marginal labor cost to zero here. Costly trade attenuates the optimal subsidy (as the latter always partly goes to imports, driving up the trade volume). See also that as γ approaches 1, the cooperative subsidy goes to zero, which reflects the 'Bertrand paradox': Price competition already drives profits to 0, so there is no further need for a corrective subsidy. Since without cooperation, there will be strategic considerations like 'tax-the-foreigner' effects, I expect subsidies to be lower then. Proposition 1 and the ensuing discussion have already shown that for the most part, taxes are lower under tied markets.

[13]One further thing to note about the comparison is that with market separation, each country's best response function does not depend on the other country's tax rate, whereas with market integration, the Nash assumption in the tax-setting game is really needed in that the best responses depend on each others' policy choices (i.e., they can be represented by $t^{d,\,i}(t^{*\,d,\,i},\cdot)$ and $t^{*\,d,\,i}(t^{\,d,\,i},\cdot)$, respectively, which are upward-sloping, making taxes strategic complements where they were strategically independent under market separation).

[14]Formally, this can be shown by plugging prices from (11) and taxes from (15) into the direct demand functions to obtain the reduced form for x^* under segmented markets, $x^{*\,s}$, and by proceeding analogously with prices from (21) and taxes from (24) to get x^* under integrated markets, $x^{*\,i}$. Then, it is a tedious but straightforward exercise to show that the locus of $\gamma - \tau$-combinations where $x^{*\,i}$ equals 0 is strictly below the corresponding locus where $x^{*\,s}$ equals 0.

[15]At $\gamma = 1/2$, the prohibitive level of trade costs, solving $x^{*\,,i} \overset{!}{=} 0$, is equal to $20/49 \approx 0.41$. At this point, this coincides with the locus where $t^{d,\,s} = t^{d,\,i}$. See Figure 5.1.

[16]See also Haufler and Pflüger (2007), who show that this equivalence also extends to production vs. consumption taxes.

It turns out that the cooperative subsidy is lower than both $t^{d,\,s}$ and $t^{d,\,i}$: $t^{d,\,s}$, $t^{d,\,i} > t_{coop.}$.[17] Since all externalities become smaller in absolute value as τ grows, the gap between both non-cooperative solutions and $t_{coop.}$ narrows in τ. Since $t_{coop.}$ also grows in τ, this is no contradiction to the fact that $t^{d,\,i}$ goes up (i.e., becomes less negative) as the real trade cost grows: The cost pass-on rule forbidding firms to 'underinvoice' the real trade cost abroad drives foreign consumer prices up, which simultaneously drives trade and thus the positive externalities on consumer surplus and the tax base down.

With the taxes from (24) substituted back into (22) and (23), I get the equilibrium welfare level under destination taxes and integrated markets, again sticking with the example of country 1:

$$W^{d,i} = \frac{1}{4\left(4-\gamma^2\right)^2\left(\gamma^2-1\right)}\{(4\tau(\gamma-3)(\gamma-1)(\gamma(2\gamma-7)+7)+ \\ 4\left(\gamma^6-8\gamma^5+23\gamma^4-17\gamma^3-42\gamma^2+89\gamma-46\right)- \\ \left(\gamma^5-5\gamma^4+3\gamma^3+27\gamma^2-64\gamma+46\right)\tau^2\big)\}\,. \tag{29}$$

Welfare without profit income is:

$$W^{d,i}_{noprofit} = \frac{1}{4}\left(4-\frac{(\gamma-3)(\tau-2)^2}{((\gamma-4)\gamma+5)^2}-\frac{\tau^2}{\gamma-1}\right) \tag{30}$$

Again, these terms are messy, so I restate them for $\gamma = 1/2$:

$$W^{d,i}|_{\gamma=\frac{1}{2}} = \frac{\tau(667\tau-640)+1654}{1014}, \quad W^{d,i}_{noprofit}|_{\gamma=\frac{1}{2}} = \frac{1}{338}(\tau(189\tau-80)+418). \tag{31}$$

Now that one has seen that non-cooperative subsidies are not as high as the cooperative solution would suggest, and that taxes under integrated markets are closer to that solution than under segmented markets, one would expect integrated markets to be preferable over segmented markets. It is in fact true that it is optimal to have an antidumping law:

Proposition 2 *Integrated markets lead to higher aggregate welfare in the presence of non-cooperatively set consumption taxes.*

Proof. $\Delta W^d \equiv W^{d,\,s} - W^{d,\,i} = 0$ has no real solution. This can be easily shown numerically.

[17] It can be shown that, for any non-prohibitive level of τ (i.e., one that ensures $x^{*\,i} = \frac{((\gamma-3)\gamma(\gamma+1)+8)\tau-2(\gamma-3)(\gamma-1)}{2(\gamma-1)(\gamma+1)((\gamma-4)\gamma+5)} > 0$), there exists no $\gamma-\tau$-combination that renders $t_{coop.}$ larger than $t^{d,\,s}$ or $t^{d,\,i}$.

The term is given in the appendix. Here, I merely illustrate it, using again the intermediate case $\gamma = 1/2$: $\Delta W^d \mid_{\gamma=1/2} = ((29080 - 59491\tau)\tau - 8800)/228150 \stackrel{!}{=} 0$, a quadratic equation that has no real solutions. To complete the proof, put in any non-prohibitive level of trade costs, which yields a $\Delta W^d < 0$. □

There are actually two pieces of intuition that drive this result. For high trade costs, I already showed that the tax difference between the two regimes becomes less significant.[18] For this realm of high levels of trade costs, reciprocal dumping is, as is well understood from existing literature, grossly inefficient, rendering integrated markets the more efficient solution. The more interesting and non-standard result materializes with lower trade costs. Suppose we are in a situation with infinitesimal real trade costs only. Then, the welfare cost of reciprocal dumping is marginal, but the tax regime is very different. In particular, integrated markets give governments strategic incentives to set their taxes lower, viz. closer to the cooperative solution. This also makes integrated markets preferable, albeit for a different reason. From these two forces driving the result and the fact that their strength increases when approaching extreme values for τ (namely, 0 and the prohibitive level, respectively), I expect the overall welfare difference between integrated and segmented markets to be hump-shaped. This in fact turns out to be the case; the appendix displays $\Delta\, W^d$ graphically in Figure 5.6.[19] One sees that integrated markets dominate separated markets everywhere, but less so for intermediate values of τ.

The fact that market integration makes subsidies larger makes one wonder about the distributional consequences of a policy shift from laissez-faire to an antidumping law. After all, it is consumers who have to pay the subsidies that go to firms. In fact, a comparison of welfare levels shows

Proposition 3 *Profits are higher under integrated markets for low trade costs. As a corollary, consumer-taxpayers are worse off for low trade costs under market integration than under segmented markets iff governments are welfare-maximizers but profits are not redistributed to consumers (and hence accrue to a single, infinitesimal individual).*

Proof. Substituting, for each regime, prices ((11), (21)) into quantities ((7), (8), and their foreign counterparts) and both into profits (9), and forming the difference of the resulting terms, $\pi^{d,s} - \pi^{d,i}$, one obtains a longish expression which is displayed in the appendix as $\Delta\pi^d$ and which equals $\frac{8(19\tau+40)(23\tau-7)}{22815}$ for $\gamma = 1/2$. This is 0 at $\tau = 7/23 \simeq 0.3$. For any

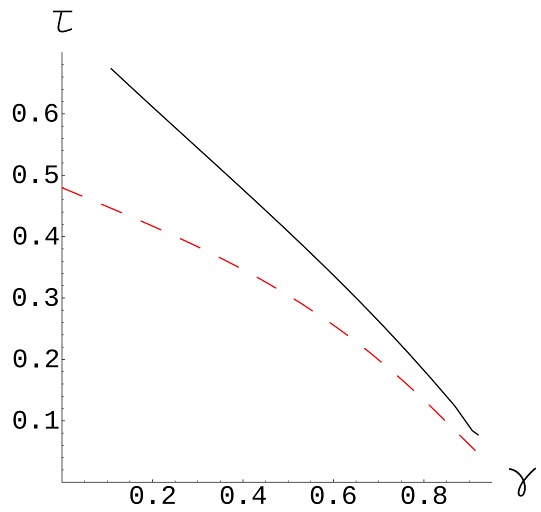
[18] Remember, from equs. (15) and (24), subsidies under segmented markets fall in τ whereas under integrated markets, they rise in τ, so the difference gets large for low trade costs.

[19] For the figure, I set γ to its benchmark value of 1/2. The graph looks qualitatively similar for other values of the substitutability parameter.

given γ, the first derivative of the general expression with respect to τ is positive for $\tau > 0$. For those levels of γ other than 1/2, refer to Figure 5.2.

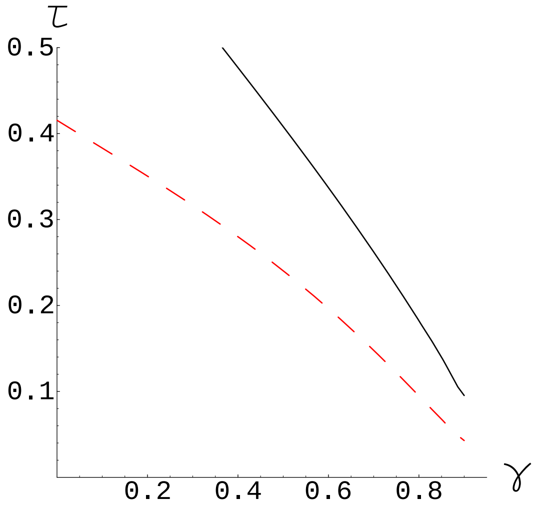
Subtracting $W^{d,i}_{noprofit}$ from $W^{d,s}_{noprofit}$, I get a term I label $\Delta W^{d}_{noprofit}$, which is shown in the appendix. For $\gamma = 1/2$, it equals $\frac{13600-7\tau(13493\tau+4840}{228150}$, which is $\frac{272}{4563} > 0$ at $\tau = 0$; for general τ, the first derivative equals $\frac{-7(13493\tau+2420)}{114075} < 0$.
That there is a parameter range for which market integration benefits consumers is also easy to show: For $\gamma = 1/2$, $\Delta W^{d}_{noprofit}$ becomes zero at $\tau \simeq 0.24$, which is strictly lower than the lowest prohibitive trade cost level of $\tau^{proh} \simeq 0.4$. For levels of γ other than 1/2, refer to Figure 5.3. □

Figure 5.2: Profits: Regions of dominance under segmented vs. integrated markets



The result with respect to profits is displayed in Figure 5.2. This result is clearly tax-driven and is at odds with what Ishikawa (2004) and Anderson at al. (1995) find. For high trade costs, the gains firms get from segmenting those markets are so high that the standard result that they lose from integration materializes. For low trade costs, however, the effect from the lower taxes under integrated markets dominates. The second part of the proposition is also shown graphically, in Figure 5.3, where I again plot the trade-prohibiting level of τ. All points below the bent dashed line are loci in $\gamma - \tau$-space where consumer-taxpayers are worse off under tied markets (assuming that the mass of them does not benefit from profits). Note that the fact that profits may be unevenly distributed (in

Figure 5.3: Consumer welfare: Regions of dominance under segmented vs. integrated markets (if the mass of consumers does not own the firm's shares)



the polar case, used to get Proposition 3's corollary in its pronounced form, they all go to one (infinitesimal, mass zero) member of society) has no bearing on the differentiated goods demands due to the quasilinearity of the utility function. That consumers are, at some point, better off under integration comes from the fact that close to the prohibitive level, a ban on reciprocal dumping, which is a waste of resources (but profit-maximizing behavior), implies a large efficiency gain. The result is not surprising after the preceding discussions. After all, it is well known that even in the simplest closed-economy case where a monopolist is optimally subsidized, this efficiency-increasing policy benefits the producer while harming consumers, who have to pay for the subsidy, as long as they do not own shares of the firm. I do not want to stretch this point too far since even though it may be unrealistic to assume profits are evenly distributed, it may be as unrealistic to assume they all accrue to some infinitesimal individual. However, especially the first part of the proposition is interesting in that it shows how a seemingly unrelated upper-level policy rule may influence specific taxes and distribution, and in that Anderson et al. (1995) also found market integration to be optimal, but with the exactly reversed distributional consequences (consumers gain, producers lose). So the message is clear: Just as in the absence of taxes, tying markets is optimal policy, but it may be easier to implement since less resistance from producers is to be expected. However, if tying markets is motivated by benefitting consumers (and national governments act as non-cooperative welfare-maximizers), that policy aim will only be reached if firm ownership is spread.[20]

5.3.3 Absentee firm ownership

It is easy to think of a scenario under which governments ignore profits: Either when firm ownership is concentrated in few hands and they disregard it in their welfare terms, or, clearly, when there is absentee ownership, i.e. the firms belong to (third-country) foreigners and profits flow abroad. Even then, I will show in what follows that due to the wasteful trade effect, for high trade costs, market integration is preferable to segmentation. However, countries will be worse off under integrated markets for low trade costs:

Proposition 4 *Suppose profits flow abroad. Then, for low trade costs, integrated markets are worse than segmented markets in the presence of non-cooperatively set consumption taxes.*

The analysis is completely analogous to the one in section 5.3.2; I present an illustration, Figure 5.4, which shows the locus (the dashed line) on which the (symmetric) countries are indifferent between market segmentation and integration. The solid line again displays the prohibitive level of trade costs.

The only difference to section 5.3.2 is that profits are not part of national welfare. The rest of the analysis is completely parallel. Then, under segmented markets, optimal destination-based taxes are

$$t^{d,\,s\,(abs.)} = t^{*\,d,\,s\,(abs.)} = \frac{(2-\tau)(1-\gamma)}{6-4\gamma}. \tag{32}$$

and reduced - form country 1 welfare '$W^{d,\,s\,(abs.)}$' amounts to

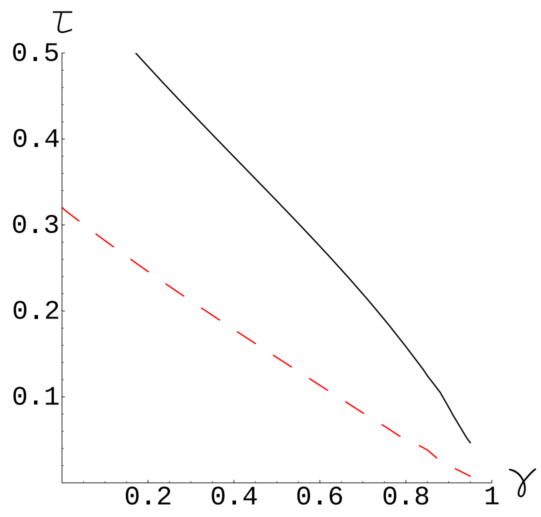
$$\frac{4(\gamma-1)(\gamma(2\gamma-1)-4)(\gamma+2)^2+4(\gamma-1)\tau(\gamma+2)^2+(7-\gamma(\gamma(\gamma+5)-1))\tau^2}{4(\gamma-1)(\gamma+1)(\gamma+2)^2(2\gamma-3)}. \tag{33}$$

Under integrated markets, taxes are

$$t^{d,\,i\,(abs.)} = t^{*\,d,\,i\,(abs.)} = \frac{(\gamma-1)(\tau-2)}{2((\gamma-6)\gamma+7)}, \tag{34}$$

[20] One note on the fact that market segmentation vs. integration is at the supranational level here: Anderson et al. (1995) show that countries find themselves in a classical prisoners' dilemma where both would gain if they both moved from segmented to tied markets, but where every single country has no incentive to unilaterally place a ban on foreign industry's pricing its output lower in its respective foreign market. Since I get very similar results in the presence of commodity taxation, both production- and consumption-based, I do not replicate that analysis here.

Figure 5.4: Welfare: Regions of dominance under absentee ownership



and welfare, '$W^{d,\,i\,(abs.)}$', is

$$\frac{1}{4\left(\gamma^2-1\right)\left(\gamma^2-6\gamma+7\right)^2}\left\{4\gamma^6-\left(\tau^2+48\right)\gamma^5+\left(11\tau^2+196\right)\gamma^4-64\tau^2+\right.$$

$$60\tau-256-\left(35\tau^2+12\tau+276\right)\gamma^3+\left(17\tau^2+68\tau-72\right)\gamma^2+$$

$$\left.4\left(16\tau^2-29\tau+113\right)\gamma\right\}. \qquad (35)$$

Note that here, even without a revenue motive, taxes are positive since lowered profits do not bother the government – to the contrary, countries will have common interest to tax third-country foreigners. However, this will make the distortion in the goods market worse.[21] Now, with foreign firm ownership, the cooperative solution is

$$t^{d,\,(abs.)}_{coop.}=\frac{(2-\tau)(1-\gamma)}{6-4\gamma}, \qquad (36)$$

which corresponds to the non-cooperative solution that prevails under market segmentation. Hence, market segmentation leads to the at least weakly more efficient taxes when strategic profit effects due to spill-overs on the respective foreign firm are absent. This does not come as a surprise, however: Recall from the main part in Section 5.3.2 that the only way a tax by country i created a spill-over on country j was an influence on j's firm's profits. This

[21]It is straightforward to show that firms will make positive profits in equilibrium, rendering a corresponding constraint slack.

is by construction cut out if the firm does not belong to j residents. From the positive spill-overs identified in the last section, consumption taxes can then be expected to be lower under integrated markets again: $t^{d,\,s\,(abs.)} - t^{d,\,i\,(abs.)} = -\frac{(\gamma-2)^2(\gamma-1)(\tau-2)}{2(2\gamma-3)((\gamma-6)\gamma+7)} > 0$ for every $\gamma\,\epsilon\,[\,0,1\,[\,,\,\tau > 0$. Forming the difference of $W^{d,\,s\,(abs.)}$ and $W^{d,\,i\,(abs.)}$, one obtains a messy expression that boils down to $\frac{3}{289} - \frac{3\tau}{289} - \frac{12063\tau^2}{28900}$ for the polar case of $\gamma = 1/2$. This expression is, for general γ, graphed in Figure 5.4. So at least for free trade, it follows immediately that *segmented* markets are preferable: Tying markets does not make a difference from a real trade cost effect (since they are zero), but it does make the non-cooperative goods taxes lower than the cooperative ones (which, again, are the same under segmented and integrated markets, and in the former case equal the non-cooperative solution). So if the differentiated goods market considered is characterized by outside ownership, tying markets will make countries worse off unless trade costs are high, which once again leads to great inefficiencies from reciprocal dumping. For low trade costs, the strategic effects of integrated markets are such that governments' competition leads to a solution that is further away from the cooperative one. So, interestingly, the strategic effects of a tax-including cost pass-on rule are such that tying markets (typically thought to help consumers) may hurt consumers if governments set destination-based taxes non-cooperatively.

5.3.4 Cost asymmetry

In this section, I consider cost differences across countries. I borrow from Hashimzade et al. (2006) the way to model an efficiency/a cost asymmetry; namely, I assume that firm 1 has an extra constant marginal production cost $\delta > 0$ over and above firm 2's (which is normalized to 0). Such efficiency differences are known to have an effect on optimal tax policy, hence why I examine their impact on my result. It turns out that the less efficient country may be worse off under market integration unless the asymmetries in marginal costs is rather small. To facilitate the exposition, I set $\gamma = 1/2$ throughout this section (I had, however, been working with a general version of substitutability, which did not change anything qualitatively). The analysis is completely analogous to the one in the previous sections, so I concentrate on the most important terms in this part. In particular, for the first time here, since countries are asymmetric, now also taxes will be asymmetric. With market segmentation, taxes will amount to:

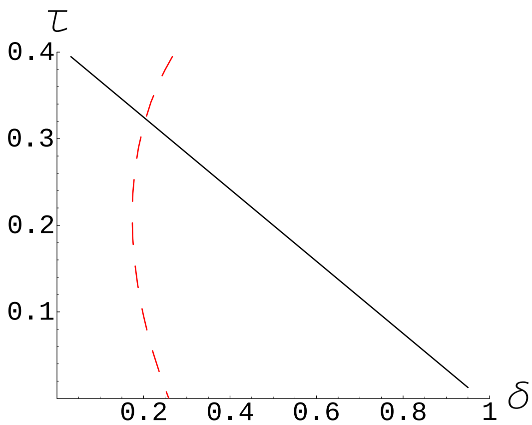
$$t^{d,\,s\,(asym.)} = \frac{3(\delta-\tau)}{10},\;\; t^{*\,d,\,s\,(asym.)} = -\frac{3}{10}(\delta+\tau). \tag{37}$$

When trade is free and the asymmetry goes to zero, we have again the result from section 5.3.2 that taxes are zero as the effect that one wishes to increase the suboptimal consumption and that one wants to shift away rents from the foreign firm offset each other. If firm 1 is in fact less efficient than firm 2, country 1 still uses subsidies with trade costs greater than the marginal cost disadvantage. Under free trade, the zero subsidy from section 5.3.1 turns into a tax (the intuition comes from the tax-the-foreigner effect: the more efficient foreigner will be taxed). With market integration, taxes will amount to:

$$t^{d,i\,(asym.)} = \frac{1}{65}(18\delta - 5(2-\tau)), \;\; t^{*\,d,i\,(asym.)} = \frac{1}{65}(-8\delta - 5(2-\tau)). \qquad (38)$$

Since the more efficient country (2) will continue to unambiguously benefit from tying markets, I will concentrate on country 1 here. Note first that the incentive to tax away rents from the efficient competitor is also present here, expressed by the fact that δ drives $t^{d,i\,(asym.)}$ and $t^{*\,d,i\,(asym.)}$ apart. Again, integrated markets[22] lead to lower taxes/higher subsidies than segmented markets; the intuition is the same as the one in section 5.3.2. Figure 5.5 shows a dashed line which stands for points on which country 1's welfare is the same under segmented and tied markets.

Figure 5.5: Welfare: Regions of dominance under cost asymmetries



For zero δ, we already showed that both countries are strictly better off under tied markets. By continuity, this still holds for small productivity differences. To the right of the bent line, i.e. for high differences in productivity, country 1 is better off under segmented

[22]Observe also that in this section, taxes differ across countries. Since countries are not symmetric any more, assuming a utilitarian welfare function (W+W^*) to work out a cooperative solution would imply a loss of generality here. Also, such a solution would have to be negotiated and would typically display the more efficient firm getting a higher subsidy (as the payoff is greater).

markets, whereas country 2 (the more efficient one) is, as already said, always better off under market integration. I may thus state

Proposition 5 *Market integration may harm relatively inefficient countries under consumption taxation.*

Proof. The proof can be found in the appendix. □

To understand why, it is instructive to once again recall the motive for country 1 to raise a tax (if trade is free) under segmented markets. The larger is δ, the more inefficient is the home firm, making government 1's rent-shifting incentive to tax the (relatively ever more efficient) firm 2 larger. Since the positive consumer surplus and tax base externality (absent under market segmentation) curtail the non-cooperative taxes under integration, the ability to tax at the cost of firm 2 is hurt. This intuition is confirmed by the fact that country 1 is more likely (in the sense that the bent curve in Figure 5.5 is shifted leftwards) to lose from market integration if there is an exogenous revenue need (to be introduced in the next subsection), making the lower integrated markets taxes particularly harmful.[23]

So another message of this paper is that there is yet another qualification to the main finding that integrated markets are desirable: This last result shows that there may be winners and losers, at least if countries are sufficiently asymmetric. I conjecture that cost asymmetries are only one source of such potential conflicts of interest across countries. For instance, a size asymmetry (in terms of population) gives a smaller country with a firm higher per capita profits, which has a bearing on how strongly it is hit by the different externalities and which may also affect the comparison of separated vs. tied markets.

5.4 Robustness

This section checks the robustness of my results against some more changes in modelling.

[23]The algebraic demonstration is completely standard, but involves very messy terms, so I do not state it here.

5.4.1 Revenue needs

It is arguably undesirable to have negative equilibrium taxes in the analysis (with the exception of the case with foreign ownership). This is clearly driven by the fact that a revenue motive is absent in the main part of the paper, leaving governments with the incentive to remedy the market distortion that arises from imperfect competition. However, it is straightforward to introduce a weight $\omega > 1$, representing an exogenous excess burden of taxation. This is pre-multiplied to tax revenues in the government objective functions. With the rest of the analysis carried out just as in section 5.3, it is then simple to elicit conditions on ω which ensure positive cooperative and non-cooperative tax levels. I follow Keen and Lahiri (1998) who argue that a value of 1.25 for ω could be considered normal, and values above 1.5 uncommon. The result that welfare is higher under integrated markets, via lower (and thus closer to cooperative) taxes, did not change in the large realm of ω values $\epsilon\,[1,3]$ that I examined, which is why I will not display the corresponding formulae here. I conclude that my result does not depend on the negativity of tax rates.

5.4.2 Origin principle

When taxes are not raised where goods are consumed, but rather where they are produced, the whole effect of tying markets is simpler as the cost pass-on rule does not involve taxes. To see this, note that with production taxes, each unit will be taxed at the same rate no matter where it will be consumed. Under integrated markets, then, the price of units produced by a firm for a foreign market must exceed the price on the home market by exactly the trade cost. This immediately yields the result that market integration does not make a difference when trade costs are zero, no matter if there are taxes in place or not, under origin taxation. I relegate the corresponding algebraic expressions to the appendix and only briefly state the results here: As with consumption taxes, integrated markets are more efficient. For low to intermediate trade costs, consumers are worse off under integration to the extent that they do not own firms (and, again, to the extent that governments do take profits into account) again.[24]

As trade costs get higher, this effect is eventually dominated (as with consumption taxes) by the efficiency effect which calls for a ban on resource-consuming reciprocal dumping.

[24]However, with production taxes, this relationship is hump-shaped in trade costs: For free trade, the regime does not make a difference whatsoever; as trade costs go up, markets become increasingly separate, which gives each country an incentive to lower the tax which is now hitting its respective firm more directly.

A graph similar in spirit to Figure 5.3, along with the most important algebraic terms, is given in the appendix.

5.4.3 Origin principle vs. destination principle

As stated above, it is known from previous literature that the origin principle strictly dominates the destination principle at least for linear demand and low levels of trade cost. These results (Haufler et al. (2005), Hashimzade et al. (2005)) were derived under the assumption of segmented markets, which leaves the tied markets case to be analyzed. Forming the difference of welfare levels, $W^{o,i} - W^{d,i}$, one obtains

$$\frac{(\gamma-2)^2\left(\tau\gamma^3+4\tau\gamma^2-14\gamma^2-17\tau\gamma+36\gamma+16\tau-22\right)\left(\tau\gamma^3-4\gamma^3+6\gamma^2-\tau\gamma-4\tau-2\right)}{4(\gamma+1)\left(\gamma^2-4\gamma+5\right)^2\left(\gamma^2+3\gamma-6\right)^2}. \tag{39}$$

This term is equal to zero only for $\gamma - \tau$-combinations that are beyond the prohibitive trade cost level. At $\tau = 0$, for any $\gamma \,\epsilon\, [\,0, 1\,[$, the term is positive and rising in the trade cost, showing that the origin principle continues to dominate the destination principle with integrated markets.

5.5 Conclusion

It is the declared will of the European Commission's Directorate General for Competition that car prices in Europe converge. I have examined a strong, but easily implementable policy rule: Namely a law that binds producers to equalize their producer prices across markets. The abiding by such a rule would be rather easy to control given the observability of taxes and transport costs. Given that (in contrast to existing suggestions) firms do not lose in this framework, it may be relatively easy to gain international support as the industry (which has in the past turned out to be very outspoken against regulation, well-organized in terms of lobbying and creative in finding ways to indirectly separate markets) may be less inclined to turn it down.

I have elicited in a simple model regimes under which, given non-cooperatively set commodity taxes are in place, strict antidumping rules are optimal. This is in fact true in the symmetric case. My model also suggests two scenarios under which countries may actually lose: With relatively inefficient countries, and with countries which do not own their respective industries. One may speculate that this will hit relatively small and peripheral nations in Europe. This said, I am fully aware that all results developed in such a highly stylized framework need to be interpreted with discretion – but still, Europe with its existing different tax regimes, strongly differing pre-tax prices in car and other durable goods markets and pretty asymmetric countries seems to be a good example where I expect the effects identified to play a role.

The results also show that antidumping policy may have counterproductive effects *within* the European Union if non-coordinated national policies are in place, namely if their aim is to benefit consumers who do not own stock of the companies and when national governments are welfare-maximizers. This is not an implausible scenario as national governments are in fact likely to take profits into account, be it a national champion policy, be it because of big companies' or large shareholders' influence on the political decision process. The facts that there is a lot of market power in general consumer goods markets and that my results also hold under revenue-needy governments may even give them some relevance beyond specific taxation, towards a more general discussion on commodity taxation. To this end, I also demonstrated that the main result holds under origin taxation.

It seems promising for future work to examine the interplay of tax policies and antidumping policy vis-à-vis outside the union trading partners. Also, it would be interesting to learn more about the scenario of countries which do not have production sites themselves, rendering commodity taxes akin to an import tariff.

5.6 Appendix

Destination principle

$\Delta\pi^d \equiv \pi^{d,s} - \pi^{d,i} =$

$$= \frac{(\gamma-3)^2(\gamma-1)(\tau-2)^2}{2(\gamma+1)((\gamma-4)\gamma+5)^2} -$$

$$\frac{4\left(\gamma^2+\gamma-2\right)^2 + (\gamma(\gamma((\gamma-2)\gamma-2)+2)+5)\tau^2 - 4\left(\gamma^3-3\gamma+2\right)\tau}{2\left(\gamma^2-4\right)^2\left(\gamma^2-1\right)}. \quad \text{(A.1)}$$

The locus along which $\Delta\pi^d$ equals zero is the dashed line in Figure 5.2.
$\Delta W^d \equiv W^{d,s} - W^{d,i} =$

$$= \frac{1}{4\left(\gamma^2-1\right)\left(20-16\gamma-\gamma^2+4\gamma^3-\gamma^4\right)^2}\left\{-4(-1+\gamma)^3(2+\gamma)^2\left(9-8\gamma+2\gamma^2\right) - \right.$$

$$4(1-\gamma)^2\left(86-37\gamma-62\gamma^2+37\gamma^3+6\gamma^4-7\gamma^5+\gamma^6\right)\tau +$$

$$\left.\left(261-289\gamma-115\gamma^2+271\gamma^3-65\gamma^4-55\gamma^5+18\gamma^6+12\gamma^7-7\gamma^8+\gamma^9\right)\tau^2\right\}. \quad \text{(A.2)}$$

$\Delta W^d_{noprofit} \equiv W^{d,s}_{noprofit} - W^{d,i}_{noprofit} =$

$$= \frac{1}{4(2-\gamma)^2(\gamma+2)^2(5-(4-\gamma)\gamma)^2\left(\gamma^2-1\right)}\left\{4(\gamma+2)^2(2(\gamma-5)\gamma+13)(\gamma-1)^3 + \right.$$

$$4(\gamma+2)(\gamma(\gamma(\gamma((\gamma-9)\gamma+26)-13)-48)+51)\tau(\gamma-1)^2 +$$

$$\left.\left(223+179\gamma-675\gamma^2+227\gamma^3+321\gamma^4-283\gamma^5+70\gamma^6+8\gamma^7-7\gamma^8+\gamma^9\right)\tau^2\right\}. \quad \text{(A.3)}$$

The locus along which $\Delta W_{noprofit}$ equals zero is the dashed line in Figure 5.3.

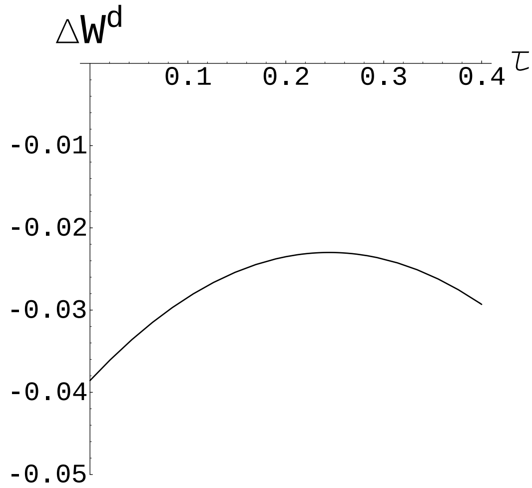
Figure 5.6 shows the difference in welfare ($\Delta W^d \equiv W^{d,s} - W^{d,i}$) for levels of trade costs from 0 to the prohibitive one.

Cost asymmetry

Proof of Proposition 5:

Having plugged the taxes from (37) and (38) into the respective price ((11), (21)) and quantity ((7), (8), and the country 2 counterparts) expressions from sections 5.3.1 and

Figure 5.6: Difference in welfare depending on the level of trade costs



$\gamma = 1/2$.

5.3.2, and the resulting expressions (and profits according to (9)) into country 1's welfare expressions for segmented (13) and integrated (22) markets, one can form the difference: $\Delta W^{d\,(asym.)} \equiv W^{d,\,s\,(asym.)} - W^{d,\,i\,(asym.)}$ is equal to:

$$\frac{-17020\delta^2 - 4(5819\tau - 9610)\delta + (29080 - 59491\tau)\tau - 8800}{228150}, \tag{A.4}$$

which is equal to 0 at

$$\tau_{1,2} = \frac{2\left(7270 - 5819\delta \pm 39\sqrt{-51300 + 2(160125 - 72082\delta)\delta}\right)}{59491}, \tag{A.5}$$

It is then straightforward, but tedious to show that for small δ, these values are below the prohibitive trade cost level (which solves $x^{*\,d,\,i\,(asym.)}$). The relation is plotted in Figure 5.5. To show that a higher δ makes $\Delta W^{d\,(asym.)}$ larger, observe that the first derivative with respect to δ is $\frac{2(-8510\delta - 5819\tau + 9610)}{114075}$. Then, this can be shown to be greater than zero for any permissible $\delta - \tau$-combination, which completes the proof.

Robustness: Origin principle

Under the origin principle, profits are

$$\begin{aligned}\pi^{o} &= (q_x - t)x + (q_{x^*} - t - \tau)x^*,\\ \pi^{*\,o} &= (q_{y^*} - t^*)y^* + (q_y - t^* - \tau)y.\end{aligned} \tag{A.6}$$

Segmented markets

With market segmentation, again, producers maximize (A.6) for each market independently. This leads (again using $p_x = q_x - t$, $p_{x^*} = q_{x^*} - t^* - \tau$, and the analogues for firm 2) to equilibrium consumer prices of

$$\begin{aligned}q_x &= \frac{2(t+1) - \gamma^2 + (\tau + t^* - 1)\,\gamma}{4-\gamma^2},\\ q_{x^*} &= \frac{2(t+\tau+1) - \gamma^2 + t^*\gamma - \gamma}{4-\gamma^2},\\ q_{y^*} &= \frac{2(t^*+1) - \gamma^2 + (\tau + t - 1)\,\gamma}{4-\gamma^2},\\ q_y &= \frac{2(t^*+\tau+1) - \gamma^2 + t\gamma - \gamma}{4-\gamma^2}.\end{aligned} \tag{A.7}$$

Welfare in 1 now differs in that tax revenue comes from the respective home production:

$$W^{o,\,s} = (x+y) - \frac{1}{2}\left(x^2 + 2\gamma yx + y^2\right) - q_x x - q_y y + 1 + t(x + x^*) + \pi^{d,s}; \tag{A.8}$$

the expression for country 2 is analogous. Having substituted prices into demands ((7), (8), and their foreign analogues), the latter into (A.8) (and its foreign analogue), and having maximized these welfare terms with respect to taxes, one obtains a Nash equilibrium in taxes of

$$t^{o,\,s} = t^{*\,o,\,s} = \frac{\left(-(2-\tau)\gamma^2 + \gamma + 2\tau - 7\right)\gamma^2 + 4}{\gamma^2(\gamma+5) - 12}, \tag{A.9}$$

leading to an equilibrium welfare level of

$$\begin{aligned}W^{o,\,s} = &\frac{1}{2\left(\gamma^2-1\right)\left(\gamma^2(\gamma+5)-12\right)^2}\left\{2\tau\left(60 - 12\gamma - 53\gamma^2 + 4\gamma^3 + 13\gamma^4\right)\cdot\right.\\ &(1-\gamma)(2+\gamma) + \left(\gamma^2\left(\gamma\left(\gamma\left(6\gamma^2 - 2\gamma - 51\right) + 6\right) + 129\right) - 108\right)\tau^2 +\\ &\left.2(-1+\gamma)(2+\gamma)^2(68 + \gamma(-24 + \gamma(-55 + \gamma(15 + \gamma(7+\gamma)))))\right\}.\end{aligned} \tag{A.10}$$

Integrated markets

Proceeding analogously to the previous section, but with the restriction that $p_x = p_{x^*}$, $p_y = p_{y^*}$, one obtains producer prices of

$$\begin{aligned} p_x = p_{x^*} &= \frac{2(t-1)\gamma^2 + 2(t^*-1)\gamma - 4t + (\gamma^2+\gamma-2)\,\tau + 4}{8-2\gamma^2}, \\ p_y = p_{y^*} &= \frac{2(t^*-1)\gamma^2 + 2(t-1)\gamma - 4t + (\gamma^2+\gamma-2)\,\tau + 4}{8-2\gamma^2}. \end{aligned} \tag{A.11}$$

and corresponding consumer prices:

$$\begin{aligned} q_x &= \frac{4t - 2\gamma + (\gamma^2+\gamma-2)\,\tau + 2\gamma\,(t^*-\gamma) + 4}{8-2\gamma^2}, \\ q_x^* &= \frac{4t + (-\gamma^2+\gamma+6)\,\tau - 2\,(\gamma^2 - t^*\gamma + \gamma - 2)}{8-2\gamma^2}, \\ q_y^* &= \frac{4t^* - 2\gamma + (\gamma^2+\gamma-2)\,\tau + 2\gamma\,(t-\gamma) + 4}{8-2\gamma^2}, \\ q_y &= \frac{4t^* + (-\gamma^2+\gamma+6)\,\tau - 2\,(\gamma^2 - t\gamma + \gamma - 2)}{8-2\gamma^2}. \end{aligned} \tag{A.12}$$

After substitution, maximizing (A.8) and 2's corresponding term w. r. t. taxes, I get the Nash equilibrium in taxes of

$$t^{o,\,i} = t^{*\,o,\,i} = \frac{2\gamma(\gamma(2\gamma-3)-1) + (2-\gamma^3+\gamma)\,\tau + 4}{2(\gamma(\gamma+3)-6)}. \tag{A.13}$$

This leads to an equilibrium welfare level of

$$\begin{aligned} W^{o,\,i} = \frac{1}{2\,(1-\gamma^2)\,(\gamma(\gamma+3)-6)^2}\,\big\{&(28+\gamma(1+\gamma)(-20+\gamma(7+\gamma)))\tau^2 + \\ &2(\gamma-1)(\gamma(\gamma+1)(\gamma(\gamma+7)-20)+28)\tau + \\ &2(1-\gamma)(68+\gamma(-24+\gamma(-55+\gamma(15+\gamma(7+\gamma)))))\big\}. \end{aligned} \tag{A.14}$$

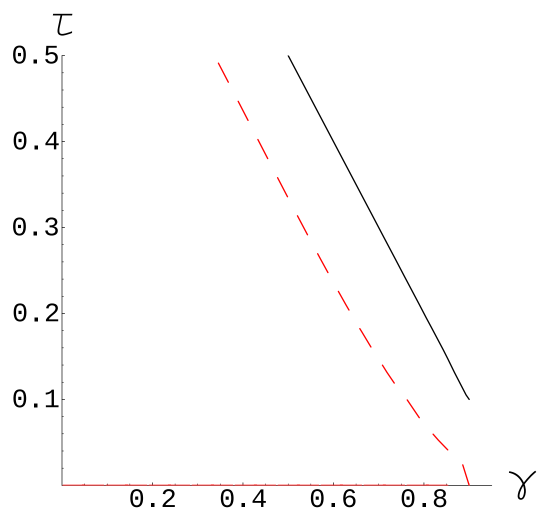
Comparison

Like under destination taxation, taxes are lower under integrated markets. Under a production tax/subsidy, tying markets only involves the trade cost. The latter has to be charged to foreign consumers, so for any $\tau > 0$ the foreign market will be served relatively less (as compared to reciprocal dumping), rendering the subsidy a better instrument. Accordingly, market integration leads to higher welfare. This can be shown formally: Setting $W^{o,s} - W^{o,i}$ equal to zero has no real solution in $\gamma - \tau$-space for any non-prohibitive level of trade costs. The equation $\Delta W^o \equiv W^{o,s} - W^{o,i}$ equals

$$\frac{(\gamma+1)\tau\left(2(\gamma-2)^2(\gamma+2)(\gamma-1)^2+((\gamma-1)\gamma(\gamma(7\gamma+3)-24)+4)\tau\right)}{2(\gamma-1)\left(\gamma^2(\gamma+5)-12\right)^2}, \tag{A.15}$$

and setting it to zero yields only $\tau = 0$ and a (non-permissible) negative value of τ as solution for any $\gamma \epsilon\, [\, 0, 1\, [$.

Figure 5.7: Consumer welfare: Regions of dominance under segmented vs. integrated markets, origin principle (if the mass of consumers does not own the firm's shares)



Substituting prices and quantities into profits (A.6), I can again, as in the main part, elicit 1's welfare levels without profits for segmented and integrated markets, respectively. I merely present the result similar to that in Proposition 3 graphically in Figure 5.7 .

This figure displays the prohibitive level of trade costs (solid line). Again, for low trade costs (below the dashed line), consumer-taxpayer welfare is lower under market integration unless profits are redistributed. A contrast to Figure 5.3 is that for free trade, there is no difference whatsoever, as discussed in the main part: There is no cross-country strategic effect of taxes, and tied markets do not make a difference under free trade. The same is true for profits: The difference $\pi^{o,i}$-$\pi^{o,s}$ is hump-shaped in trade costs for any given γ.

Chapter 6

Fiscal competition over taxes and public inputs: Theory and evidence

6.1 Introduction

It is widely believed that national as well as local governments have powerful tools to affect the allocation of mobile capital, and that how these tools are used has significant consequences for the welfare of citizens. However, compared to the vast overall number of factors typically regarded as crucial for private investors when deciding where to invest, governments have mainly two sets of instruments at their disposal that directly affect investors' choices: the taxation of businesses and the provision of public inputs. When analyzing government behavior related to competition for capital, it thus seems natural to assume that governments make use of both available instruments, and that the choices affecting the taxation of firms and decisions on public input provision will typically be interdependent. Accordingly, a thorough analysis of how governments compete for mobile capital should be based on analytical tools treating the relevant business tax rates and infrastructure investments as jointly determined policy instruments.

The theoretical literature has pointed to the role of taxes and infrastructure investments as joint determinants of private investment early on. Extending the analysis of Zodrow and Mieszkowski (1986), Keen and Marchand (1997) have shown that in the presence of a productivity-enhancing public good the composition of public spending tends to be systematically biased towards a relative overprovision of public inputs compared to public goods which are consumed directly by residents. Focusing on the strategic choice of policy instruments, Büttner (1999) has suggested a model where governments optimize over tax rates and shares of income that are spent on productive public goods. More recently, Hindriks et al. (2008) have presented a framework in which the level of public inputs is chosen in the first stage of a game while the tax rate is determined in the second. This dynamic setting implies an incentive for governments to underinvest in public inputs in order to alleviate second-stage tax competition.

In contrast to the aforementioned contributions, the bulk of theoretical work on fiscal competition has treated the cases of pure tax competition and expenditure competition separately. While Mintz and Tulkens (1986), Wilson (1986), and Wildasin (1988) have discussed the issue of inefficiently low equilibrium tax rates and a corresponding underprovision of consumptive public goods, Taylor (1992) and Bucovetsky (2005) have dealt with the problem of overprovision of public infrastructure. The related empirical literature has been dominated by applications testing for the strategic choice of business tax rates, mostly ignoring the issue of public inputs.[1]

Building on much of the theoretical as well as empirical work mentioned above, we offer a comprehensive treatment of tax and public input competition, with a focus on the strategic behavior of governments in choosing both policy instruments. In our theoretical model, the governments of two symmetric jurisdictions compete for mobile capital by simultaneously setting both the business tax rate as well as the level of provision of a productive public input. The public input makes private capital more productive and can thus be used by governments to attract investment. On the other hand, providing public inputs is costly. We characterize the reaction functions for both policy instruments and show that governments react to tax cuts in the other jurisdiction by cutting their own tax rate and providing more public inputs. If the other jurisdiction improves its infrastructure, governments lower the business tax rate and increase the provision of public inputs. We then proceed with an empirical test of the nature of strategic behavior of governments with autonomy to set a business tax rate and to provide a productive public input. Using a rich data set of local jurisdictions in Germany, we estimate an empirical counterpart of the two-dimensional

[1] One of the few empirical studies acknowledging the joint impact of taxes and public infrastructure on the allocation of private capital is Bénassy-Quéré et al. (2007). They investigate FDI flows from the U.S. to several European countries and find that both the corporate tax rate and the stock of public capital are significant in explaining inward FDI. In contrast to their study, we take the responsiveness of investment to inter-jurisdictional differences in tax rates and public infrastructure as given and explore whether governments make use of taxation and public inputs as strategic instruments to attract private capital. A further study providing some related evidence on OECD countries is Gomes and Pouget (2008). Early contributions include Brueckner and Saavedra (2001), Büttner (2001), and Hayashi and Boadway (2001).

system of fiscal reaction functions. To the best of our knowledge, we provide the first empirical analysis of tax and public input competition that allows for taxes and spending on infrastructure to be jointly determined endogenous variables. Building on recent work of Kelejian and Prucha (2004), we run a four-step systems estimation approach for spatially interrelated equations. Our approach is very general. First of all, it allows for both policy instruments to depend on tax rates and public inputs in neighboring jurisdictions. Secondly, we treat the business tax rate as a function of a government's own level of public input provision, and vice versa. Thirdly, it accounts for potential cross-sectional correlation in unobservables and potential cross-equation correlation of residuals.

The picture of local government behavior that emerges from our estimations is much more complex than suggested by previous empirical work on fiscal competition. Across various specifications, our findings suggest that governments set both the business tax rate and the level of public input provision strategically, i.e. they set both instruments taking into account the respective choices of competing governments. In particular, we find that local governments tend to adjust their business tax rate towards levels chosen in neighboring jurisdictions. Moreover, if neighbors increase their spending on the local infrastructure, governments react by strongly increasing their own spending, too. Finally, our results suggest that a government's level of spending on public inputs is also affected by the tax rates of neighboring jurisdictions, with the sign of the effect as predicted by the theoretical model. Treating taxes and public inputs as alternative means to attract capital thus reveals that local governments react to competition by other jurisdictions in a rather flexible way: municipalities experiencing a boost in local infrastructure investment in neighboring communities will, on average, raise the level of public input provision, too. If neighbors choose to lower the tax burden on locally installed capital, municipalities will adjust both the tax rate and the spending on infrastructure to restore competitiveness. All these empirical findings are in line with the predictions of our theoretical model.

The paper proceeds as follows. In Section 6.2 we introduce our theoretical model of tax and public input competition. Section 6.3 describes our estimation approach and presents evidence based on data on local jurisdictions in Germany. Conclusions are drawn in Section 6.4.

6.2 The model

Our theoretical analysis of tax and public input competition builds on the literature on strategic tax competition in the tradition of contributions such as Wilson (1991), Wildasin (1991) and Brueckner and Saavedra (2001). In these models, governments compete for capital which is in fixed supply, and countries are large enough to have an influence on each other's optimal behavior. We extend this model of pure tax competition by allowing for public inputs as a second strategic policy instrument. We aim at characterizing the model's reaction functions, describing how governments react with both instruments to the respective choices of a competing jurisdiction. Since we want to account for strategic interaction across instruments, we let governments simultaneously set taxes and spending on the public input. The governments in our model thus compete by choosing a mix of instruments capable of attracting mobile capital. The simultaneity in the choice of fiscal policies rules out commitment effects emerging in a setting with sequential moves.

We consider a federation of two symmetric jurisdictions, labeled $i = 1, 2$. In each jurisdiction, production of a homogeneous consumption good takes place, using perfectly mobile capital k_i and a publicly provided input, g_i. The public input is of the factor-augmenting type and raises the marginal productivity of the primary input factor. To keep the model tractable, we use a simple quadratic production function of the form

$$F_i(k_i, g_i) = (a + g_i)k_i - b\frac{k_i^2}{2}, \tag{1}$$

where a and b are parameters. Governments levy per unit taxes t_i on capital employed in their respective jurisdictions. With capital perfectly mobile across regions, the arbitrage condition requires its net return to be equalized such that

$$F_i'(k_i, g_i) - t_i = F_j'(k_j, g_j) - t_j, \tag{2}$$

where F_i' denotes the marginal product of capital. With the world capital stock denoted as k, we can solve (2) for the capital employed in i, to obtain

$$k_i = \frac{kb + g_i - g_j - t_i + t_j}{2b}. \tag{3}$$

Equation (3) shows how a government's own choice regarding t and g affects its tax base, and that making use of the instruments involves fiscal externalities. Note that due to the symmetric setting and the specification of the production function, we have

$$\frac{\partial k_i}{\partial g_i} = -\frac{\partial k_i}{\partial t_i} = -\frac{\partial k_i}{\partial g_j} = \frac{\partial k_i}{\partial t_j} = \frac{1}{2b}. \tag{4}$$

The governments are assumed to maximize welfare in their own jurisdiction. Assuming absentee ownership of capital,[2] we define the objective function of the government in i to be

$$U_i = F_i(k_i, g_i) - F_i'(k_i, g_i)k_i + t_i k_i - \frac{(k_i g_i)^2}{2}, \tag{5}$$

where the first term captures total output, the second capital income of foreign owners, the third local tax revenue, and the fourth the cost of public input provision. Hence, welfare consists of the return to the immobile factor and tax revenue minus the costs of providing infrastructure. This specification is very close to the one used in Hindriks et al. (2008), for two major reasons: First of all, this makes our results with simultaneous choices comparable to theirs with a sequential setting. In addition, and more importantly, this simple framework is able to capture all effects that are relevant to our question while still being fully analytically solvable.[3]

While the first three terms are straightforward, the expression capturing the cost of providing the productive input requires some discussion. First of all, including the cost of public input provision in the welfare function instead of imposing a budget constraint implies (realistically) that governments do not rely exclusively on capital taxes as the source of funding for public inputs. Secondly, the specification avoids the need for a further policy instrument. Otherwise, with two instruments and the requirement to balance the government's budget, only one policy instrument could be set strategically.[4] The convex cost of supplying the public input captures a congestion externality in the use of the public input. Accounting for such an externality is motivated by two facts: first of all, the presence of congestion externalities seems to be a natural assumption with regard to common public inputs like road networks, telecommunication infrastructure or land for business parks.[5]

[2]This simplifies the algebra, but all our main results hold if we allow for domestic ownership of capital.

[3]It is a common feature of models in this literature that analytical solutions and the signing of even basic effects tend to come at the cost of functional form assumptions. See, e.g., Wildasin (1991) and Devereux et al. (2008).

[4]As first discussed by Wildasin (1991), equilibria in fiscal competition games with two instruments related via a budget constraint crucially depend on which instrument is set strategically. See Bayindir-Upmann (1998) for an exploration with taxes and public inputs as policy instruments.

[5]Bergstrom and Goodman (1973) provide evidence suggesting that most local public goods are congestible. Craig (1987) finds substantial congestion effects using the example of police services, and Fernald (1999) shows that after 1973, with the U.S. Interstate Highway system being well-established, an increase in total miles driven reduced road services to individual producers significantly.

Secondly, the existence of a pure-strategy Nash equilibrium in a simultaneous-move game with taxes and public inputs is only guaranteed in general if the latter is crowded to some degree Petchey and Shapiro (2008). The intuition for our specification of the congestion externality is that, for any given level of g, the welfare costs of providing it are higher the more it is used, i.e. the 'relative' costs of providing public inputs are convex. Stated differently, we assume that governments trying to ensure an adequate provision of g for any unit of k will see the costs of g rising with k. This is a standard way of modelling crowding externalities in the context of local public inputs Matsumoto (2000).[6] In anticipation of our empirical example involving jurisdictions providing a local road network, one might think of an increase in the number of vehicles as leading to a more than proportionate increase in the need for roads due to nonlinearities in congestion effects. Alternatively, one could argue that the maintenance costs of public infrastructure increase as it is being used more heavily. With respect to the specific functional form of the cost term, we build on Hindriks et al. (2008) by using a simple quadratic form, again a standard way to keep the model tractable. This form is obviously ad hoc, but it is the simplest conceivable way to get convex costs, ensuring interior solutions, and to grasp the idea that the costs of public infrastructure increase with capital to use it. [7]

Using (3) and (5), we derive the welfare level as a function of k_i as

$$U_i(k_i) = \frac{\delta_i}{8b^2}[b^2k + g_i^2(g_j - g_i + t_i - t_j) + b(g_i - g_i^2k - g_j + 3t_i + t_j)], \tag{6}$$

where $\delta_i \equiv kb + g_i - g_j - t_i + t_j$. Our main interest lies in the slopes of the tax and public input reaction functions, $t_i = f_t(t_j, g_j)$ and $g_i = f_g(t_j, g_j)$, around the equilibrium. In most of the literature, policy instruments are referred to as 'strategic substitutes' if the derivative $\partial^2 U_i/(\partial x_i \partial x_j)$ is negative, and as 'strategic complements' if it is positive, where x denotes an instrument at players' disposal. With just one instrument, this translates one to one into negatively and positively sloped reaction functions, respectively. This is, of course, no longer true in our case as a government will generally find it optimal to respond to a marginal policy change by its competitor using both instruments. Taking account of this, to obtain the slopes of the tax and public input reaction functions, we proceed by totally differentiating the governments' first order conditions with respect to t_i and g_i. In

[6] An alternative would be to include the congestion externality in the production function (see Büttner (1999)). While this does not change the intuition for the crowding effect, it makes the algebra significantly more involved.

[7] It is instructive to take a look at the change in the marginal cost of public inputs caused by more capital, $\partial^2(g_i^2k_i^2/2)\,/\,(\partial g_i \partial k_i) = 2g_ik_i$: It rises in k_i, reflecting the crowding, and g_i, reflecting the larger stock that has to be adapted - to stick with our example, expanding the road network is more expensive at the margin if roads are heavily used and the network already is large.

general form, the resulting system of equations reads

$$\begin{pmatrix} \frac{\partial^2 U_i}{\partial t_i \partial t_i} & \frac{\partial^2 U_i}{\partial t_i \partial g_i} \\ \frac{\partial^2 U_i}{\partial g_i \partial t_i} & \frac{\partial^2 U_i}{\partial g_i \partial g_i} \end{pmatrix} \begin{pmatrix} dt_i \\ dg_i \end{pmatrix} = - \begin{pmatrix} \frac{\partial^2 U_i}{\partial t_i \partial t_j} & \frac{\partial^2 U_i}{\partial t_i \partial g_j} \\ \frac{\partial^2 U_i}{\partial g_i \partial t_j} & \frac{\partial^2 U_i}{\partial g_i \partial g_j} \end{pmatrix} \begin{pmatrix} dt_j \\ dg_j \end{pmatrix}. \quad (7)$$

Since we assume jurisdictions to be identical, we follow the common practice to focus on the symmetric equilibrium characterized by $t_i = t_j = t$ and $g_i = g_j = g$. Using the specific values of all the derivatives (note that we have relegated most formal derivations to the appendix), it is straightforward to derive from (7) the four effects of interest as

$$\frac{dg_i}{dg_j} = -\frac{dg_i}{dt_j} = \frac{1}{|H|} \frac{gk - 1}{4b^2} \quad (8)$$

and

$$\frac{dt_i}{dt_j} = -\frac{dt_i}{dg_j} = \frac{1}{|H|} \frac{k(bk + g(4 - 3gk))}{16b^2}, \quad (9)$$

where $|H|$ denotes the determinant of the Hessian (it is shown in the appendix that $|H|$ is positive). The symmetries in dt_i/dt_j and dt_i/dg_j as well as dg_i/dg_j and dg_i/dt_j are driven by the fact that, as shown in (3), the absolute values of the marginal changes in the tax base are equal across instruments.

To sign the slopes of the reaction functions, we make use of the values for g and t in the symmetric Nash equilibrium, which turn out to be $g^* = 2/k$ and $t^* = (bk^2 + 4)/(2k)$ (see the appendix for derivations, and also a discussion of stability).[8] If we evaluate (8) at the symmetric Nash equilibrium, we find unambiguous signs for the reactions in public inputs,

$$\frac{dg_i}{dg_j} = \frac{4}{3bk^2} > 0; \quad \frac{dg_i}{dt_j} = -\frac{4}{3bk^2} < 0. \quad (10)$$

The expressions in (10) show that if the opponent deviates from the symmetric equilibrium by increasing its supply of public inputs, a region will find it optimal to respond by supplying more g, too. Moreover, a region will also react by providing more of the costly input if the opponent competes for capital by cutting its tax rate.

[8]Note that with absentee ownership, capital has a participation constraint, namely that its net of tax return has to be positive, $F'(k_i, g_i) - t_i > 0$. This condition reduces to $a > bk$. Note that this condition is also sufficient to ensure a positive marginal product of capital.

Evaluating (9) in equilibrium, we see that the signs of the reactions in taxes depend on b, the parameter measuring the curvature of the production function:

$$\frac{dt_i}{dt_j} = \frac{bk^2 - 4}{3bk^2}; \quad \frac{dt_i}{dg_j} = -\frac{bk^2 - 4}{3bk^2}. \tag{11}$$

Hence, the finding of Brueckner and Saavedra (2001) that the slope of the reaction function in a model of pure tax competition cannot be signed unambiguously carries over to our setting. As long as we are willing to assume that b is larger than $4/k^2$, however, we find

$$\frac{dt_i}{dt_j} > 0; \quad \frac{dt_i}{dg_j} < 0. \tag{12}$$

Under the given restriction on b, the optimal reaction to a decrease in the opponent's tax rate is to decrease taxes and to increase public input provision. Similarly, if the opponent provides more public inputs, it is optimal to increase provision, too, and to cut the tax rate. Inspection of (10) and (11) reveals that the smaller is b, the stronger will be the reaction in public inputs and the smaller will be the reaction in taxes. This is intuitive, as the following example demonstrates: imagine region j becomes a tougher competitor for mobile capital by raising g_j. The government in i can respond to this with its two instruments, t_i and g_i, and will typically use both. The reason for the crucial role of b is that it determines the curvature of the production function, thereby driving the residual income the country earns (after having paid the mobile factor its marginal product). This residual income is, besides tax revenues, the reason why a country is interested in attracting capital in the first place. If b is very small, the production function is almost linear, rendering the residual income small and the motive to tax local capital comparatively more important. For i's government it will then be optimal to respond to the increase in g_j by a relatively strong increase in g_i, thereby defending its tax base, and by an increase in its tax rate t_i. With a larger b, the residual income becomes more significant, strengthening the incentive to attract capital for its direct contribution to the region's welfare. If b is sufficiently large, the optimal response to an increase in g_j will therefore be to lower t_i and still increase the costly g_i.

Formally, the rationale for requiring $b > 4/k^2$ can be seen from the components of a region's welfare, which after substitution of the residual income is

$$U_i = \frac{b}{2}k_i^2 + t_i k_i - \frac{(g_i k_i)^2}{2}. \tag{13}$$

Evaluating this expression at the symmetric Nash equilibrium shows that the condition

$b > 4/k^2$ is equivalent to the requirement that the residual income is larger than the cost of providing g. If this condition is not met, the welfare effect of attracting additional units of capital is negative once we net out the contribution of tax revenue. This makes the motive to raise tax revenue so strong that governments will react to increased competition by increasing their tax rate. Hence, imposing the condition $b > 4/k^2$ essentially means restricting attention to situations where fiscal policies are driven by a motive to attract investment as an income-generating factor and, at the same time, to raise tax revenue. Effectively, the condition ensures that governments react to policy changes in the competing jurisdiction by adjusting both fiscal policy instruments such that the adjustment in each instrument contributes to offsetting the resulting change in a region's relative attractiveness for private capital.

To get an intuition for the role of the congestion externality in shaping the strategic behavior of governments, consider the reason for the sign of dg_i/dg_j to be positive: with the congestion externality in place, attracting additional units of capital drives up the cost for the public input. For governments, this affects the optimal fiscal policy mix by making the attraction of capital less and using the tax instrument to generate revenue more attractive. Hence, the congestion externality alleviates tax competition. The consequently relatively higher taxes make the tax base effect important, inducing governments to respond with an increase (decrease) in public input provision to a corresponding increase (decrease) abroad.

In the following, we suggest an approach to estimate empirical counterparts of the tax and public input reaction functions of local jurisdictions. Since the congestion externality in the use of the public input is a distinctive feature of our model, we use an example where such externalities arise quite naturally: the provision and maintenance of a local road network.

6.3 Empirical Analysis

6.3.1 Estimation Approach

To accommodate strategic government behavior as implied by our model, our estimation approach must be flexible enough to allow for tax rates and public inputs to be determined simultaneously. Moreover, the design of the empirical model needs to account for the interdependence of all jurisdictions' choices regarding taxes and inputs, i.e. each jurisdiction's tax rate as well as the level of inputs provided to attract mobile capital should be allowed to depend on both taxes and inputs of all other jurisdictions.

Our structural empirical model builds on $t_i = f_t(t_j, g_j)$ and $g_i = f_g(t_j, g_j)$ as the general form reaction functions of the tax and public input competition model. To facilitate estimation, we make use of linearized versions of these functions and define the following system of equations,

$$\tau_i = \theta_\tau s_i + \lambda_\tau \tau_{-i} + \varphi_\tau s_{-i} + \beta_\tau X_{\tau i} + u_i \tag{14}$$

$$s_i = \theta_s \tau_i + \lambda_s \tau_{-i} + \varphi_s s_{-i} + \beta_s X_{si} + v_i, \tag{15}$$

where τ denotes the tax rate and s a jurisdiction's spending on the public input, $\tau_{-i} = \sum_j w_{ij}\tau_j$ and $s_{-i} = \sum_j w_{ij}s_j$ indicate the average tax rate and average inputs of other jurisdictions, weighted by the predetermined weights $w_{i1}, \ldots, w_{iN}$, and $X_{\tau i}$ and X_{si} denote vectors of control variables (including a constant) in the tax and input equation, respectively. The variables entering both $X_{\tau i}$ and X_{si} are subsets of a set of exogenous variables, $X_i = (x_{1i}, \ldots, x_{Ki})$.

Note that in specifying our system of equations, we include s_i among the right-hand side variables of the tax equation and τ_i as an explanatory variable in the input equation. In doing so, we deviate from the usual approach to use counterparts of reduced-form reaction functions when estimating models of fiscal competition with more than one choice variable (see Devereux et al., 2008). The reason for allowing a government's own policy instruments to appear as explanatory variables is that we want the empirical model to allow for the fact that governments are not always free to adjust both instruments to optimal levels. For instance, governments might face political costs when frequently changing the business tax rate, and prefer to keep the tax rate constant if the difference between the optimal rate and the rate actually implemented is sufficiently small. Taking into account the effect on the government's budget, the optimal choice of public inputs should then be modeled as being conditional on a given business tax rate. A similar argument can be made with respect to public inputs, where investments often require considerable planning effort. As a result, it may take some time until a government can adjust its stock of public capital to the desired level. Again, this may affect the government's budget and, thereby, the tax rate.

Apart from modeling tax rates and inputs to be interrelated both within and across jurisdictions, we also allow for cross-sectional dependence in the disturbances u and v,

$$u_i = \rho_u u_{-i} + \epsilon_i \quad \text{and} \quad v_i = \rho_v v_{-i} + \varepsilon_i, \tag{16}$$

where $u_{-i} = \sum_j w_{ij} u_j$ and $v_{-i} = \sum_j w_{ij} v_j$. The innovation vectors ϵ and ε are assumed to be identically and independently distributed with zero mean. Hence, we require that the innovations are free of spatial correlation. Note, however, that we allow for contemporaneous cross-equation correlation among innovations of the same cross-sectional unit.

Following most of the literature on tax competition among local jurisdictions, we choose a spatial metric which accounts for the physical distance between jurisdictions. Moreover, we also want the weights to reflect differences in the jurisdictions' size. We therefore use the metric

$$w_{ij} = \frac{n_{ij}\, pop_j}{\sum\limits_{k \neq i} n_{ik}\, pop_k},$$

where n_{ij} is an indicator for neighbors of i (with $n_{ii} = 0$) and pop_j is j's population. To determine which jurisdictions are 'neighbors' of a given community, we either use a maximum great circle distance between the centroids of jurisdictions, or we apply an mth-nearest-neighbors criterion, defining as neighbors the m nearest jurisdictions in terms of physical distance. Note that the spatial metric defines an environment for each municipality that is assumed to be the relevant local market for mobile investment. Although all municipalities in our sample are part of an integrated capital market, it nevertheless seems reasonable to assume such a local environment. One reason is that the population of firms in almost all municipalities is dominated by small and mid-size firms with limited management capacity. Imposing a spatial metric based on geographical proximity essentially means that these small and mid-size firms are assumed to consider only a 'local environment' of municipalities as alternative locations.

While our specification of the empirical reaction functions is more general than the commonly employed reduced-form version, it also makes the estimation of the parameters of interest more involved. In fact, allowing the choice variables to appear as explanatory variables means that we have to deal with a total of four endogenous explanatory variables: s_i, τ_{-i}, and s_{-i} in the tax equation, and τ_i, τ_{-i}, and s_{-i} in the public input equation. To account for all endogeneity problems and to achieve efficient estimation, we use the spatial system estimator proposed by Kelejian and Prucha (2004). In the following, we briefly outline the four step estimation procedure.

As the initial step, we run a two-stage least squares (2SLS) procedure separately on the tax and the input equation, treating τ_i, s_i, τ_{-i} and s_{-i} as endogenous regressors. We use the same set of instruments in both estimations, containing $x_{1i}, \ldots, x_{Ki}$ as well as the corresponding first and second order spatial lags. In matrix notation, they can be written as

$WX_1, \ldots, WX_K, WWX_1, \ldots, WWX_K$, where W denotes the N-dimensional square matrix of weights. Using the residuals of the first stage, in the second step of the procedure the spatial auto-regressive parameters ρ_u and ρ_v are estimated by the generalized moments method originally suggested by Kelejian and Prucha (1999). The estimates of the spatial auto-regressive parameters are then used in the third step to perform a Cochrane-Orcutt-type transformation of the structural equations to remove the spatial error correlation and to re-run 2SLS on the transformed system. While the third-step estimation takes into account potential spatial correlation, it does not take into account the cross equation correlation in the innovation vectors. To utilize the full system information, in the fourth step we apply a systems instrumental variable estimator, which is efficient relative to the first and third stage single-equations estimators.

For several reasons, the systems estimation approach outlined above seems to be the ideal choice for estimating our tax and public input competition model. First of all, the procedure takes account of the fact that both taxes and public inputs are determined simultaneously. Secondly, it allows for contemporaneous interaction between jurisdictions in a very general way. In addition, it is easy to implement even in large samples, a distinctive advantage over maximum likelihood procedures.

The evidence reported in this study is derived from cross-sectional estimations. While we would like to run panel estimations accounting for fixed municipality effects, there is, unfortunately, no straightforward way to do so. The systems estimator of Kelejian and Prucha (2004) is not designed for panel data, and we are unaware of an alternative estimation procedure that combines the features of a systems estimator with general cross-sectional interdependence with ways to account for unobserved heterogeneity. Applying the systems estimation routine of Kelejian and Prucha (2004) to panel data and including a series of jurisdiction-specific constants as ordinary regressors is not a feasible option because the estimation of standard errors which are robust to serial correlation is an open question. However, as a robustness check regarding potential period-specific effects, we report the results of systems estimations using the municipality-level data after a between-transformation, i.e. we run cross-sectional regressions using variables after taking averages over time.

6.3.2 Data

The data used to estimate our empirical model of tax and public input competition come from a sample of 1100 German municipalities in the state of Baden-Wuerttemberg, covering the period 1998-2004. Note that we exclude independent cities from the sample (10 cross-sectional units), which face different incentives within the municipal system of fiscal equalization. As we will see, the treatment within this redistributive grant system exerts a strong impact on local tax and spending decisions. In the following, we briefly comment on the data which are summarized in Table 6.1.

As already pointed out, German municipalities have taxing autonomy with respect to the business tax (Gewerbesteuer), essentially a tax on local business earnings. In the time period under consideration, the statutory tax rate in the state of Baden-Wuerttemberg averaged 0.167 and varied between 0.145 and 0.21. Besides revenues from the local business tax, grants and federal tax revenue sharing play an important role in municipal financing. In our context of tax and public input competition, fiscal equalization grants deserve special attention, as redistributive grant systems affect the incentive of local governments with respect to tax and expenditure policies. The theoretical literature on the internalizing effects of fiscal capacity based equalization suggests that the implementation of redistributive grant systems tends to weaken tax and public input competition (e.g., see Köthenbürger (2002) and Bucovetsky and Smart (2006)). Recent empirical evidence for Germany (Buettner (2006); Egger et al. (2007)) supports the view that tax rates tend to rise when the degree of equalization increases. Following Büttner (2006), we therefore include two control variables in our regressions to account for substitution and income effects of equalization grants. The marginal contribution rate describes to which extent an increase in the tax base reduces the equalization transfers received. For the period between 1998 and 2004 the average rate was 13.2% with a maximum value of 14.5% and a minimum of 8.8%. Relating the marginal contribution rate to the tax rate reveals an average equalization rate of around 80%. As a means to control for pure income effects we include unconditional transfers capturing the amount of transfers a municipality would receive if its tax base were actually zero. This includes equalization transfers and the municipal share of statewide income and value added taxes.

Furthermore, since differences in taxing capacity may affect local tax and expenditure policies, we account for a municipality's relative fiscal capacity. This variable is calculated by relating a municipality's fiscal capacity (comprising the local business tax base as well as other revenue sources, in particular the share of statewide income and value added taxes) to its fiscal need, calculated by multiplying a predefined per capita spending need with the municipality's population size. Hence, controling for a municipality's relative fiscal capacity essentially captures the local budget constraint. The relative fiscal capacity shows values between 28% and 635% with an average value of 71.4%, indicating that the average municipality in the state of Baden-Württemberg is not able to cover its spending needs though own resources and depends on intergovernmental transfers.[9]

In our analysis, public input provision is defined as spending on the municipal road network. This choice is straightforward since it seems reasonable to assume that the quality of the local road infrastructure is of substantial importance for all types of firms. Moreover, the construction and maintenance of local roads is one of the most important autonomous municipal responsibilities in Germany. More than 60% of the road network falls under the municipal domain.[10] Between 1998 and 2004, municipalities have spent, on average, 130 Euros per capita (in prices of 2000) on the construction and maintenance of local roads. A standard deviation of 93 Euros per capita indicates substantial variation in this expenditure category. As municipalities receive grants in order to fulfill their self-administrated spending responsibilities, we explicitly control for specific transfers in the spending category 'local roads'. This includes grants within the so called 'traffic and transport burden sharing' (Verkehrslastenausgleich), which depend on the length of the road network and the size of the municipal area. In addition, we include other specific grants independent of the tax base in order to control for the corresponding income effects. Other conditioning variables capturing local characteristics include debt service, population size and population density as well as the population share of the young (less than 16 years) and the elderly (above 65 years). Furthermore, we also include the unemployment rate as a proxy for the general demand for spending on social services. Finally, drawing on Büttner (2001), we include the share of the population that is affiliated with one of the three major Christian churches (Catholic, Protestant State, and Protestant Free Church) as well as two variables that interact this proportion with the rate of unemployment and the share of elderly people, respectively.[11] The inclusion of these variables is warranted as the religious

[9] See Büttner (2006) for further details on the municipal system of fiscal equalization in the state of Baden-Wuerttemberg.

[10] Due to strong interlinkages of municipal and state responsibilities, other spending categories potentially capturing inputs to production, most notably educational expenditure, can not be considered as independently provided at the local level. Our empirical analysis therefore focuses on the local road network and captures other expenditures as a residual category.

[11] Data on religious affiliation is available only for 1987. The slight imprecision in the count of church members relative to overall population (10 municipalities with a reported share of church members higher than one) is known from other studies using the same data. Excluding municipalities with implausible figures does nothing to our estimation results.

orientation of the population may indicate preferences regarding the provision of local public goods and, in particular, social services and welfare. The interactions account for the possibility that, depending on the strength of religious orientation, an increase in the number of potential welfare recipients may have different effects on the socially preferred level of social services.

The fact that both the tax rate and public inputs appear as explanatory variables in our system of equations requires to use some of the exogenous characteristics as instruments for these variables. Technically, this is achieved by imposing exclusion restrictions with respect to a subset of the exogenous variables on both equations. An exclusion restriction for the tax equation is suggested by the system of specific grants. As specific grants for the construction and maintenance of local roads amount, on average, to only 1.2% of overall expenditures, the business tax rate should be independent of the level of these grants. To the contrary, we expect grants for local roads to significantly affect actual spending on the local road network. Consequently, we include specific grants in the public input equation, but exclude it from the tax equation. Note that other specific grants amount to 57.4 Euros per capita, twice as much as specific grants for local roads. We therefore include other specific grants in both equations to account for potential income effects.

Regarding the exclusion restrictions for the public input equation, note first that local roads are not only used as public inputs by firms, but are also consumed by private households. A change in infrastructure spending will therefore have direct as well as indirect effects on the utility of residents. In contrast, a change in the business tax rate will affect households only indirectly. This suggests to exclude the variables describing the religious orientation of the local population and related preferences regarding spending on social services from the input equation. We thus assume that a stronger preference for spending on social services and welfare may affect the preferred level of local taxation, but that the level of municipal spending on physical infrastructure is independent of residents' religious orientation.

Of course, the quality of the instruments obtained from imposing our exclusion restrictions is also an empirical question. In particular, to identify public inputs in the tax equation, we need the specific grants for local roads to be sufficiently strongly partially correlated with spending on local roads. Furthermore, the identification of the local business tax rate in the input equation rests on the partial correlations between the tax rate and the proportion of church members as well as the related interaction terms. We will discuss the quality of the instruments when turning to the estimation outcomes.

6.3.3 Results

Table 6.2 and 6.3 present detailed estimation results for a first set of system estimations on tax and public input competition. The spatial metric is $W^{15\text{km}}_{\text{pop adj}}$, defining as neighbors of a given community all municipalities with a physical distance of up to 15 km. As discussed above, the metric also gives higher weight to larger municipalities in terms of population size. As mentioned above, we report results from cross-sectional estimations. To check for the robustness across years, the tables depict regressions for different years.

After excluding the 10 independent cities from the sample, we are left with 1100 cross-sectional observations. Note that the sample restriction is applied after taking spatial lags. Hence, while all municipalities are included in the computation of τ_{-i} and s_{-i}, the IV estimations at the first, third and fourth step of the system estimation approach are based on the restricted sample.

Table 6.2 reports two columns for each year, where the left one shows estimated coefficients and corresponding standard errors for the tax equation and the right one depicts the results for the public input equation. The coefficients of our variables of interest are shown in the first rows. First of all, we note that the coefficient of neighbors' taxes is positive and highly significant in the tax equation in all reported cross-sections, ranging from 0.20 to 0.31. These results suggest that the municipalities in our sample react to tax policies of their neighbors by adjusting their own business tax rate towards the level chosen in nearby jurisdictions.[12] Note that this finding is well in line with the evidence presented in Büttner (2001). However, our results also reveal that there are several other effects at work, suggesting that the behavior of local governments is much more complex than described in the earlier empirical tax competition literature. In particular, we find a positive and statistically significant effect of neighbors' spending on infrastructure on a community's own spending level in three out of four cross-sections. The coefficients indicate that a one-Euro increase in neighbors' average spending per capita triggers an increase in a municipality's own per-capita spending on infrastructure between 18 and 51 Cents. Hence, our findings suggest that the municipalities engage in simultaneous tax and public input competition

[12] In the following, we sometimes interpret the estimates of the strategic effects in terms of reactions of governments to changes in other municipalities' policy instruments. Such interpretations always refer to the partial effects in our static empirical model, and not to any sort of dynamic adjustment.

for mobile capital.[13] A second effect that has not been considered in previous work is that of neighbors' taxes on a municipality's own level of spending on public inputs. In two out of four cross-sections, we find a negative and statistically significant effect, pointing to local governments increasing their per-capita spending on infrastructure by about 7 to 11 Euros per capita in reaction to a one percentage point decrease of their neighbors' average tax rate. Note that the sign of all these effects are in line with the predictions of the model discussed in Section 6.2.

Interestingly, our results also point to direct interaction between fiscal variables within a community: a one percentage point increase in the statutory tax rate triggers an increase in spending per capita of 32 Euros in 1998 and of 24 Euros in 2000, while in the 2002 cross-section we find a negative effect of about 22 Euros. Moreover, for 1998 and 2000 there is a positive partial effect of public inputs on taxation, indicating that an increase of spending by 100 Euros per capita would result in a tax rate increase of 0.1 to 0.2 percentage points. All these findings support the notion that it is important to account for the fact that not all policy instruments might be adjustable to optimal levels at all points in time.

Besides the evidence on tax and public input competition, there are additional findings that are worth mentioning. Confirming our expectations, the marginal contribution rate positively affects the tax rate, while unconditional transfers exert a negative impact on local taxes. Both findings are in line with Büttner (2006) and support the view that a higher degree of redistribution within a system of fiscal equalization alleviates business tax competition. In addition, there is evidence for a negative impact of the marginal contribution rate on public input provision in two out of four cross-sections. This suggests that fiscal equalization counteracts both tax and public input competition. Furthermore, unconditional transfers are found to positively affect public inputs. An increase of these transfers by one Euro per capita brings about an increase in infrastructure spending per capita of 0.18 to 0.24 Euros. Regarding relative fiscal capacity, our expectations are also confirmed: municipalities with higher capacity set lower tax rates and spend more on public inputs. With respect to the characteristics which are used as instruments in either the tax or the public input equation, we note that spending on local roads strongly reacts to the amount of specific grants received for that purpose. In addition, we find at least two highly significant variables capturing the religious orientation of the population in

[13] The positive impact of neighbors' spending on a municipality's own spending is unlikely to be driven by technological externalities since the construction and maintenance of major interconnecting roads and highways falls into the responsibility the federal government or the states. Our measure of local public input provision thus includes only spending on roads with a very limited potential impact on the productivity of capital invested in other municipalities.

all cross-sections.[14] Finally, we note a positive impact of debt service on local taxes and a negative impact on public input provision, and a negative (positive) effect of unemployment (population) on the tax rate.

Regarding the quality of the instruments, we first note that τ_{-i} and s_{-i} are identified by a strong partial correlation with first and second-order spatial lags of exogenous community characteristics, resulting in F-statistics of the excluded instruments in the corresponding first-stage regressions larger than 50 in general.[15] Hence, we are confident that our identification approach with respect to the spatial effects does not suffer from a weak instruments problem. With respect to a community's own tax rate and public input as endogenous explanatory variables, we first checked the performance of the instruments in the first stage regression in terms of statistical significance. The specific-grants variable is always highly significant in the first-stage regression of public inputs on the set of instruments, with t-statistics around 10. In the first-stage regression of the tax rate, both the proportion of church members and the interaction with the rate of unemployment are generally significant at the 1% level. However, since the F-statistics for a community's own tax rate and public input are relatively small, we also checked the critical values for the Stock-Yogo weak identification test. We were able to reject the null that the bias of our IV estimation exceeds 20% of the bias in the corresponding OLS estimation in all cases, lending further support to our identification strategy.

The spatial metric used in the estimations reported in Table 6.2 assigns 23 neighbors on average to each municipality. In addition, there is substantial variation in the number of neighbors, ranging from one to 54. As a first robustness check of our findings with respect to the definition of neighborliness among municipalities, Table 6.3 reports results of the same estimations as before, with the metric $W^{10\,\text{nearest}}_{\text{pop adj}}$ based on the definition of the 10 nearest communities (in terms of physical distance) as neighbors, weighted by population.

A first point to mention is that all main effects from Table 6.2 are robust to the change in the metric. The effect of neighbors' taxes on a municipality's own tax rate is estimated to be significantly positive but somewhat smaller than before, ranging from 0.16 to 0.21. The impact of neighbors' spending on infrastructure on the local provision of public inputs is of similar size as before, with estimated coefficients ranging from 0.22 to 0.39. The results also confirm the finding that the municipalities take into account the level of taxes among neighbors when choosing their level of spending on the local road network. Even

[14] Note, however, that this finding is not sufficient to rule out a potential problem of weak identification. We comment on this below.

[15] We refer to the 2SLS estimation that is performed as the third step of the estimation procedure.

with respect to the strength of the interaction, we do not find any significant difference compared to the results reported in Table 6.2. A brief inspection of the evidence regarding the control variables reveals that the effects mentioned above are highly robust to the change in the metric, too.

To some extent, the evidence on tax and public input competition depends on which cross-sections are used for estimation, and it might therefore be useful to have a look on average effects. Table 6.4 reports the results of a system estimation after applying a between-transformation, i.e. after taking averages of all variables over time. Using $t = 1, \ldots, T$ as the index of time periods, the transformed system reads

$$\bar{\tau}_i = \theta_\tau \bar{s}_i + \lambda_\tau \bar{\tau}_{-i} + \varphi_\tau \bar{s}_{-i} + \beta_\tau \bar{X}_{\tau i} + \bar{u}_i \quad (17)$$

$$\bar{s}_i = \theta_s \bar{\tau}_i + \lambda_s \bar{\tau}_{-i} + \varphi_s \bar{s}_{-i} + \beta_s \bar{X}_{si} + \bar{v}_i, \quad (18)$$

where $\bar{\tau}_i = T^{-1} \sum_t \tau_{it}$, $\bar{X}_i = T^{-1} \sum_t X_{it}$, $\bar{\tau}_{-i} = \sum_j w_{ij} \bar{\tau}_j$, etc. The between-estimations confirm the presence of direct strategic interaction in the choice of taxes and public inputs. Using $W^{15\text{km}}_{\text{pop adj}}$ as the spatial metric, we find an average direct tax competition effect of 0.263 and a direct public input competition effect of 0.211. With $W^{10\,\text{nearest}}_{\text{pop adj}}$, the corresponding point estimates are 0.328 and 0.215, respectively.

The result regarding the impact of neighbors' taxes on own spending on infrastructure is mixed: the null of no interaction cannot be rejected under the metric $W^{15\text{km}}_{\text{pop adj}}$, but it is rejected under $W^{10\,\text{nearest}}_{\text{pop adj}}$ at the 10% level of significance. However, the magnitude of the estimated effect is rather small.

6.3.4 Robustness

The results discussed so far have been derived under specific assumptions with respect to spatial metrics. In related applications it has been shown that the choice of the metric may be of critical importance Baicker (2005), and it therefore seems to be warranted to discuss the issue in more detail.

While choosing a metric based on some geographical definition of neighborliness seems to be accepted as a general rule in applications involving local jurisdictions (Büttner (2001), Büttner (2003)), no consensus has evolved how to exactly specify the weights. However, as argued by Conley (1999), in many cases the application itself suggests a certain strategy.

In our case, for instance, the significant differences in the jurisdictions' size together with the fact that the key issue driving local governments into strategic interaction is a fiscal externality warrant to include some measure of size. Moreover, there are also technical aspects that need to be considered. As shown in the descriptive statistics (Table 6.1), the cross-sectional variation of the tax rate is rather limited. Taking averages over neighboring jurisdictions' tax rates will, of course, give a variable with even smaller variation. This problem can be expected to become the more severe the more municipalities are, on average, defined as neighbors for a given community. In fact, with sufficiently many communities included in the calculation of neighbors' taxes, τ_{-i} will quickly converge towards the regional (or even the statewide) average of taxes. Defining many municipalities as neighbors for a given community will thus result in τ_{-i} becoming a poor measure for the tax effort of nearby municipalities.

To exemplify the last point, we have assembled in Table 6.5 some descriptive statistics for neighbors' average tax rates (τ_{-i}) and neighbors' expenditures on infrastructure (s_{-i}) according to different spatial metrics (based on data for the year 2000).

The first four rows depict statistics for spatial metrics that take either the municipalities within a distance of up to 15km or the 10 geographically closest municipalities to be neighbors of a given municipality. Irrespective of whether we take the weights of neighbors to be uniform or to be defined based on the inverse of the great circle distance, the variable capturing the average tax rate of neighbors shows very limited variation. With uniform weights assigned to municipalities within a distance up to 15km, for instance, the variation in neighbors' average tax rate is actually modest, with a minimum of 0.16 and a maximum of 0.177. However, if we account for asymmetries in population size (last two rows), the variation in the resulting series is significantly higher. Note that, due to higher variation in local expenditures per capita, the computation of neighbors' spending on infrastructure does not seem to be affected by the problem of quick convergence towards regional or statewide averages.

Based on the preceding discussion, we expect the estimates regarding the impact of τ_{-i} to critically depend on the choice of the spatial metric. In contrast, the estimates regarding the coefficient of s_{-i} should be more robust to the definition of neighbors. To check to what degree this presumption is supported by our data, we estimated our system of reaction functions using the different spatial metrics. Table 6.6 gives an overview on the estimated coefficients of interest for a number of cross-sections.

We note that using $W^{15\text{km}}_{\text{uniform}}$, $W^{15\text{km}}_{\text{inverse}}$, $W^{10\text{ nearest}}_{\text{uniform}}$ and $W^{10\text{ nearest}}_{\text{inverse}}$ results in very large estimates of λ_τ compared to $W^{15\text{km}}_{\text{pop adj}}$ and $W^{10\text{ nearest}}_{\text{pop adj}}$. This is well in line with our expectations, as the variation in τ_{-i} tends to be low (recall that, with the weight matrix approaching a matrix of uniform weights for *all* other municipalities, τ_{-i} becomes a constant measuring the average tax rate among all communities). Note that for our system of equations to be stable, λ_τ is required to be smaller than one in absolute value. There are two estimations based on the 2004 cross-section where this requirement is barely met, adding further doubt about the appropriateness of spatial metrics that define 'large' sets of neighbors and that do not account for the municipalities' relative population size. It is also worth mentioning that the estimate for the interaction effect in public input provision, φ_s, is much more robust to changes regarding the spatial metric. Noting that the variation in spending on infrastructure is much higher than the variation in tax rates, and that defining a composite neighbor from a large set of communities should therefore be less of a technical problem, it is reassuring that the conclusions regarding public input competition are not critically affected by the choice of a spatial metric that defines either smaller or larger sets of neighbors.

6.4 Conclusions

Although it seems natural to think of governments' choices regarding taxes and public inputs as alternative means to attract mobile capital, most of the literature on fiscal competition has focused either on taxes or on expenditures. This study offers a comprehensive treatment of tax and public input competition, with a focus on the strategic interaction between governments in simultaneously choosing both policy instruments. We use a simple theoretical model to characterize the two-dimensional system of tax and public input reaction functions. We then test the predictions of the model with respect to the strategic behavior of governments. Using a systems estimator for spatially interrelated equations, we show that the fiscal policies of local jurisdictions in Germany are well in line with the model's predictions.

Our findings suggest that the behavior of local jurisdictions is much more complex than described by the earlier empirical literature on fiscal competition. In particular, the estimation results of our system of interrelated equations show a positive and significant direct interaction effect in the local business tax rate. Municipalities facing competition by low-tax jurisdictions thus set lower taxes than municipalities with high-tax neighbors. Secondly, the local governments also adjust their level of spending on infrastructure towards the average level among neighboring jurisdictions. For our preferred specifications, the direct interaction effect in public input provision is statistically different from zero in 10 out of 14 cross-sections, and it tends to be larger than the direct interaction effect in taxes. Moreover, treating taxes and public inputs as alternative means to attract capital reveals that the municipalities react to competition in a rather flexible way: if neighbors lower their taxes, a municipality not only adjusts its own tax rate, but also increases its level of public input provision. Finally, we demonstrate that our results depend on the choice of the spatial spatial metric in a predictable way, and that all main results are robust across various cross-sections.

Several lines of further research seem to be promising. First of all, it would be interesting to compare our results to evidence regarding tax and expenditure competition from other countries. Depending on the institutional environment, taking into account different policy instruments could yield further insights into the rather complex process of fiscal policy decision making at the local level. For instance, with respect to the US, our findings suggest to treat local property taxes and local expenditures for public schools as well as public safety as jointly determined endogenous variables. Moreover, we think that some of the recently proposed improvements regarding spatial estimation techniques can fruitfully be applied in cases that are of interest both from an academic and from a policy perspective. Further advances towards estimation techniques for systems of interrelated equations and panel data would therefore be highly welcome.

6.5 Appendix

The system (7) under symmetry

Plugging in the various derivatives into (7) gives

$$\begin{pmatrix} -\frac{g^2+3b}{4b^2} & \frac{g^2+2bkg+b}{4b^2} \\ \frac{g^2+2bkg+b}{4b^2} & -\frac{g^2+b^2k^2+b(4gk-1)}{4b^2} \end{pmatrix} \begin{pmatrix} dt_i \\ dg_i \end{pmatrix} = \begin{pmatrix} -\frac{g^2+b}{4b^2} & \frac{g^2+b}{4b^2} \\ \frac{g^2+2bkg-b}{4b^2} & \frac{-g^2-2bkg+b}{4b^2} \end{pmatrix} \begin{pmatrix} dt_j \\ dg_j \end{pmatrix}. \tag{A.1}$$

The symmetric equilibrium

In order to derive the symmetric Nash equilibrium, we form the first order conditions of (6) with respect to the tax rate,

$$t_i = \frac{(g_i^2 + b)\,(bk + g_i - g_j + t_j)}{g_i^2 + 3b}. \tag{A.2}$$

Having done that for each country, we invoke symmetry in g, giving us a symmetric tax rate of

$$t^o = \frac{1}{2}(b + g^2)k. \tag{A.3}$$

In the next step, we proceed analogously for public inputs, i.e. we form the first order conditions of (6) with respect to public inputs, then impose symmetry in t, giving us

$$g^o = \frac{\sqrt{b^2k^4 + 4bk^2 + 8tk} - bk^2}{2k}. \tag{A.4}$$

Combining (A.3) and (A.4) provides us with the Nash equilibrium values of

$$g^* = 2/k, \quad t^* = (bk^2 + 4)/(2k). \tag{A.5}$$

Sufficient conditions

We have to check that the second derivatives of the welfare function with respect to own instruments are negative at the symmetric equilibrium. To see this, note that

$$\left.\frac{\partial^2 U_i}{\partial t_i \partial t_i}\right|_{g=g^*} = -\frac{3b + \frac{4}{k^2}}{4b^2} < 0 \tag{A.6}$$

and

$$\left.\frac{\partial^2 U_i}{\partial g_i \partial g_i}\right|_{g=g^*} = -\frac{b\left(bk^2 + 7\right) + \frac{4}{k^2}}{4b^2} < 0. \tag{A.7}$$

Note furthermore that the Hessian determinant evaluated at the Nash equilibrium is

$$|H|\,|_{g=g^*} = \frac{3k^2}{16b}. \tag{A.8}$$

Since this expression is positive, all sufficient conditions for a maximum are met.

Stability

To address the issue of stability of the symmetric equilibrium, we take a look at the slopes of the reaction functions, given in (10) and (11). There, we see that $(bk^2 - 4)/3bk^2$, $-(bk^2-4)/3bk^2$, $-4/3bk^2$ and $4/3bk^2$ are all less than one in absolute value for any $b > 4/k^2$, the condition imposed in the main text. Note furthermore that due to the symmetric marginal reaction of capital to both instruments from (4), it is possible to determine the slope of a 'net policy response function' by adding the absolute values of the slopes of both of i's reactions to a marginal change in one of j's instruments. They add to 1/3, demonstrating stability in the policy response around the symmetric Nash equilibrium. To give an example, a marginally higher public input in j triggers a reaction in i's tax instrument with slope $-(bk^2-4)/3bk^2$ and a reaction in the public input with slope $4/3bk^2$. From (3), we know that the tax response affects capital in just the opposite direction than the public input response, so adding both terms in absolute values gives us the combined 'policy response' slope of 1/3.

Table 6.1: Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max
Statutory tax rate, τ	0.167	0.006	0.145	0.210
Spending for local roads per capita, s	130	92.8	0.815	1739
Marginal contribution rate	0.132	0.011	0.088	0.145
Unconditional transfers per capita	300	50.3	96.5	447
Fiscal capacity	0.714	0.272	0.276	6.35
Specific grants for local roads per capita	27.3	53.7	-76.5	1730
Other specific grants per capita	57.4	33.0	-3.92	282
Debt service per capita	10.6	35.2	-858	280
Population (1,000s)	7.81	10.7	0.101	112
Population density[a]	0.300	0.302	0.017	2.50
Unemployment	0.062	0.013	0.025	0.127
% population <16 years	0.181	0.022	0.101	0.300
% population >65 years	0.155	0.027	0.071	0.347
% church members	0.891	0.053	0.706	1.04

[a] (total population)/1000 per square kilometer; Nob=7700 (1100 municipalities from 1998 to 2004, independent cities excluded); Fiscal variables in Euros (prices of 2000). Source: Statistical Office of Baden-Wuerttemberg and own calculations.

Table 6.2: Tax and public input competition, system estimation using $W^{15\text{km}}_{\text{pop adj}}$

Cross section	1998		2000		2002		2004	
Dependent variable	τ	s	τ	s	τ	s	τ	s
Neighbors' tax rate	0.196***	-731**	0.207***	-1055**	0.278***	68.4	0.314***	60.0
	(0.049)	(350)	(0.049)	(427)	(0.055)	(559)	(0.058)	(480)
Neighbors' public input	-0.000	0.178*	-0.000	0.507***	0.000	0.237**	0.000	0.148
	(0.000)	(0.095)	(0.000)	(0.096)	(0.000)	(0.124)	(0.000)	(0.108)
Own tax rate	-	3190***	-	2396***	-	-2176**	-	-171
		(801)		(924)		(1057)		(772)
Own public input	0.00002***	-	0.00001***	-	0.000	-	-0.000	-
	(4D-06)		(4D-06)		(0.000)		(0.000)	
Marg. contr. rate	0.098***	-810***	0.091***	-523	0.065**	342	0.088***	-469*
	(0.029)	(302)	(0.026)	(318)	(0.030)	(426)	(0.030)	(276)
Uncond. transfers	-0.00002***	0.241***	-0.00002***	0.175**	-0.00002***	0.199**	-0.00004***	0.215***
	(7D-06)	(0.070)	(6D-06)	(0.075)	(7D-06)	(0.097)	(8D-06)	(0.075)
Fiscal capacity	-0.001	46.0***	-0.002*	87.7***	-0.002*	95.7***	-0.004***	52.8***
	(0.001)	(13.5)	(0.001)	(14.4)	(0.001)	(15.7)	(0.001)	(10.5)
Specific grants	-	0.995***	-	1.05***	-	1.30***	-	1.12***
for local roads		(0.044)		(0.051)		(0.047)		(0.037)
Other specific	0.00001*	-0.005	0.000	0.025	0.000	0.010	0.00002**	0.004
grants	(7D-06)	(0.071)	(0.000)	(0.073)	(0.000)	(0.078)	(7D-06)	(0.060)
Debt service	0.00005***	-0.112	0.00004***	-0.153**	0.00004***	-0.100	0.00002***	-0.116**
	(6D-06)	(0.072)	(6D-06)	(0.074)	(5D-06)	(0.078)	(5D-06)	(0.049)
Unemployment	-1.01***	194	-1.27***	265	-1.50***	-70.3	-1.23***	166
	(0.266)	(147)	(0.316)	(200)	(0.344)	(280)	(0.337)	(186)
Population	0.0002***	0.119	0.0002***	0.309	0.0002***	1.02**	0.0002***	0.625**
(1,000s)	(0.00002)	(0.272)	(0.00002)	(0.308)	(0.00002)	(0.418)	(0.00002)	(0.274)
Pop. density	0.000	-22.1**	0.001	-18.1*	0.000	-6.59	0.000	-7.80
	(0.000)	(9.25)	(0.001)	(10.1)	(0.000)	(11.6)	(0.000)	(8.17)
% pop. $<$ 16 years	-0.005	-42.8	-0.004	25.6	-0.005	40.6	-0.015	212*
	(0.012)	(120)	(0.012)	(138)	(0.012)	(165)	(0.014)	(127)
% pop. $>$ 65 years	-0.272**	-37.8	-0.187*	-112	-0.075	50.4	-0.089	140
	(0.111)	(98.3)	(0.111)	(109)	(0.111)	(124)	(0.118)	(88.2)
% church members	-0.132***	-	-0.114***	-	-0.115***	-	-0.109***	-
	(0.028)		(0.026)		(0.029)		(0.032)	
% church members$\times$	1.07***	-	1.32***	-	1.57***	-	1.28***	-
unemployment	(0.295)		(0.352)		(0.383)		(0.374)	
% church members$\times$	0.308**	-	0.219*	-	0.108	-	0.107	-
% pop. $>$ 65 years	(0.123)		(0.123)		(0.123)		(0.130)	
R^2	0.20	0.37	0.20	0.37	0.20	0.43	0.17	0.49
F-tests of excluded IVs:								
τ_{-i}	110.3	215.7	105.4	199.6	73.6	133.9	94.1	115.0
s_{-i}	77.7	91.2	95.6	104.1	68.0	65.4	49.8	54.7
Own tax rate	-	5.0	-	5.8	-	6.9	-	5.4
Own public input	7.3	-	8.7	-	7.7	-	16.6	-

Sample includes all municipalities up to independent cities, Nob=1100. Spatial metric for constructing τ_{-i} and s_{-i} is $W^{15\text{km}}_{\text{pop adj}}$ (see notes in Table 6.5 for details). Standard errors in parentheses. R^2 is from the third step of the estimation procedure (2SLS after taking account of spatial error correlation). F-tests of excluded IVs are from first-stage regressions of the 2SLS estimation in the third step of the estimation procedure. Significance levels: * 10%; ** 5%; *** 1%.

Table 6.3: Tax and public input competition, system estimation using $W^{10\,\text{nearest}}_{\text{pop adj}}$

Cross section	1998		2000		2002		2004	
Dependent variable	τ	s	τ	s	τ	s	τ	s
Neighbors' tax rate	0.158***	-678*	0.177***	-796*	0.212***	-604	0.213***	-1412***
	(0.041)	(398)	(0.040)	(481)	(0.040)	(503)	(0.044)	(373)
Neighbors' public input	-0.000	0.086	0.000	0.389***	0.00001*	0.134	-0.000	0.217***
	(0.000)	(0.072)	(0.000)	(0.075)	(7D-06)	(0.086)	(0.000)	(0.080)
Own tax rate	-	3039***	-	1276	-	-560	-	3283***
		(821)		(923)		(1066)		(800)
Own public input	0.00002***	-	0.00001*	-	0.000	-	0.000	-
	(4D-06)		(4D-06)		(0.000)		(0.000)	
Marg. contr. rate	0.089***	-774**	0.080***	-470	0.089***	120	0.098***	-763***
	(0.028)	(303)	(0.025)	(323)	(0.029)	(433)	(0.029)	(289)
Uncond. transfers	-0.00002***	0.225***	-0.00002***	0.170**	-0.00002***	0.265***	-0.00004***	0.304***
	(7D-06)	(0.071)	(6D-06)	(0.073)	(7D-06)	(0.09)	(8D-06)	(0.080)
Fiscal capacity	-0.001	45.7***	-0.003**	85.2***	-0.003**	100***	-0.004***	62.4***
	(0.001)	(13.4)	(0.001)	(14.2)	(0.001)	(15.5)	(0.001)	(10.6)
Specific grants	-	0.999***	-	1.05***	-	1.30***	-	1.10***
for local roads		(0.045)		(0.051)		(0.047)		(0.038)
Other specific	0.00001*	-0.004	0.00001*	0.064	0.00001*	0.003	0.00001*	-0.060
grants	(7D-06)	(0.071)	(6D-06)	(0.073)	(6D-06)	(0.078)	(7D-06)	(0.062)
Debt service	0.00004***	-0.096	0.00004***	-0.089	0.00003***	-0.153**	0.00002***	-0.194***
	(6D-06)	(0.072)	(6D-06)	(0.074)	(5D-06)	(0.077)	(5D-06)	(0.048)
Unemployment	-0.961***	189	-1.10***	187	-1.18***	93.7	-0.913***	425***
	(0.264)	(140)	(0.312)	(183)	(0.334)	(248)	(0.316)	(157)
Population	0.0002***	0.169	0.0002***	0.315	0.0002***	0.585	0.0002***	0.027
(1,000s)	(0.00002)	(0.267)	(0.00002)	(0.275)	(0.00002)	(0.3759)	(0.00002)	(0.272)
Pop. density	0.000	-26.8***	0.000	-22.8**	-0.000	-12.7	-0.000	-12.3
	(0.000)	(8.45)	(0.000)	(9.29)	(0.000)	(10.5)	(0.000)	(7.56)
% pop. < 16 years	-0.003	-9.84	-0.000	51.8	-0.001	80.9	-0.007	241*
	(0.012)	(118)	(0.011)	(136)	(0.012)	(163)	(0.014)	(128)
% pop. > 65 years	-0.248**	-7.39	-0.198*	-52.5	-0.094	77.1	-0.025	115
	(0.110)	(97.0)	(0.110)	(107)	(0.109)	(120)	(0.112)	(87.8)
% church members	-0.124***	-	-0.106***	-	-0.100***	-	-0.077**	-
	(0.027)		(0.026)		(0.028)		(0.030)	
% church members×	1.02***	-	1.16***	-	1.25***	-	0.965***	-
unemployment	(0.294)		(0.349)		(0.372)		(0.351)	
% church members×	0.280**	-	0.229*	-	0.126	-	0.037	-
% pop. > 65 years	(0.122)		(0.122)		(0.121)		(0.124)	
R^2	0.21	0.38	0.22	0.39	0.22	0.45	0.21	0.48
F-tests of excluded IVs:								
τ_{-i}	77.0	76.1	76.3	63.2	69.0	63.4	88.6	93.7
s_{-i}	72.6	78.7	67.1	63.9	38.9	33.7	37.5	36.8
Own tax rate	-	4.9	-	5.8	-	5.7	-	4.1
Own public input	6.9	-	9.5	-	7.1	-	14.7	-

Sample includes all municipalities up to independent cities, Nob=1100. Spatial metric for constructing τ_{-i} and s_{-i} is $W^{10\,\text{nearest}}_{\text{pop adj}}$ (see notes in Table 6.5 for details). Standard errors in parentheses. R^2 is from the third step of the estimation procedure (2SLS after taking account of spatial error correlation). F-tests of excluded IVs are from first-stage regressions of the 2SLS estimation in the third step of the estimation procedure. Significance levels: * 10%; ** 5%; *** 1%.

Table 6.4: Tax and public input competition, system estimation after between-transformation

Spatial metric	$W^{15km}_{pop\,adj}$		$W^{10\,nearest}_{pop\,adj}$	
Dependent variable	τ	s	τ	s
Neighbors' tax rate	0.263***	-387	0.211***	-505*
	(0.050)	(352)	(0.039)	(263)
Neighbors' public input	-0.000	0.328***	-0.000	0.215***
	(0.000)	(0.081)	(0.000)	(0.060)
Own tax rate	-	1658***	-	1591**
		(568)		(632)
Own public input	0.00002***	-	0.00001***	-
	(5D-06)		(5D-06)	
Marginal contribution rate	0.098***	-372	0.093**	-438
	(0.037)	(278)	(0.036)	(282)
Unconditional transfers	-0.00003***	0.261***	-0.00003***	0.259***
	(7D-06)	(0.054)	(7D-06)	(0.057)
Fiscal capacity	-0.002	87.7***	-0.003**	84.7***
	(0.002)	(11.7)	(0.001)	(11.8)
Specific grants for local roads	-	1.17***	-	1.17***
		(0.044)		(0.044)
Other specific grants	0.00001*	0.016	0.00001*	0.019
	(7D-06)	(0.047)	(6D-06)	(0.048)
Debt service	0.00004***	-0.166***	0.00004***	-0.153***
	(6D-06)	(0.050)	(6D-06)	(0.050)
Unemployment	-1.41***	179	-1.15***	232*
	(0.314)	(147)	(0.306)	(134)
Population (1,000s)	0.0002***	0.133	0.0002***	0.198
	(0.00002)	(0.203)	(0.00002)	(0.228)
Pop. density	0.000	-8.43	0.000	-15.8**
	(0.000)	(6.38)	(0.000)	(6.19)
% pop. $<$ 16 years	-0.010	90.6	-0.004	109
	(0.013)	(94.7)	(0.013)	(94.6)
% pop. $>$ 65 years	-0.141	-4.47	-0.135	25.8
	(0.108)	(70.3)	(0.107)	(69.6)
% church members	-0.127***	-	-0.109***	-
	(0.028)		(0.027)	
% church members×unemployment	1.47***	-	1.21***	-
	(0.349)		(0.340)	
% church members×% pop. $>$ 65 years	0.165	-	0.158	-
	(0.120)		(0.118)	
R^2	0.22	0.48	0.22	0.39
F-tests of excluded IVs:				
τ_{-i}	108.2	149.1	81.2	91.1
s_{-i}	124.0	123.8	83.5	79.9
Own tax rate	-	6.3	-	6.0
Own public input	15.9	-	16.5	-

Sample includes observations for all municipalities up to independent cities after between-transformation using years 1998, 2000, 2002, and 2004, Nob=1100. Standard errors in parentheses. R^2 is from the third step of the estimation procedure (2SLS after taking account of spatial error correlation). F-tests of excluded IVs are from first-stage regressions of the 2SLS estimation in the third step of the estimation procedure. Significance levels: * 10%; ** 5%; *** 1%.

Table 6.5: Neighbors' tax rates and infrastructure spending for different spatial metrics, year 2000

	Mean		Std. Dev.		Min		Max	
Spatial metric	τ_{-i}	s_{-i}	τ_{-i}	s_{-i}	τ_{-i}	s_{-i}	τ_{-i}	s_{-i}
$W^{15\text{km}}_{\text{uniform}}$	0.167	140	0.0030	31.3	0.160	76.3	0.177	253
$W^{15\text{km}}_{\text{inverse}}$	0.167	139	0.0032	33.6	0.159	68.8	0.182	329
$W^{10\,\text{nearest}}_{\text{uniform}}$	0.167	139	0.0034	37.4	0.157	66.0	0.181	332
$W^{10\,\text{nearest}}_{\text{inverse}}$	0.167	139	0.0036	40.6	0.156	66.9	0.182	465
$W^{15\text{km}}_{\text{pop adj}}$	0.171	147	0.0068	28.9	0.160	83.7	0.198	281
$W^{10\,\text{nearest}}_{\text{pop adj}}$	0.169	146	0.0066	35.4	0.156	72.0	0.204	326

$W^{15\text{km}}_{\text{uniform}}$: Municipalities with distance <15km defined as neighbors, weights uniform. $W^{15\text{km}}_{\text{inverse}}$: Municipalities with distance <15km defined as neighbors, weights based on inverse distance. $W^{10\,\text{nearest}}_{\text{uniform}}$: 10 geographically closest municipalities defined as neighbors, weights uniform. $W^{10\,\text{nearest}}_{\text{inverse}}$: 10 geographically closest municipalities defined as neighbors, weights based on inverse distance. $W^{15\text{km}}_{\text{pop adj}}$: Municipalities with distance <15km defined as neighbors, weights based on relative population size. $W^{10\,\text{nearest}}_{\text{pop adj}}$: 10 geographically closest municipalities defined as neighbors, weights based on relative population size. All weight matrices are row-standardized.

Table 6.6:

Selected parameter estimates for different spatial metrics

			$W^{15km}_{uniform}$							$W^{15km}_{inverse}$			
Year	λ_τ	φ_τ	θ_τ	λ_s	φ_s	θ_s	Year	λ_τ	φ_τ	θ_τ	λ_s	φ_s	θ_s
1998	0.68***	-	0.00001***	-3643***	0.22**	5307***	1998	0.73***	-	0.00001***	-2497*	0.20**	3584***
1999	0.72***	-	-	-	0.32***	-	1999	0.73***	-	-	-	0.31***	-
2000	0.77***	-	0.00001*	-3225**	0.53***	4127***	2000	0.74***	-	-	-	0.53***	-
2001	0.72***	-	-	-3389*	0.38***	4194**	2001	0.75***	-	-	-	0.32***	3105*
2002	0.85***	-	-	-	0.38***	-	2002	0.87***	-	-	-	0.31***	-
2003	0.71***	0.00001**	-	-7091***	-	6658***	2003	0.77***	0.00001**	-	-10092***	-	9554***
2004	0.94***	-	-	-6560***	0.21**	7378***	2004	0.93***	-	-	-7963***	-	8549***
			$W^{10\,nearest}_{uniform}$							$W^{10\,nearest}_{inverse}$			
Year	λ_τ	φ_τ	θ_τ	λ_s	φ_s	θ_s	Year	λ_τ	φ_τ	θ_τ	λ_s	φ_s	θ_s
1998	0.57***	-	0.00001**	-	-	-	1998	0.55***	-	0.00001**	-	-	-
1999	0.54***	-	-	-	0.19***	-	1999	0.53***	-	-	-	0.17***	-
2000	0.54***	-	-	-	0.46***	-	2000	0.53***	-	-	-	0.42***	-
2001	0.56***	0.00001*	-	-	0.24***	-2505*	2001	0.57***	0.00001*	-	-	0.20***	-
2002	0.70***	0.00001**	-	-	0.22***	-	2002	0.71***	0.00001**	-	-	0.21***	-
2003	0.58***	0.00001**	0.00001*	-	-	-2765*	2003	0.60***	0.00001*	-	-	-	-
2004	0.77***	-	0.00001*	-6812***	0.18**	7703***	2004	0.78***	-	0.00001*	-8853***	0.13*	9613***
			$W^{15km}_{pop\,adj}$							$W^{10\,nearest}_{pop\,adj}$			
Year	λ_τ	φ_τ	θ_τ	λ_s	φ_s	θ_s	Year	λ_τ	φ_τ	θ_τ	λ_s	φ_s	θ_s
1998	0.19***	-	0.00001***	-731**	0.17*	3190***	1998	0.15***	-	0.00001***	-678*	-	3039***
1999	0.20***	-	0.00001***	-741*	0.25***	-	1999	0.14***	-	0.00001**	-	0.14*	-
2000	0.20***	-	0.00001***	-1005**	0.50***	2396***	2000	0.17***	-	0.00001*	-796*	038***	-
2001	0.22***	-	-	-862**	0.37***	1702*	2001	0.15***	-	-	-	0.25***	-
2002	0.27***	-	-	-	0.23*	-2176**	2002	0.21***	0.00001*	-	-	-	-
2003	0.22***	-	-	-	0.40***	-	2003	0.18***	-	-	-	-	-
2004	0.31***	-	-	-	-	-	2004	0.21***	-	-	-1412***	0.21***	3283***

For definitions of spatial metrics, see Table 6.5. Bars (-) indicate that the coefficient is not statistically different from zero at the 10% level of significance. * significant at 10% level; ** significant at 5% level; *** significant at 1% level.

Conclusion

So, what do I make of all this? In a wide sense, my work on this dissertation has taught me just how many ways and channels there are, even in simple settings, through which taxes that are set in policy competition affect economic actors and their behavior, and how ample the realm of immediate and oblique impacts (and hence the scope of their purpose) is. International taxation is a fascinating field of study precisely because it features two traits: On the one hand, competition from a different country has a bearing on the feasibility of optimal policy, as illustrated, e.g., by Chapter 5. This is the standard, well-examined competition effect with all the ensuing externalities that arise when non-cooperative solutions are reached. But on the other hand, things like, for instance, the subsidy-induced outsourcing to circumvent a labor market distortion from Chapter 3, are possible via taxes, and roles can be played by them, that are not even conceivable in closed economies. I have built on a large literature that is centered around the question how governments are constrained in their tax policy-choosing behavior in a world where integration is becoming ever deeper in goods and factor markets (above all the capital market); and I have put emphasis on the question how this is related to labor market distortions, on which a huge, different body of work exists.

Obviously, the questions asked and the tools and methods used to analyze the topics in question in this dissertation vary rather widely, and this is definitely not a place where I want to repeat all the findings. This whole project has shown roles for taxes that go far beyond what typically comes to one's mind firstly when thinking about subsidies and business or commodity taxes. In the different chapters, taxes first rather conventionally serve as a way to attract a new competitor to a concentrated market - duly taking into account how this affects existing industry. They are then used as a strategic device to give a labor market institution an incentive to behave in a way that is desirable from the viewpoint of the governments, in a setting where the latter are using a subsidy to compete for mobile capital. In this interpretation, Chapter 2's taxes are like a deal offer to a trade union. Chapter 3 then shows how a unionized country's tax can be interpreted as an offer to the other country – so, taxes play their efficiency-enhancing role in another way: This time the union is not tamed, but outplayed in that production moves to a non-unionized location, whose tax rate is strategically pushed down to the benefit of the unionized one. The story then goes on in that the next part, Chapter 4, shows yet another role for taxes: They are theoretically predicted and empirically shown to compensate firms for wage differentials. In that way, they present an offer to firms. In a somewhat bold reduction, one could say that a labor market distortion, typically very difficult to tackle directly, may be addressed with tax and subsidy policies by taming a union, outplaying it or by compensating firms. To the extent to which tax competition is a partial remedy to a labor market distortion, it is clearly advantageous, especially in view of experiences that direct approaches, otherwise preferable, are often hard to implement. So an insight that may be helpful for policymakers is that lowered business taxes may well have reasons and purposes that go beyond the simple 'competing for capital' story.

With those little bits and pieces pulled together, it becomes clear what an eminent role labor market distortions play in tax competition. Imperfect goods markets have been analyzed for a while in this context, but I think there is a lot of work to be done, of both theoretical and then definitely also empirical nature, on how tax competition in various fields influences and is fed back on by labor market institutions and distortions. Chapter 3 has already given a first glance at my expectance that a lot will depend on how important efficiency aspects will be relative to distributional issues. This arguably not only differs across countries, but also across sectors. In light of the importance that is given to labor market distortions and especially their consequences like unemployment by politicians and the general public, it is astounding that there is not more work on this. After all, a badly working labor market has the spiny property of at the same time making the marginal value of an inflow of capital larger (in a 'real' and a 'political economy' sense) and the government budget leeway smaller. Europe today, with its integrated capital market and countries which differ in size, labor costs, labor market institutions and, at least for the time being, business and commodity tax regimes, seems a fascinating playing field for policy analysis, with many policy-relevant practical questions to be addressed, modelled and later estimated. It would be especially promising when one could empirically disentangle to which extent lowered business taxes increase the scope for high-wage policies, and to which extent unions increasingly view themselves as competitors for mobile capital, aligning their interests to governments' at least in this respect.

Another point this dissertation has made is just how important and influential ownership structures can be in competition for mobile capital, as well as in goods taxation. To the extent that globalization leads to more and more firms (or greater percentages of their stock) being owned by foreigners, the likelihood that any two competing governments will disregard them goes up. In Chapter 1, I have shown that not owning 'its' industry may make a government more likely to attract FDI, even without any lobbying by home industry involved; Chapter 5 shows how foreign ownership of firms can render otherwise optimal regulation relatively inefficient. Again, Europe will be an interesting place to watch as with the free movement of capital in an integrated market, more and more capital can be expected to be by in non-residents' hands. This thesis has shown this will not only be relevant in capital, but also in commodity taxation.

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Curriculum Vitae

PERSÖNLICHE ANGABEN

Name:	Ferdinand Mittermaier
Geburtsdatum:	17. März 1982
Geburtsort:	München
Staatsangehörigkeit:	Deutsch

SCHULISCHER WERDEGANG

1988 - 1992	Grundschule Helfendorf, Aying
1992 - 2001	Gymnasium Ottobrunn, Landkreis München; Abitur (Note 1,0)

AKADEMISCHER WERDEGANG

2002 - 2006	Studium der Volkswirtschaftslehre Ludwig–Maximilians-Universität München Diplom-Volkswirt (Note 1,1)
seit 11 / 2006	Wissenschaftlicher Mitarbeiter am Seminar für Wirtschaftspolitik der Ludwig–Maximilians-Universität München/ Stipendiat des Bavarian Graduate Program in Economics
2004 - 2005	ERASMUS-Student an der University of Southampton, UK
2008	Visiting PhD-Student an der Simon Fraser University, BC, Kanada

SONSTIGES

2001-2002	Zivildienst im Haus Hoheneck (Pflegeheim), Aschbach, Landkreis Rosenheim